**TSG-RAN Meeting #10**　　　　　　　　　　　　　　　　　　　　　　*RP-000566*
**Bangkok, Thailand, 6 - 8 December 2000**

**Title:**　　　　　**Agreed CRs to TS 25.305**

**Source:**　　　　**TSG-RAN WG2**

**Agenda item:　5.2.3**

| Doc-1st- | Status- | Spec | CR | Rev | Subject | Cat | Version | Versio |
|---|---|---|---|---|---|---|---|---|
| R2-002097 | agreed | 25.305 | 025 | 1 | Editorial and Minor Technical Clean-up | F | 3.3.0 | 3.4.0 |
| R2-001977 | agreed | 25.305 | 026 |  | Editorial corrections | F | 3.3.0 | 3.4.0 |
| R2-001978 | agreed | 25.305 | 027 |  | Removal of SoLSA concepts | F | 3.3.0 | 3.4.0 |
| R2-002050 | agreed | 25.305 | 029 | 1 | Signalling flows on Iub and Iur | F | 3.3.0 | 3.4.0 |
| R2-002106 | agreed | 25.305 | 030 | 1 | LCS functionality during SRNS relocation | F | 3.3.0 | 3.4.0 |
| R2-002005 | agreed | 25.305 | 031 |  | UE Search Correction from R2-001721 (CR 021r3) | F | 3.3.0 | 3.4.0 |
| R2-002104 | agreed | 25.305 | 032 | 2 | Signaling Between RNC and Stand-Alone LMU | F | 3.3.0 | 3.4.0 |
| R2-002416 | agreed | 25.305 | 033 | 5 | Use of RTT measurements in the Assisted GPS procedure | F | 3.3.0 | 3.4.0 |
| R2-002100 | agreed | 25.305 | 034 | 1 | LCS assistance data delivery | F | 3.3.0 | 3.4.0 |
| R2-002422 | agreed | 25.305 | 035 | 2 | Description for frequency reference | F | 3.3.0 | 3.4.0 |
| R2-002414 | agreed | 25.305 | 036 | 2 | Editorial clean-up | F | 3.3.0 | 3.4.0 |
| R2-002415 | agreed | 25.305 | 038 | 2 | Clarification on information to be transferred between UTRAN nodes | F | 3.3.0 | 3.4.0 |
| R2-002420 | agreed | 25.305 | 039 | 1 | Moving of semantic descriptions from RRC | F | 3.3.0 | 3.4.0 |

## 3GPP TSG-RAN WG2 Meeting #16
## Bejing, China; October 9-13, 2000

**Document** **R2-002097**

*e.g. for 3GPP use the format    TP-99xxx*
*or for SMG, use the format    P-99-xxx*

# CHANGE REQUEST

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**25.305** **CR** **025r1**    Current Version: **3.3.0**

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑*    *↑ CR number as allocated by MCC support team*

| For submission to: | TSG-RAN #10 | for approval | **X** | strategic | | *(for SMG* |
|---|---|---|---|---|---|---|
| *list expected approval meeting # here* ↑ | | for information | | non-strategic | | *use only)* |

*Form: CR cover sheet, version 2 for 3GPP and SMG*    *The latest version of this form is available from:* ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

**Proposed change affects:** (U)SIM ☐    ME **X**    UTRAN / Radio **X**    Core Network ☐
*(at least one should be marked with an X)*

**Source:** TSG-RAN WG2    **Date:** October 9, 2000

**Subject:** Editorial and Minor Technical Clean-up

**Work item:**

**Category:**    F  Correction    **X**    **Release:**    Phase 2 ☐
    A  Corresponds to a correction in an earlier release ☐        Release 96 ☐
*(only one category*    B  Addition of feature ☐        Release 97 ☐
*shall be marked*    C  Functional modification of feature ☐        Release 98 ☐
*with an X)*    D  Editorial modification ☐        Release 99 **X**
            Release 00 ☐

**Reason for change:** Readability and technical clarity

**Clauses affected:** 4.4, 5.3.2.1, 6.1, 6.6.4.1, 6.6.4.1.3, 10.4, 10.5.2

| **Other specs** | Other 3G core specifications | ☐ | → | List of CRs: | |
|---|---|---|---|---|---|
| **affected:** | Other GSM core specifications | ☐ | → | List of CRs: | |
| | MS test specifications | ☐ | → | List of CRs: | |
| | | ☐ | → | List of CRs: | |
| | O&M specifications | ☐ | → | List of CRs: | |

**Other comments:** Revision 1 text changes shown in yellow shading.

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*3GPP*

*< NEXT MODIFIED SECTION >*

# 4.4 Standard LCS Methods

The standard LCS methods supported within UMTS are:.:

- cell ID based method;

- OTDOA method with network configurable idle periods (the idle period configurability is to be specified in the specification); and

- network assisted GPS methods.

NOTE: GPS based solutions are being standardised in T1P1; it is intended that the UTRAN navigational assisted solution will be synergistic with the work in T1P1.

*< NEXT MODIFIED SECTION >*

## 5.3.2.1 UTRAN Location System Control Function (U-LSCF)

The UTRAN Location System Control Function in RNC is responsible for co-ordinating location requests within the RNC handling entity. This function manages call-related and non-call-related location requests and allocates network resources for handling them. This function "insulates" the Location clients in the Core Network from the detailed operation of the location method in order that the UTRAN may be used by several types of core network and with several location methods.

The U-LSCF provides flow …

*< NEXT MODIFIED SECTION >*

# 6.1 LCS signalling between SRNC and MSC/SGSN

LCS signalling between SRNC and MSC/SGSN is handled through the Iu interface, which is described in clause 6.6.36.6.1.

## < NEXT MODIFIED SECTION >

*Editing note:    In figure 6.1, "4. RRC Measurement Report" has been changed to "2. RRC Measurement Report.*

## 6.6.4.1    Signalling between S-RNC and Target UE

LCS related signalling between an S-RNC and a target UE is supported by the RRC protocol.

The location Request to UE signalling flow is generic for all UE based or assisted location methods (OTDOA and Network Assisted GPS).
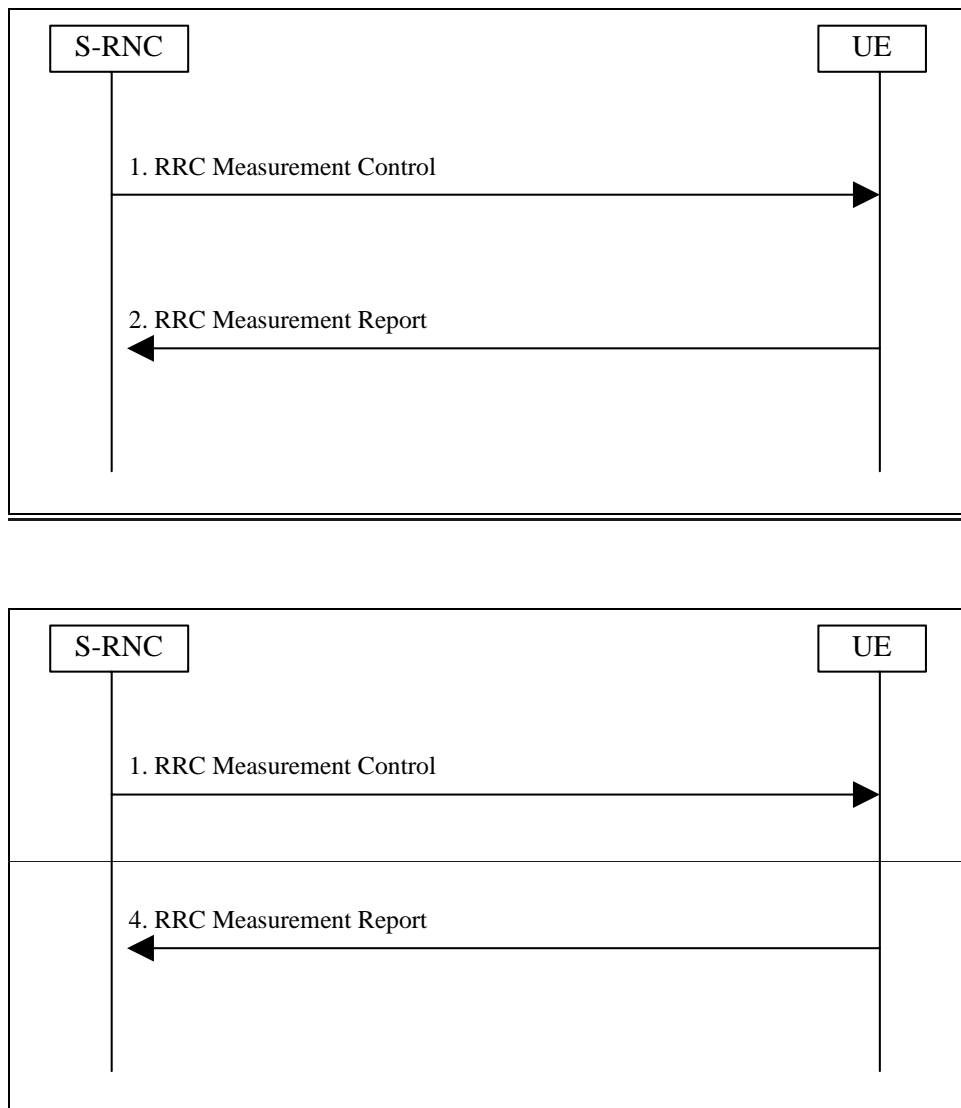




**Figure 6.1: OTDOA /GPS Location Message Flow**

1. The S-RNC determines possible assistance data and sends a MEASUREMENT CONTROL request to the UE.

2. Provided that the location request meets the privacy criteria, the UE performs the requested measurements. If the UE is able to calculate its own location, and this is requested, the UE computes a location estimate based on measurements. Any assistance data necessary to perform these operations will either be provided in the MEASUREMENT CONTROL request or be available from broadcast sources. The resulting measurements or location estimate are returned to UTRAN in a MEASUREMENT REPORT response. If the UE cannot fulfil the request, a MEASUREMENT CONTROL FAILURE message is returned.

*< NEXT MODIFIED SECTION >*

### 6.6.4.1.3 Broadcast of Assistance Data

In the UE Based OTDOA or Network Assisted GPS methods, where the measurements and/or location calculation is done in the UE, assistance data may be broadcast to the UE.

The assistance data to be broadcast for UE Based OTDOA contains the Relative Time Difference (RTD) values (e.g. in case of a non-synchronised network) and base station co-ordinates. In addition, the broadcast data may contain other information to simplify the OTDOA measurements. The length of the message depends on how many neighbours are included in the assistance data. Part of the broadcast message (e.g. the serving and neighbour base station geographic co-ordinates) may be ciphered.

The assistance data to be broadcast for assisted GPS may contains a subset of or all of the following information: reference time, reference location, DGPS corrections, ephemeris and clock corrections, or as well as and almanac and other data. Part of the broadcast message may be ciphered.

The broadcast channel that is used for the OTDOA and GPS assistance data makes use of the common UTRAN broadcast service.

*< NEXT MODIFIED SECTION >*

## 10.4   UE search

Provided that timing and/or data assistance is available in the UE, they should be applied in the GPS signal search procedure. UE search procedure involves a three-dimensional search for a satellite PRN (pseudorandom) code, time of arrival of a signal and the associated carrier Doppler.

"Modulation wipe-off" is defined here to mean a removal of the GPS navigation data bit modulation to GPS signals received at the UE, through the application of UTRAN timing and data assistance provided from the UTRAN to the UE. This process allows the UE to coherently integrate received GPS signals beyond 1 data bit period (i.e., 20 milliseconds).

*< NEXT MODIFIED SECTION >*

## 10.5.2   UE-assisted method

In the UE-assisted method, the UE employs a reduced complexity GPS receiver functionality. This carries out the pseudorange (code phase) measurements. These are signalled, using higher layer signalling, to the specific network element that estimates the location of the UE and carries out the remaining GPS operations. In this method, accurately timed code phase signalling (as specified in [17] and [18]) is required on the downlink. If DGPS is performed in the UE, then differential corrections must be signalled to it. On the other hand, DGPS corrections can be applied to the final result in the network to improve the location accuracy without extra signalling to the UE.

The following information may be signalled from the UTRAN (LSIF) to the UE:

- number of satellites for which assistance is provided;

- reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]);

- satellite ID for identifying the satellites for which the assistance is provided;

- doppler ($0^{th}$ order term);

- Doppler Search Window width;

- doppler ($1^{st}$ order term);

- code phase;

- code phase centre and Search Window width;

- ephemeris;

- almanac;

- azimuth;

- elevation.

The following information may be signalled from the UE to the UTRAN (LSIF):

- reference time for GPS ($T_{UE-GPS}$) (specified in [17] and [18]);

- number of Pseudoranges;

- SVID;

- satellite C/No;

- doppler;

- satellite Code Phase;

- multipath indicator;

- pseudorange RMS Error.

Additional parameters, …

*Document* **R2-001977**

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*or for SMG, use the format   P-99-xxx*

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| 25.305 | CR | 026 | | Current Version: | 3.3.0 |
|---|---|---|---|---|---|

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑*          *↑ CR number as allocated by MCC support team*

For submission to:   TSG-RAN #10      for approval   **X**                strategic ☐   *(for SMG*
*list expected approval meeting # here*                for information ☐          non-strategic ☐   *use only)*
↑

*Form: CR cover sheet, version 2 for 3GPP and SMG*      *The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

**Proposed change affects:**     (U)SIM ☐     ME **X**     UTRAN / Radio **X**     Core Network ☐
*(at least one should be marked with an X)*

**Source:**          TSG-RAN WG2                                          **Date:**   08.10.2000

**Subject:**         Editorial corrections

**Work item:**

**Category:**     F   Correction                                                    **X**     **Release:**     Phase 2        ☐
                  A   Corresponds to a correction in an earlier release     ☐                  Release 96      ☐
*(only one category*   B   Addition of feature                                      ☐                  Release 97      ☐
*shall be marked*   C   Functional modification of feature                 ☐                  Release 98      ☐
*with an X)*       D   Editorial modification                                   ☐                  Release 99      **X**
                                                                                                        Release 00      ☐

| **Reason for change:** | Several editorial changes were made, including: |
|---|---|
| | • The figure in clause 8 was changed based on discussions in RAN WG2 #15 |
| | • "MS" is replaced by "UE" |
| | • Usage of terms Node B, SRNC and DRNC clarified |

| **Clauses affected:** | 4.1, 4.4.1, 5, 5.1, 5.2.1, 5.3, 5.3.3.1, 5.3.3.3, 5.4, 5.5.1.1, 5.5.1.2.1, 5.5.1.2.2, 5.5.3, 6.6.2, 6.6.3, 6.6.4, 6.6.4.1, 6.6.4.1.1, 8, 8.1, 8.1.1, 8.1.2.1,   8.1.2.2, 8.3, 9.6, Annex A |
|---|---|

| **Other specs affected:** | Other 3G core specifications | | → List of CRs: | |
|---|---|---|---|---|
| | Other GSM core specifications | | → List of CRs: | |

| | | | |
|---|---|---|---|
| MS test specifications | | → List of CRs: | |
| BSS test specifications | | → List of CRs: | |
| O&M specifications | | → List of CRs: | |

**Other comments:**

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<--------- double-click here for help and instructions on how to create a CR.

# 4.1 Assumptions

As a basis for the operation of LCS in UTRAN the following assumptions apply:

- the UE must support SFN-SFN observed time difference type 2 measurements, thus support of network based OTDOA without idle periods is mandatory in the UE.

- both, TDD and FDD will be supported in release '99;

- the provision of the location service in UTRAN is optional through support of the specified method(s) in Node-B and the CRNC;

- LCS is applicable to any target UE whether or not the UE supports LCS, but with restrictions on choice of location method or notification of a location request to the UE user when LCS or individual location methods, respectively, are not supported by the UE;

- RNC contains SMLC functionality and LCS information is transported between RNCs via the Iur interface;

- LCS shall be applicable for both circuit switched and packet switched services;

- the location information may be used for internal system operations to improve system performance;

- there are different types of LMU, e.g. a standalone LMU and/or LMU integrated in Node B;

- the location process shall include the option to accommodate several techniques of measurement and processing to ensure evolution to follow changing service requirements and to take advantage of advancing technology.

## 4.4.1 Cell ID Based Method

In the cell ID based (i.e. cell coverage) method the location of an UE is estimated with the knowledge of its serving Node-B. The information about the serving Node-B and cell may be obtained by paging, locating area update, cell update, URA update, or routing area update.

The cell coverage based location information can be indicated as the Cell Identity of the used cell, the Service area identity or as the geographical co-ordinates of a location related to the serving cell. The location information shall include a QoS estimate (e.g. regarding achieved accuracy).

When geographical co-ordinates are used as the location information, the estimated location of the UE can be a fixed geographical location within the serving cell (e.g. location of the serving Node-B), the geographical centre of the serving cell coverage area, or some other fixed location within the cell coverage area. The geographical location can also be obtained by combining information on the cell specific fixed geographical location with some other available information, such as the signal Round Trip Time (RTT) in FDD (as specified in [17]) or Rx Timing deviation measurement (as specified in [18]) and knowledge of the UE timing advance, in TDD.

The operation of the cell ID based location method is described in clause 8.

# 5 UTRAN LCS Architecture

Figure 5.1 shows the general arrangement of the Location Service feature. This illustrates, generally, the relation of LCS Clients and servers in the core network with the UTRAN. The definition and operation of LCS entities operating in the core network is outside the scope of the present document. The LCS entities within the UTRAN communicate with the Core Network (CN) across the Iu interface. Communication among the UTRAN LCS entities makes use of the messaging and signalling capabilities of the UTRAN.

As part of their service or operation, the LCS Clients may request the location information of User Equipment (UE) (UE without a valid SIM/USIM) or mobile stations. There may be more than one LCS client. These may be associated with the core network, associated with the UTRAN, operated as part of a UE application or accessed by the UE through its access to an application (e.g. through the Internet).

Within the UTRAN, typically the serving RNC, receives authenticated requests for LCS information from the core network across the Iu interface. LCS entities then manage the UTRAN resources, including the Node‑Bs (base stations), LMU, the UE and calculation functions, to estimate the location of the UE and return the result to the CN.
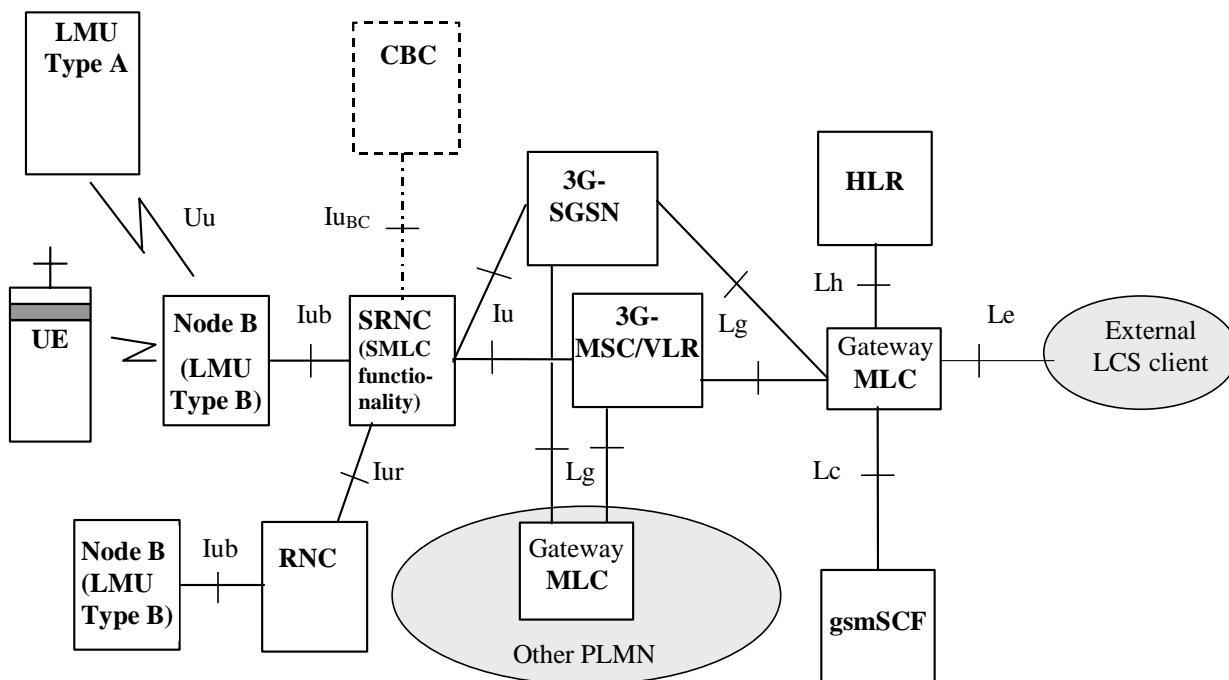


NOTE: This figure is taken from TS 23.002, Network Architecture.

**Figure 5.1: General arrangement of LCS in UMTS**

# 5.1 LCS Operations

The schematic functional description of LCS operations in UMTS is defined in [1].

Upon request from the UMTS LCS entities or for internal operations, the UTRAN LCS functional entities will:

- request measurements, typically from the UE and one or more Node‑B radio apparatus;

- send the measurement results to the appropriate calculating function within UTRAN;

- receive the result from the calculating function within UTRAN;

- perform any needed co-ordinate transformations;

- send the results to the LCS entities in the core network or to application entities within UTRAN.

In the event that the client is internal to UTRAN the request may be made directly to the UTRAN LCS entities as the internal clients are considered to be "pre-authorised".

As part of its operation, the UTRAN LCS calculating function may require additional information. This may be obtained by the function directly by communication with a database, or it may be through a request to UTRAN LCS entities that will mediate the request and return of information from the appropriate database (or databases if more than one is needed to fulfil the requests).

There may possibly also be available independent information that is able to supply the location information directly, or may be able to supply auxiliary information to the calculation function. The UTRAN LCS co-ordination function, as part of its activity to supervise the location process, may query the UE or other elements of the UTRAN to determine their capabilities and use this information to select the mode of operation.

This general operation is outlined in the following (generic) sequence diagram figure 5.2. This figure is not intended to show the complete LCS operation for UTRAN, but to simply to outline the basis for operation.
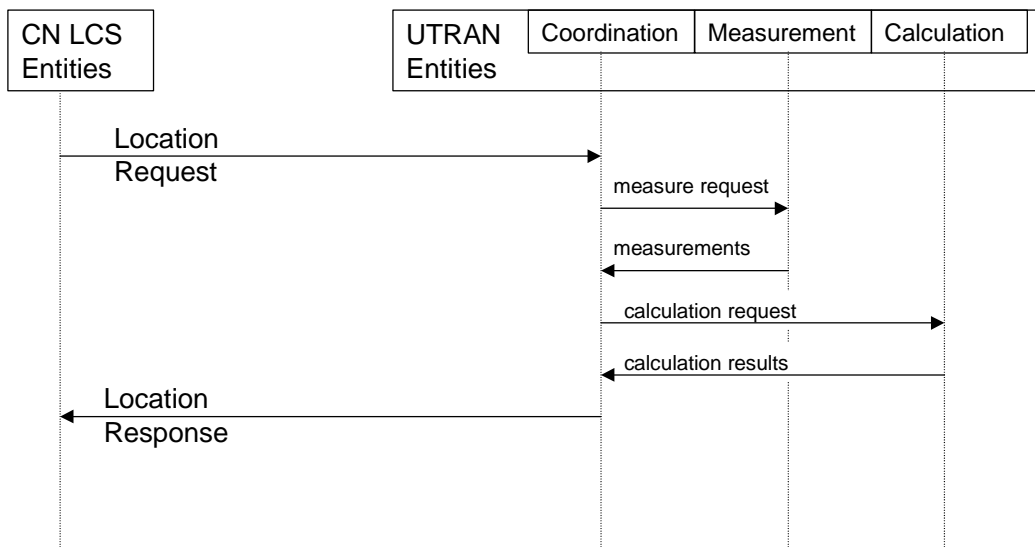


**Figure 5.2: General sequence for LCS operation**

## 5.2.1 Co-ordination, Measurement and Calculation Functions

These UTRAN functions (including functions in the System handling and Positioning groups) provide the co-ordination, measurement and calculation functions needed to provide a location estimate. The functions interface with the requesting application and select the appropriate location method and speed of response. The functions co-ordinate the operations of the radio and measurement equipment to transmit the needed signals and to make the needed measurements. The measurements may be made by Node -Bs, radio apparatus associated with the Node -B or separate Location Measurement Units (LMU) that may be associated with Node -B, independently located or remote (i.e. communicating over the Uu interface).

The functions may also access databases or other sources of information appropriate for the location method. The functions also provide the calculation functions appropriate for the location method to estimate the UE location and the accuracy of the report. The functions may also make co-ordinate translations to the geographic co-ordinate system requested by the application. The functions also may record information on the usage of the LCS that may be used for administrative purposes (e.g. forwarded to a billing function in the Core Network). If needed by the location method, the functions will ensure the broadcast of information and gather and update information concerning UTRAN operating parameters (e.g. timing of Node -B transmissions) needed for LCS operations.

These entities are mainly concerned with the location method, controlling the radio equipment and performing the calculations to determine the location and thus may be associated with the RNC in the UTRA access network. These functions may receive location requests from either the core network or from applications internal to the UTRAN.

The UTRAN LCS entities may also request the subscription and authorisation functions in the core network to authenticate an application or a UE subscription or to verify the subscriber privacy parameters.

These functions communicate with the core network across the Iu interface, with other entities in the UTRAN across the Iur interface and with the Node -B and LMU across the Iub interface and with the UE and the remote LMU across the Uu interface.

## 5.3 UTRAN LCS Functional Entities

The diagram of the UTRAN LCS functional entities is shown in figure 5.3. In this arrangement, the LCS clients in the core network communicate with the UTRAN LCS entities across the Iu interface. The LCS RNC Handling Entities and the Positioning Handing Entities work together with the UE to measure and calculate the location information for the requested target UE. These entities within the UTRAN are described in more detail in the following subclauses.

The figure shows the general arrangement of the Location Service feature in UTRAN. LCS entities are added to the UTRAN to provide the location service. Communication among these entities makes use of the messaging and signalling capabilities of the UTRAN across the Iu, Iur, Iub and Uu interfaces. A Location Measurement Unit (LMU) is also added to the UTRAN to make measurements as needed by the selected location method.

This figure does not include elements of the next generation mobile Core Network, but focuses on those that participate with the LCS functions in the UTRAN. The association of the LCS entities within the Core Network (CN) (e.g. with 3G-MSC or 3G-SGSN) is outside the scope of the present document and is not illustrated in the diagram.

Within the UTRAN, the LCS Entities may be associated with, or part of the RNC, the Node -B and the UE. Internal LCS Applications may also be part of the RNC and the UE.

The mobile position calculation function (PCF) is logically associated with the Serving RNC in UTRAN.

The LCS in UMTS also makes use of the standardised Iur interface between RNCs, when base station information, measurements and results are collected.

The functional model presented in the figure includes functional entities for UE utilising either or both circuit switched (CS) and packet switched (PS) services. This model also supports of all the entities needed for different location methods (e.g. network based, mobile based, mobile assisted, and network assisted (see note 1) methods) exploiting either uplink or downlink measurements.

NOTE 1: In this approach mobile station may use the GPS technique but still make use of auxiliary information from the serving network.

Implementations may often associate the UTRAN LCS Entities with an RNC (as illustrated in the figure). However, for networks with a small volume of LCS requests, the LCS Entities in the UTRAN may also be implemented as a separate element (server) which interfaces with the RNCs, and the Node -B/LMUs.

NOTE! The picture below has been changed: D-RNC replaced by DRNC, S-RNC replaced by SRNC and Node-B replaced by Node B.
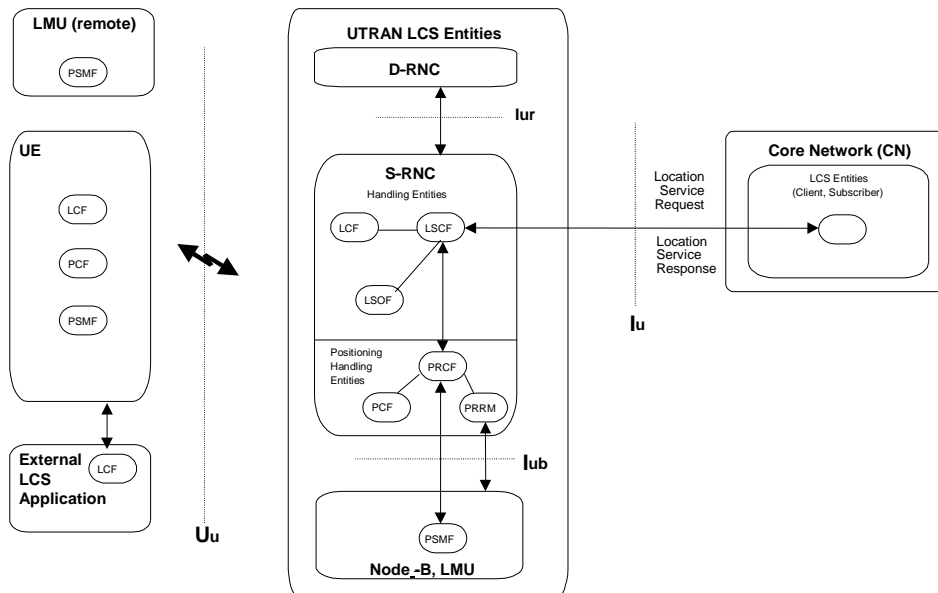


**Figure 5.3: UTRAN LCS Functional Entities**

## 5.3.3.1 UTRAN Position Radio Co-ordination Function (U-PRCF)

The UTRAN Position Radio Control Function manages a location request for a UE through overall co-ordination and scheduling of resources to perform location measurements. This function interfaces with the U-PSMF, the U-PRRM and the U-PCF. The U-PRCF determines the location method to be used based on the location request, the QoS, the capabilities of the UTRAN, and the UE's capabilities. The U-PRCF also manages the needed radio resources through the U-PRRM. It determines which U-PSMFs are to be involved, what to measure, and obtains processed signal measurements from the U-PSMF.

Some location methods may involve measurements made at the UE. In this case the U-PRCF interfaces with the UE to obtain the measurements (or the location results if they have been determined by the UE). Some location methods may involve measurements or information from several sources, including radio units at several Node -B (or other Location Measurement Units (LMU)) and involve a series of transmissions and receptions. The U-PRCF entity also provide ancillary measurements in case of network-assisted location method. Ancillary information may be extracted from navigating systems like GPS.

The U-PRCF forwards the signal measurement data to the U-PCF.

It is the function of the U-PRCF to co-ordinate the sequence of activities and compensate for failures (if they occur) to provide the location estimate.

### 5.3.3.3　　UTRAN Position Signal Measurement Function (U-PSMF)

The UTRAN Position Signal Measurement Function (U-PSMF) is responsible for performing and gathering uplink or downlink radio signal measurements for use in the calculation of a UE's location. These measurements can be location related or ancillary.

There may be one or more PSMF within a UTRAN and they may be located at the UE, the Node -B, or a separate Location Measurement Unit (LMU). The PSMF, generally, may provide measurement of signals (i.e. satellite signals) in addition to measurements of the UTRA radio transmissions. The measurements to be made will depend on the selected location method.

# 5.4　　Assignment of LCS Functional Entities to UTRAN Elements

The preceding figure 5.3 and the following table 5.1 show the generic configuration for different location methods, including network-based, mobile-based, mobile-assisted and network-assisted methods. With this approach both the network and the mobiles are able to measure the timing of signals and compute the mobile's location estimate. Depending on the applied location method it is possible to utilise the corresponding configuration containing all needed entities. For instance, if a network-based location method is applied, the entities that are involved in measuring the mobile's signal and calculating its location estimate are allocated to the network elements of the access stratum. On the other hand, in case mobile-based or network-assisted methods are used these entities should be allocated to the mobile station.

**Table 5.1: Example Allocation of LCS Functional Entities to Network Elements**

| U- | UE | Node -B | LMU | RNC |
|------|------|---------|-----|-----|
| LCF | X | | | X |
| LSCF | | | | X |
| PRCF | | | | X |
| PCF | X | | | X |
| PRRM | | | | X |
| PSMF | X | X | X | |
| LSOF | X | X | X | X |

# 5.5　　Functional Description of UTRAN LCS Network elements

## 5.5.1　　Radio Network Controller (RNC)

### 5.5.1.1　　Serving RNC

The Serving RNC (SRNC) is a network element of UTRAN and contains functionality required to support LCS in one PLMN.

The SRNC manages the overall co-ordination and scheduling of resources required for the location of a mobile. It also calculates the final location estimate and estimates the achieved accuracy.

The SRNC may control a number of LMUs for the purpose of obtaining radio interface measurements to locate or help locate MS UE subscribers in the area that it serves. The SRNC is administered with the capabilities and types of

measurement produced by each of its LMUs. Signalling between an SRNC and LMU is transferred using the Iub interface, sometimes the Iur interface. The following measurements returned by an LMU to an SRNC have a generic status in being usable for more than one location method:

- radio interface timing information.

The SRNC and GMLC are connected through the 3G-VMSC or 3G-SGSN. When the VMSC and GMLC are in different PLMNs, they are interconnected via the Lg interface.

### 5.5.1.2 Other RNC

#### 5.5.1.2.1 Controlling RNC

The Controlling RNC is a UTRAN element that has the role to control Node -Bs. The controlling RNC may ask its associated NodeBs and LMUs for LCS measurements. The measurement results are delivered from the LMUs to the Controlling RNC that then forwards the results to the serving RNC.

#### 5.5.1.2.2 Drift RNC

Drift RNC is a UTRAN element that has active link to the UE that shall be located. Drift RNC may ask its associated Node Bs for LCS measurements. The measurement results are delivered from the Node Bs and to the Drift RNC that then forwards the results to the serving RNC.

## 5.5.2 Node B

Node B is a network element of UTRAN that may provide measurement results for location estimation. It contains a PSMF and makes measurements of radio signals and communicates these measurements to the SRNC.

The Node B may make its measurements in response to requests (e.g. from the SRNC), or it may autonomously measure and report regularly or when there are significant changes in radio conditions (e.g. changes in the RTD).

## 5.5.3 Location measurement unit (LMU)

The LCS Measurement Unit (LMU) entity makes measurements (e.g. of radio signals) and communicates these measurements to the S-RNC (e.g. the PRCF). The LMU contains a PSMF and may also perform calculations associated with the measurements.

The LMU may make its measurements in response to requests (e.g. from the S-RNC (e.g. the PRCF)), or it may autonomously measure and report regularly (e.g. timing of Node -B transmissions) or when there are significant changes in radio conditions (e.g. changes in the RTD).

There may be one or more LMU associated with the UTRAN and an LCS request may involve measurements by one or more LMU. The LMU may be of several types and the S-RNC will select the appropriate LMUs depending on the LCS method being used.

The LMU may be used, for example, to measure UTRA transmissions either uplink or downlink. These measurements may be made either, for example, to locate the UE or to measure a system parameter needed by the LCS system such as the timing offset (RTD) of transmissions of two or more base stations. The LMU may also measure other transmissions, such as those of satellite navigation systems (i.e. the Global Position System (GPS)) and either report the measurements for use by the S-RNC (e.g. the PCF), or report the location results as determined by internal calculations of the LMU). The details of the measurements to be made by the LMU will be defined by the chosen LCS method.

An LMU makes radio measurements to support one or more location methods. These measurements fall into one of two categories:

(a) location measurements specific to one UE and used to compute its location;

(b) assistance measurements applicable to all UEs in a certain geographic area.

All location and assistance measurements obtained by an LMU are supplied to a particular S-RNC associated with the LMU. Instructions concerning the timing, the nature and any periodicity of these measurements are either provided by the S-RNC or are pre-administered in the S-RNC (e.g. using O&M).

There are two classes of LMU:

- **Stand-Alone LMU:** accessed over the UTRAN air interface;

- **Associated LMU:** accessed over the Iub interface.

The associated LMU signalling protocol is the NBAP. The protocol for stand-alone LMU signalling has not been defined yet.

NOTE 1: The stand-alone LMU signalling protocol could be, for example, RRC or LLP, but this is still for further study.

**Stand-Alone LMU**

A stand-alone LMU is accessed exclusively over the UTRAN air interface (Uu interface). There is no other connection from the stand-alone LMU to any other UTRAN network element.

NOTE 2: This does not preclude a stand-alone LMU from also communicating with other networks (e.g. GSM) through interfaces that are not part of the present document.

A stand-alone LMU has a serving Node-B that provides signalling access to a controlling S-RNC. A stand-alone LMU also has a serving 3G-MSC, VLR and a subscription profile in an HLR. A stand-alone LMU always has a unique IMSI and supports all radio resource and mobility management functions of the UTRAN air interface that are necessary to support signalling. A stand-alone LMU shall support those connection management functions necessary to support LCS signalling transactions with the S-RNC and may support certain call control functions of to support signalling to an S-RNC using a circuit switched data connection.

NOTE 3: A network operator may assign specific ranges of IMSI for its LMUs and may assign certain digits within the IMSI to indicate the associated S-RNC. Certain digits in the IMSI may also be used as a local identifier for an LMU within an S-RNC.

To ensure that a Stand-alone LMU and its associated S-RNC can always access one another, an LMU may be homed (camped) on a particular cell site or group of cell sites belonging to one 3G-MSC. For any Stand-alone LMU with a subscription profile in an HLR, a special profile may be used to indicate the assigned supplementary services (e.g. the SMS-PP MT for data download via the SIM application toolkit, and barring of all incoming and possibly outgoing calls). An identifier in the HLR profile also distinguishes an LMU from a normal UE. All other data specific to an LMU is administered in the LMU and in its associated S-RNC.

**Associated LMU**

An associated LMU is accessed over the Iub interface from an RNC. An associated LMU may make use of the radio apparatus and antennas of its associated Node-B. The LMU may be either a logically separate network element addressed using some pseudo-cell ID, or connected to or integrated in a Node-B. Signalling to an associated LMU is by means of messages routed through the controlling Node-B.

An associated LMU may be separated from the Node-B, but still communicate with the S-RNC via the Node-B Iub interface. The interface between the associated LMU and its Node-B is not part of the present document.

NOTE 4: An associated LMU is not precluded from also communicating with other networks (e.g. GSM) through interfaces that are not part of the present document.

**Measurements**

The assistance measurements obtained by an LMU have are generic and are usable by more than one location method. These include:

- **Radio Interface Timing measurements:** include Absolute Time Differences (ATDs) or Relative Time Differences (RTDs) of the signals transmitted by Node-B, where timing differences are measured relative to either some Absolute Time Difference (ATD) or the signals of another Node-B (RTD);

- **Inter-System Timing measurements:** include the Absolute Time Difference (ATD) or Relative Time Difference between the UTRAN radio signals transmitted by a Node-B and an external system such as the GPS satellite navigation system or GSM.

## 6.6.2 Iur Interface

LCS operations at the Iur interface are defined in [14].

The Iur interface is used to communicate between the LCS functional entities associated with the serving RNC and other RNC in the UTRAN. The Iur interface is also used to communicate between the serving RNC and the Internal LCS Applications in the UTRAN. The LCS entities associated with the serving RNC are responsible for co-ordinating and responding to location requests received from the LCS entities in the core network or Internal Clients.

When communicating between the serving RNC and the UTRAN Internal LCS Applications (ILA), the messages and protocols are the same as those used over the Iur interface.

The Iur interface is also used to communicate between the LCS Entities in the serving RNC and those in other RNC. The location method, for example, may require measurements by several LMU or Node‑B, some of which may be associated with other RNC. Commands and responses from these LCS Entities are communicated over the Iur interface. In some cases, the LCS Entities in the serving RNC may make use of entities associated with other RNC. For example, a calculating function (PCF) may be used in another RNC if the serving RNC is too busy or does not contain the function or database information required by the chosen location method.

The Iur interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the RNC.

Iur shall be used for LCS signalling whenever it is available, even in the case when the RNCs connected to different 3G-MSCs or 3G-SGSN.

Within UTRAN, Iur supports inter-RNC soft handover. Inter-RNC handover should also include LCS, meaning that whenever an inter-RNC soft handover occurs, Iur should be able to support the functionality of the LCS entities in RNCs, including PCF, PRRM, PSMF, and LSOF.

In addition, in case of SRNC relocation Iur should support the relocation mechanism in order for DRNC to be able to handle the responsibility of SRNC in LCS process. That is, to transfer the PCF, PRRM, PSMF, and LSOF functionality from SRNC to DRNC. Iur shall be used also to collect RTD and other LCS information from base stations under different RNCs that are not involved in handover.

## 6.6.3 Iub Interface

LCS operations at the Iub interface are defined in [15].

The Iub interface is used to communicate among the LCS entities associated with the serving RNC, the Node‑B and the associated Location Measurement Units (LMU).

This interface passes the request for measurements, the measurement results and requests for LCS related transmissions or other radio operations needed by the location method (e.g. broadcast of parameters needed for a UE based location method).

The Iub interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the Node‑B or the LMU.

### 6.6.3.1 Signalling between RNC and associated LMU

Signalling exchanges between an RNC and a LMU under the control of that RNC will be specified in the NBAP protocol for associated LMUs.

The protocol layers employed to enable signalling between the RNC and an associated LMU are defined in 25.430. The LMU signalling information elements are included directly in the NBAP protocol, defined in 25.433.

## 6.6.4 Uu Interface

LCS operations at the Uu interface are generally defined in [1]. This specification defines in more detail the procedures needed for messaging for each individual location method.

The Uu interface is used to communicate among the LCS entities associated with the RNC, the UEs and the stand-alone Location Measurement Units (LMU) (the Uu interface is also used to communicate between the LCS entities in the core network and the UE. Those communications are beyond the scope of this specification).

This interface may pass measurement requests and results to and from the UE or the stand-alone LMU.

The Uu interface may also pass location requests from internal or external LCS Applications at the UE.

NOTE: These requests may require the services of the LCS entities associated with the core network to authenticate clients and subscriber subscriptions to aspects of the LCS.

The Uu interface may also be used for broadcast of information that may be used by the UE or stand-alone LMU for their LCS operations. This may, for example, include timing and code information about nearby Node -B transmissions that may assist the UE or LMU in making their measurements.

The Uu interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the UE or the remote LMU.

## 6.6.4.1 Signalling between S-RNC and Target UE

LCS related signalling between an S-RNC and a target UE is supported by the RRC protocol.

The location Request to UE signalling flow is generic for all UE based or assisted location methods (OTDOA and Network Assisted GPS).

NOTE: S-RNC changed to SRNC in the picture below.



**Figure 6.1: OTDOA /GPS Location Message Flow**

1. The S-RNC determines possible assistance data and sends a MEASUREMENT CONTROL request to the UE.

2. Provided that location request meets the privacy criteria, the UE performs the requested measurements. If the UE is able to calculate its own location, and this is requested, the UE computes a location estimate based on measurements. Any assistance data necessary to perform these operations will either be provided in the MEASUREMENT CONTROL request or be available from broadcast sources. The resulting measurements or location estimate are returned to UTRAN in a MEASUREMENT REPORT response. If the UE cannot fulfil the request, a MEASUREMENT CONTROL FAILURE message is returned.

### 6.6.4.1.1 Assistance Data Delivery to UE

The assistance data signalling flow illustrated here is generic for UE based location methods, including OTDOA and Network Assisted GPS. Note that if the assistance data is sent as part of a broadcast message, then no assistance data acknowledgement is required.
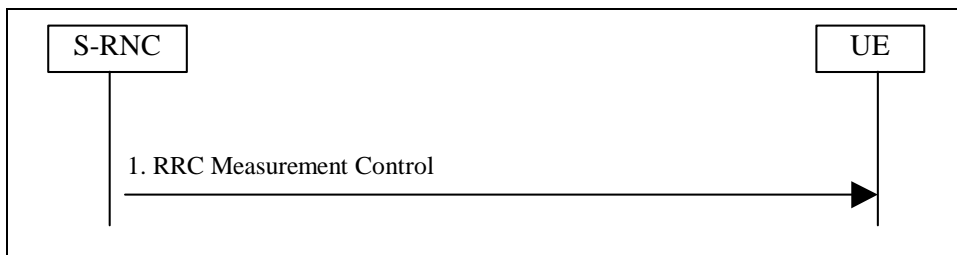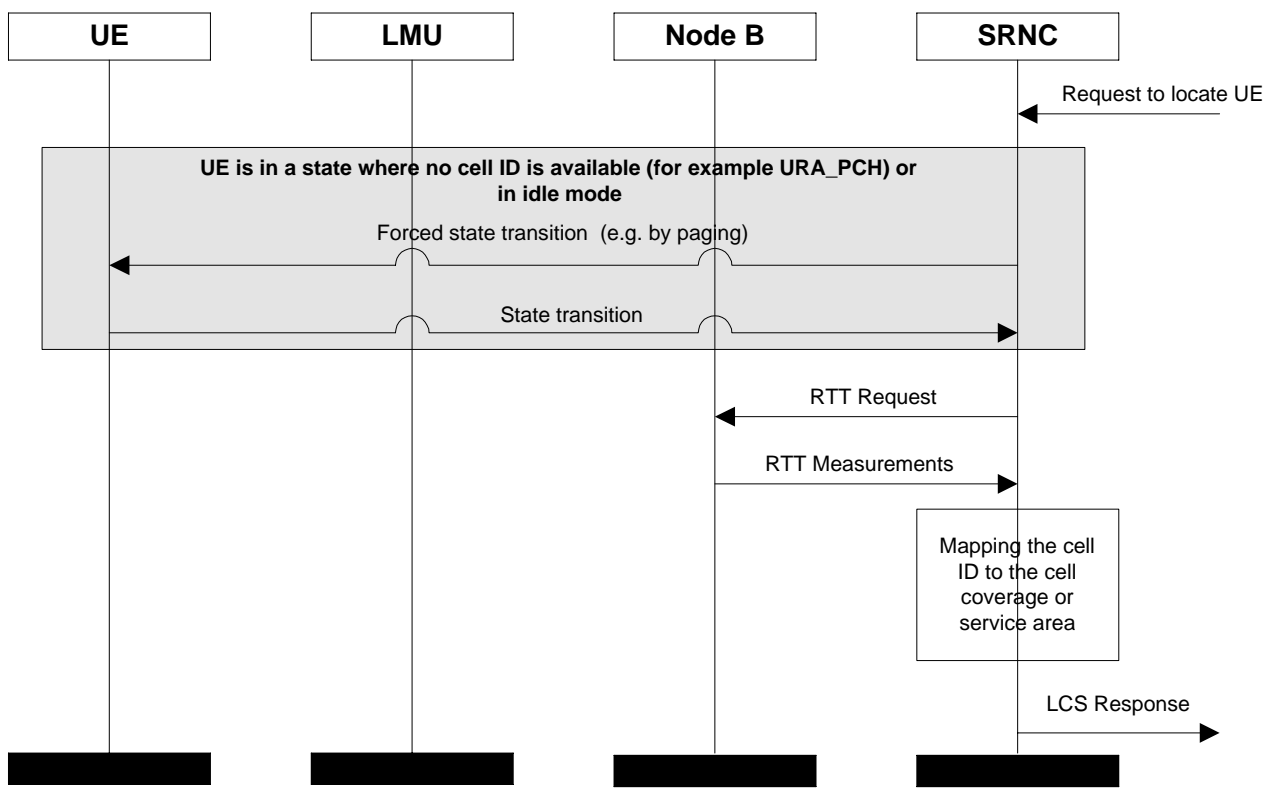
**Figure 6.2: OTDOA or GPS Assistance Data Delivery Flow**

1. The S-RNC determines assistance data and sends it in the RRC MEASUREMENT CONTROL message to the UE.

# 8 Cell ID based location method

In the Cell ID based method, the S-RNC determines the identification of the cell providing coverage for the target UE. This subsection outlines the procedures for this location method. Sub-section 8.1 provides procedures for the determination of the cell ID depending on the operational status of the target UE. Sub-section 8.2 discusses the relation between the LCS location service and the Support of Localised Service Area (SoLSA) feature. Sub-section 8.3 provides a procedure for the mapping of the Cell ID to a corresponding Service Area Identifier (SAI) to be returned to the LCS application in the core network. The general flow to determine the cell ID is shown in figure 8.1.

**Figure 8.1: Cell ID Based Method**

# 8.1　Cell ID determination

In order for the S-RNC to determine the cell ID when an LCS request is received, additional operations may be needed depending on the operational status of the UE.

Figure 8.1 illustrates the procedure for the cell ID based location method when the UE is in different RRC states. When the LCS request is received from the core network the S-RNC checks the state of the target UE. If the UE is in a state where the cell ID is available, the target cell ID is chosen as the basis for the UE location. In states where the cell ID is not available, the UE is paged, so that S-RNC can establish the cell with which the target UE is associated. In order to improve the accuracy of the LCS response the S-RNC may also request RTT or RX Timing Deviation measurements from the Node B or LMU associated with the cell ID. The S-RNC may also map the cell ID to a corresponding Service Area Identifier (SAI) to match the service coverage information available in the core network.

The cell ID based method shall determine the location of the UE regardless of the RRC state, including URA_PCH, Cell_PCH, Cell_DCH, Cell_FACH, cell reselection, inter-system modes, as well as an idle mode.

## 8.1.1　UE Cell ID is not known

For UE for which the cell ID is not known at the time the LCS request is received at the S-RNC, the UE may be paged to locate its current cell ID. If the UE is in an idle mode and there is a need for it to be paged, then the paging may be initiated either by the core network or by the S-RNC in the UTRAN access network. For example, the UE can be forced to perform a transition to a Cell_FACH state to define the cell ID of its current cell.

If the UE is in an idle mode, Cell_PCH state or in any other state when there is a need to page for the UE to obtain the cell ID, the Core Network may initiate paging, authentication and ciphering, as specified in TS 23.171.

Alternatively, the cell ID may be determined as the one that was used during the last active connection to the UE. This determination should be accompanied by the time-of-day of the last connection in the cell.

## 8.1.2　UE Cell ID is known

### 8.1.2.1　UE not in Soft handover

The cell ID may be determined as the cell that is providing an active connection for the UE at the time of receiving the LCS request at the S-RNC.

### 8.1.2.2	UE in Soft handover

In order for the S-RNC to provide the geographical co-ordinates of a target UE in soft handover, the S-RNC combines the information about all cells associated with the UE.

In soft handover, the UE may have several signal branches connected to different cells, reporting different cell IDs. A reference cell ID may be determined by the S-RNC based on the coverage area of each cell. The reference cell ID may be selected based on one or more of the following principles:

- the cell ID may be selected based on the parameters defining the quality of the received signal branches. That is, the cell ID with the best quality signal branch is selected as the reference cell ID;

- the cell ID may be selected that was used during connection set-up between the UE and the serving Node B;

- the cell ID of the cell most recently associated with the UE may be selected;;

- the cell ID of the latest "new" cell that the UE has started to receive, but has not yet been handed over to may be selected;

- the cell ID may be selected as the cell to which UE has the shortest distance (to the Node -B site);

- the cell ID may be selected as the cell that provides an active connection for the UE at the time of receiving theLCS request at the S-RNC.

The selection may also be based on measurements of Round Trip Time, power levels and received signal strengths in UE and related Node B or LMU.

Other relevant mechanisms such as Idle Period Downlink, (IPDL) or Site Selection Diversity Transmit power control (SSDT) should also be taken into account when applying the cell ID selection procedure for UE in a soft handover mode.

## 8.3	Mapping the Cell ID to Geographic Co-ordinates or a Service Area

A UTRAN cell ID should be mapped to geographical coordinates or a Service Area Identifier (SAI) before being sent from UTRAN to the core network. The Service Area Identifier may include one or several cells. The mapping may be accomplished either in the S-RNC, in a Network Management System (NMS, including Network Management Unit, NEMU) or by co-operation of various access network elements.

The core network may request the geographical co-ordinates or the SAI, or both for the target UE. The SAI may be used for routing of corresponding Emergency calls, or for CAMEL services to correspond to the usage of Cell ID in the core network of GSM. However, the MSC shall not send the Service Area Identity to GMLC.

Although the mapping of the cell(s) associated with the target UE into geographical co-ordinates by the S-RNC is not standardised, the response to the core network location request with geographical co-ordinates shall be as defined in TS 23.032.

It should be noted that the Service Area concept is different from the Localised Service Area concept used for SoLSA services.

In order to determine a cell coverage estimate and to map it to the geographical coordinates or Service Area parameter Identity, the S-RNC may use parameters such as the best reference signal, Round Trip Time (RTT) in FDD [17] or Rx Timing Deviation [18] and knowledge of the UE timing advance in TDD, as well as antenna beam direction parameters.

Alternatively, the service area coverage of a cell may be determined by using a reference signal power budget. Based on the reference signal power budget it is possible to obtain, for example, the base station transmitted power, isotropic path loss, coverage threshold at coverage area border for a given location probability, and a cell radius for an indoor and outdoor coverage.

The S-RNC may use a reference signal link budget based cell radius estimate, in conjunction with the cell identifier, to make a coverage estimation for the cell(s) related to the target UE.

Additionally, the S-RNC may compare the received power levels with the power budget, whereby more accurate information of the location of the UE may be provided.

Also, the interaction between neighbouring cell coverage areas may be used to determine a more exact location of the UE.

# 9.6 OTDOA network location procedures

The following diagram illustrates the operations for the OTDOA-LCS when the request for location information is initiated by an LCS application signalled from the Core Network. As these operations are internal to the RNC, this diagram is to illustrate information flow and implementations may use alternate arrangements.

This illustration only includes the information flow related to LCS operations and does not indicate other operations that may be required, for example, to establish a signalling connection between the UE and the SRNC. Also not illustrated is the signalling used to initiate the location service request (from the Location Client Function) from the Core Network or a UE based application.



**Figure 9.2: OTDOA Signalling Operations**

1. The operation begins with an authenticated request for location information about a UE from an application in the core network being received at the LSCF. The LSCF acts as interface between the Core Network and the LCS entities in the UTRAN.

2. The LSCF considers the request and the capabilities of the UE and the network and forwards the request to the appropriate PRCF in the Serving RNC.

3. The PRCF requests from the UE the measurement of the OTDOA for the signals in the active and neighbourhood sets. These measurements may be made while the UE is in the idle state or while it is connected.

4. If it is considered advantageous to do so, the PRCF requests the UE TX-Rx timing difference information from the UE.

5. The UE returns the OTDOA measures to the PRCF. The PRCF receives the OTDOA information and co-ordinates obtaining other information to support the calculation request (not illustrated).

6. The UE returns the UE TX-Rx timing difference information to the PRCF, together with a time stamp of when the value was obtained.

7. If there are insufficient OTDOA measures, or it is otherwise considered advantageous to do so, the PRCF requests the RTT measure for the UE from the PSMF in the serving Node -B.

8. The PRCF requests the RTD measures for the associated transmitters from the LSOF (database). These may be stored locally if they are constant over time, otherwise they must be updated to represent the RTD timing at the time-of-day the OTDOA measurements were made.

9. The PSMF in the Node -B returns the RTT measures to the PRCF if they were requested.

10. The LSOF returns the RTD information to the PRCF.

11. The PRCF passes the OTDOA, RTD and, if necessary, RTT information to the PCF and requests a location calculation. The calculation may include a co-ordinate transformation to the geographic system requested by the application.

12. The PCF returns the location estimate to the PRCF. This estimate includes the location, the estimated accuracy of the results and the time of day of the estimate.

13. The PRCF passes the location estimate to the LSCF.

14. The LSCF passes the location estimate to the Core Network.

# Annex A (informative): Definitions and Terms

This annex provides definitions and terms for the general LCS. Not all of these are applicable to the UTRAN environment.

**CAMEL:** CAMEL is a network functionality, which provides the mechanisms of Intelligent Network to a mobile user.

**Current Location:** after a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp is referred to as the 'current location' at that point in time.

**Deferred location request:** a location request where the location response (responses) is (are) not required immediately.

**Global Positioning System:** the Global Positioning System (GPS) consists of three functional elements: Space Segment (satellites), User Segment (receivers), and Control Segment (maintenance etc.). The GPS receiver estimates its own location based on the observed times of arrival of the satellite signals.

**Immediate location request:** a location request where a single location response only is required immediately.

**Initial Location:** in the context of an originating emergency call the location estimate and the associated time stamp at the commencement of the call set-up is referred to as 'initial location'.

**Last Known Location:** the current location estimate and its associated time stamp for Target UEMS stored in the LCS Server is referred to as the 'last known location' and until replaced by a later location estimate and a new time stamp is referred to as the 'last known location'.

**LCS (LoCation Services):** LCS is a service concept in system (e.g. GSM or UMTS) standardisation. LCS specifies all the necessary network elements and entities, their functionalities, interfaces, as well as communication messages, due to implement the location service functionality in a cellular network.

NOTE: LCS does not specify any location based (value added) services except locating of emergency calls.

**LCS Client:** a software and/or hardware entity that interacts with a LCS Server for the purpose of obtaining location information for one or more Mobile Stations. LCS Clients subscribe to LCS in order to obtain location information. LCS Clients may or may not interact with human users. The LCS Client is responsible for formatting and presenting data and managing the user interface (dialogue). The LCS Client may reside in the Mobile Station (MS)UE.

**LCS Client Access barring list:** an optional list of MSISDNs per LCS Client where the LCS Client is not allowed to locate any MSISDN therein.

**LCS Client Subscription Profile:** a collection of subscription attributes of LCS related parameters that have been agreed for a contractual period of time between the LCS client and the service provider.

**LCS Feature:** the capability of a PLMN to support LCS Client/server interactions for locating Target ~~MSs~~UEs.

**LCS Server:** a software and/or hardware entity offering LCS capabilities. The LCS Server accepts requests, services requests, and sends back responses to the received requests. The LCS server consists of LCS components, which are distributed to one or more PLMN and/or service provider.

**Local Service:** a service, which can be exclusively provided in the current serving network by a Value added Service Provider.

**Local Information:** information related to a given location, or general information, which is made available in a given location.

**Location (/location detecting):** location is a functionality, which estimates a geographical location (of e.g. a mobile terminal).

**Location (Based) Application:** a location application is an application software processing location information or utilising it in some way. The location information can be input by a user or detected by network or ~~MS~~UE. Navigation is one location application example.

**Location Based Service (LBS):** a service provided either by teleoperator or a 3$^{rd}$ party service provider that utilises the available location information of the terminal. Location Application offers the User Interface for the service. LBS is either a pull or a push type of service (see Location Dependent Services and Location Independent Services). In ETSI/GSM documentation of SoLSA, LBS is called "Location Related Service". ETSI and/or 3GPP –wide terminology harmonisation is expected here.

**Location Dependent Service:** a service provided either by teleoperator or a 3$^{rd}$ party service provider that is available (pull type) or is activated (push type) when the user arrives to a certain area. It doesn't require any subscription in advance, but the push type activation shall be confirmed by the user. The offered service itself can be any kind of service (e.g. a public Xerox machine or the discount list in a store).

**Location Estimate:** the geographic location of an ~~MS and/or a valid Mobile Equipment (ME)~~UE, expressed in latitude and longitude data, and optionally altitude data. The Location Estimate shall be represented in a well-defined universal format. Translation from this universal format to another geographic location system may be supported, although the details are considered outside the scope of the primitive services.

**Location Independent Service:** a service provided either by teleoperator or a 3$^{rd}$ party service provider that is available and therefore can be activated anywhere in the network coverage. It is activated by the user's request or by other user's activated service, and therefore it requires a subscription in advance (pull type). The offered service itself can be any kind of service (e.g. MMS, SWDL, or LBS!).

**Location method (/locating method):** a principle and/or algorithm which the estimation of geographical location is based on, e.g. AOA, TOA, TDOA. For example, GPS is based on TOA, and E-OTD (on GSM) is based on TDOA.

**Location technology (/locating technology):** a technology or system concept including the specifications of RF interfaces, data types, etc. to process the estimation of a geographical location, e.g. GPS, E-OTD (GSM), and IPDL-TDOA (WCDMA).

**PLMN Access barring list:** an optional list of MSISDN per PLMN where any LCS Client is not allowed to locate any MSISDN therein except for certain exceptional cases.

**Predefined area:** a geographical area which is not related to cell or radio coverage. The mobile may take special action when it recognises it has entered or left a predefined area.

**Privacy Class:** list of LCS Clients defined within a privacy exception class to which permission may be granted to locate the target UE~~MS~~. The permission shall be granted either on activation by the target ~~MS~~ UE or permanently for a contractual period of time agreed between the target UE~~MS~~ and the service provider.

**Privacy Exception List:** a list consisting of various types of privacy classes (i.e. operator related, personal etc.). Certain types of classes may require agreement between the service provider and the target UE~~MS~~.

**Prohibited area:** an area where the mobile must not activate its transmitter. The Prohibited area may be a Predefined area described above or related to radio cell(s).

**Subscription Profile:** the profile detailing the subscription to various types of privacy classes.

**Target UEMS:** the UEMS being located.

| CHANGE REQUEST | *Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.* |
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**25.305** CR **027**     Current Version:   3.3.0

*GSM (AA.BB) or 3G (AA.BBB) specification number* ↑      ↑ *CR number as allocated by MCC support team*

For submission to:   TSG-RAN #10    for approval   **X**      strategic     *(for SMG*
*list expected approval meeting # here*
↑     for information      non-strategic     *use only)*

*Form: CR cover sheet, version 2 for 3GPP and SMG*     *The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

**Proposed change affects:** (U)SIM ☐ ME **X** UTRAN / Radio **X** Core Network ☐
*(at least one should be marked with an X)*

| | |
|---|---|
| **Source:** | TSG-RAN WG2 |

**Date:** 08.10.2000

**Subject:** Removal of SoLSA concepts

**Work item:**

**Category:**

*(only one category shall be marked with an X)*

| | | | |
|---|---|---|---|
| F | Correction | **X** | |
| A | Corresponds to a correction in an earlier release | | |
| B | Addition of feature | | |
| C | Functional modification of feature | | |
| D | Editorial modification | | |

**Release:**

| | |
|---|---|
| Phase 2 | |
| Release 96 | |
| Release 97 | |
| Release 98 | |
| Release 99 | **X** |
| Release 00 | |

| **Reason for change:** | Since the SoLSA concept was officially dropped from Release 99 by TSG SA, all references to it are removed from TS 25.305. |
|---|---|

**Clauses affected:** 8, 8.2 (removed), 8.3, Annex A

| **Other specs** | Other 3G core specifications | | $\rightarrow$ | List of CRs: | |
|---|---|---|---|---|---|
| **affected:** | Other GSM core specifications | | $\rightarrow$ | List of CRs: | |
| | MS test specifications | | $\rightarrow$ | List of CRs: | |
| | BSS test specifications | | $\rightarrow$ | List of CRs: | |
| | O&M specifications | | $\rightarrow$ | List of | |

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**Other comments:**

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# 8 Cell ID based location method

In the Cell ID based method, the S-RNC determines the identification of the cell providing coverage for the target UE. This subsection outlines the procedures for this location method. Sub-section 8.1 provides procedures for the determination of the cell ID depending on the operational status of the target UE. ~~Sub-section 8.2 discusses the relation between the LCS location service and the Support of Localised Service Area (SoLSA) feature.~~ Sub-section 8.3 provides a procedure for the mapping of the Cell ID to a corresponding Service Area Identifier (SAI) to be returned to the LCS application in the core network. The general flow to determine the cell ID is shown in figure 8.1.



**Figure 8.1: Cell ID Based Method**

## 8.2 Localised Service Area

Void.

~~The Support of Localised Service Area (SoLSA) feature is quite close to the location service in principle, but SoLSA is based, for example, on radio network cell coverage and cell configuration. SoLSA has been standardised in GSM and is being developed for UTRAN. Some SoLSA service features like Exclusive Access and LSA only Access may be less applicable in UTRAN due to the 1 frequency reuse.~~

~~It should be noted that the Service Area concept described in this specification is different from the Localised Service Area concept defined for SoLSA.~~

## 8.3 Mapping the Cell ID to Geographic Co-ordinates or a Service Area

A UTRAN cell ID should be mapped to geographical coordinates or a Service Area Identifier (SAI) before being sent from UTRAN to the core network. The Service Area Identifier may include one or several cells. The mapping may be accomplished either in the S-RNC, in a Network Management System (NMS, including Network Management Unit, NEMU) or by co-operation of various access network elements.

The core network may request the geographical co-ordinates or the SAI, or both for the target UE. The SAI may be used for routing of corresponding Emergency calls, or for CAMEL services to correspond to the usage of Cell ID in the core network of GSM. However, the MSC shall not send the Service Area Identity to GMLC.

Although the mapping of the cell(s) associated with the target UE into geographical co-ordinates by the S-RNC is not standardised, the response to the core network location request with geographical co-ordinates shall be as defined in TS 23.032.

~~It should be noted that the Service Area concept is different from the Localised Service Area concept used for SoLSA services.~~

In order to determine a cell coverage estimate and to map it to the geographical coordinates or Service Area parameter Identity, the S-RNC may use parameters such as the best reference signal, Round Trip Time (RTT) in FDD [17] or Rx Timing Deviation [18] and knowledge of the UE timing advance in TDD, as well as antenna beam direction parameters.

Alternatively, the service area coverage of a cell may be determined by using a reference signal power budget. Based on the reference signal power budget it is possible to obtain, for example, the base station transmitted power, isotropic path loss, coverage threshold at coverage area border for a given location probability, and a cell radius for an indoor and outdoor coverage.

The S-RNC may use a reference signal link budget based cell radius estimate, in conjunction with the cell identifier, to make a coverage estimation for the cell(s) related to the target UE.

Additionally, the S-RNC may compare the received power levels with the power budget, whereby more accurate information of the location of the UE may be provided.

Also, the interaction between neighbouring cell coverage areas may be used to determine a more exact location of the UE.

# Annex A (informative):
# Definitions and Terms

This annex provides definitions and terms for the general LCS. Not all of these are applicable to the UTRAN environment.

**CAMEL:** CAMEL is a network functionality, which provides the mechanisms of Intelligent Network to a mobile user.

**Current Location:** after a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp is referred to as the 'current location' at that point in time.

**Deferred location request:** a location request where the location response (responses) is (are) not required immediately.

**Global Positioning System:** the Global Positioning System (GPS) consists of three functional elements: Space Segment (satellites), User Segment (receivers), and Control Segment (maintenance etc.). The GPS receiver estimates its own location based on the observed times of arrival of the satellite signals.

**Immediate location request:** a location request where a single location response only is required immediately.

**Initial Location:** in the context of an originating emergency call the location estimate and the associated time stamp at the commencement of the call set-up is referred to as 'initial location'.

**Last Known Location:** the current location estimate and its associated time stamp for Target MS stored in the LCS Server is referred to as the 'last known location' and until replaced by a later location estimate and a new time stamp is referred to as the 'last known location'.

**LCS (LoCation Services):** LCS is a service concept in system (e.g. GSM or UMTS) standardisation. LCS specifies all the necessary network elements and entities, their functionalities, interfaces, as well as communication messages, due to implement the location service functionality in a cellular network.

　　NOTE:　　LCS does not specify any location based (value added) services except locating of emergency calls.

**LCS Client:** a software and/or hardware entity that interacts with a LCS Server for the purpose of obtaining location information for one or more Mobile Stations. LCS Clients subscribe to LCS in order to obtain location information. LCS Clients may or may not interact with human users. The LCS Client is responsible for formatting and presenting data and managing the user interface (dialogue). The LCS Client may reside in the Mobile Station (MS).

**LCS Client Access barring list:** an optional list of MSISDNs per LCS Client where the LCS Client is not allowed to locate any MSISDN therein.

**LCS Client Subscription Profile:** a collection of subscription attributes of LCS related parameters that have been agreed for a contractual period of time between the LCS client and the service provider.

**LCS Feature:** the capability of a PLMN to support LCS Client/server interactions for locating Target MSs.

**LCS Server:** a software and/or hardware entity offering LCS capabilities. The LCS Server accepts requests, services requests, and sends back responses to the received requests. The LCS server consists of LCS components, which are distributed to one or more PLMN and/or service provider.

**Local Service:** a service, which can be exclusively provided in the current serving network by a Value added Service Provider.

**Local Information:** information related to a given location, or general information, which is made available in a given location.

**Location (/location detecting):** location is a functionality, which estimates a geographical location (of e.g. a mobile terminal).

**Location (Based) Application:** a location application is an application software processing location information or utilising it in some way. The location information can be input by a user or detected by network or MS. Navigation is one location application example.

**Location Based Service (LBS):** a service provided either by teleoperator or a $3^{rd}$ party service provider that utilises the available location information of the terminal. Location Application offers the User Interface for the service. LBS is either a pull or a push type of service (see Location Dependent Services and Location Independent Services). In ETSI/GSM documentation of SoLSA, LBS is called "Location Related Service". ETSI and/or 3GPP -wide terminology harmonisation is expected here.

**Location Dependent Service:** a service provided either by teleoperator or a $3^{rd}$ party service provider that is available (pull type) or is activated (push type) when the user arrives to a certain area. It doesn't require any subscription in advance, but the push type activation shall be confirmed by the user. The offered service itself can be any kind of service (e.g. a public Xerox machine or the discount list in a store).

**Location Estimate:** the geographic location of an MS and/or a valid Mobile Equipment (ME), expressed in latitude and longitude data, and optionally altitude data. The Location Estimate shall be represented in a well-defined universal format. Translation from this universal format to another geographic location system may be supported, although the details are considered outside the scope of the primitive services.

**Location Independent Service:** a service provided either by teleoperator or a $3^{rd}$ party service provider that is available and therefore can be activated anywhere in the network coverage. It is activated by the user's request or by other user's activated service, and therefore it requires a subscription in advance (pull type). The offered service itself can be any kind of service (e.g. MMS, SWDL, or LBS!).

**Location method (/locating method):** a principle and/or algorithm which the estimation of geographical location is based on, e.g. AOA, TOA, TDOA. For example, GPS is based on TOA, and E-OTD (on GSM) is based on TDOA.

**Location technology (/locating technology):** a technology or system concept including the specifications of RF interfaces, data types, etc. to process the estimation of a geographical location, e.g. GPS, E-OTD (GSM), and IPDL-TDOA (WCDMA).

**PLMN Access barring list:** an optional list of MSISDN per PLMN where any LCS Client is not allowed to locate any MSISDN therein except for certain exceptional cases.

**Predefined area:** a geographical area which is not related to cell or radio coverage. The mobile may take special action when it recognises it has entered or left a predefined area.

**Privacy Class:** list of LCS Clients defined within a privacy exception class to which permission may be granted to locate the target MS. The permission shall be granted either on activation by the target MS or permanently for a contractual period of time agreed between the target MS and the service provider.

**Privacy Exception List:** a list consisting of various types of privacy classes (i.e. operator related, personal etc.). Certain types of classes may require agreement between the service provider and the target MS.

**Prohibited area:** an area where the mobile must not activate its transmitter. The Prohibited area may be a Predefined area described above or related to radio cell(s).

**Subscription Profile:** the profile detailing the subscription to various types of privacy classes.

**Target MS:** the MS being located.

# CHANGE REQUEST

*Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.*

| **25.305** | CR | **029r1** | Current Version: | 3.3.0 |
|---|---|---|---|---|

*GSM (AA.BB) or 3G (AA.BBB) specification number* ↑          ↑ *CR number as allocated by MCC support team*

| For submission to: | TSG-RAN #10 | for approval | **X** | | strategic | | *(for SMG* |
|---|---|---|---|---|---|---|---|
| *list expected approval meeting # here* ↑ | | for information | | | non-strategic | | *use only)* |

*Form: CR cover sheet, version 2 for 3GPP and SMG          The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

**Proposed change affects:**          (U)SIM ☐     ME ☐     UTRAN / Radio **X**     Core Network ☐
*(at least one should be marked with an X)*

| **Source:** | TSG-RAN WG2 | | **Date:** | 9. 10. 2000 |
|---|---|---|---|---|

**Subject:**     Signalling flows on Iub and Iur

**Work item:**

| **Category:** | F | Correction | **X** | **Release:** | Phase 2 | |
|---|---|---|---|---|---|---|
| | A | Corresponds to a correction in an earlier release | | | Release 96 | |
| *(only one category* | B | Addition of feature | | | Release 97 | |
| *shall be marked* | C | Functional modification of feature | | | Release 98 | |
| *with an X)* | D | Editorial modification | | | Release 99 | **X** |
| | | | | | Release 00 | |

| **Reason for change:** | This CR   clarifies the signalling on Iub and Iur |
|---|---|

**Clauses affected:**     6.6.2.1 (new), 6.6.2.2 (new), 6.6.3

| **Other specs** | Other 3G core specifications | | → | List of CRs: | |
|---|---|---|---|---|---|
| **affected:** | Other GSM core specifications | | → | List of CRs: | |
| | MS test specifications | | → | List of CRs: | |
| | BSS test specifications | | → | List of CRs: | |
| | O&M specifications | | → | List of CRs: | |

**Other comments:**

help.doc

<--------- double-click here for help and instructions on how to create a CR.

# 6 Signalling protocols and interfaces

NOTE: This clause describes the information flows, the detailed messages and protocols are described in other clauses.

## 6.1 LCS signalling between SRNC and MSC/SGSN

LCS signalling between SRNC and MSC/SGSN is handled through the Iu interface, which is described in clause 6.6.3.

## 6.2 SRNC signalling to a target UE

SRNC signalling to a target UE is described in clause 6.6.4.1.

## 6.3 Controlling RNC signalling to a standalone LMU

Controlling RNC signalling to a standalone LMU is described in clause 6.6.4.2.

## 6.4 Controlling RNC signalling to an associated LMU

Controlling RNC signalling to an associated LMU is handled through the Iub interface, which is described in clause 6.6.1.

## 6.5 RNC-to-RNC signalling for LCS support

The RNC-to-RNC signalling for LCS support is handled through the Iur interface, which is described in clause 6.6.2.

## 6.6 Interfaces

There are four interfaces through which the LCS entities communicate. These are the Iu, the Iur, Iub and the Uu.

NOTE: the interfaces between the Internal or External LCS applications and the 3G-MSC or 3G-SGSN are outside the scope of the present document.

### 6.6.1 Iu Interface

The Iu interface is used to communicate between the LCS functional entities in the Core Network and the LCS entities in the UTRAN. Further specification of the messages and operations for LCS across the Iu interface may be found in reference [1].

### 6.6.2 Iur Interface

LCS operations at the Iur interface are defined in [14].

The Iur interface is used to communicate between the LCS functional entities associated with the serving RNC and other RNC in the UTRAN. The Iur interface is also used to communicate between the serving RNC and the Internal LCS Applications in the UTRAN. The LCS entities associated with the serving RNC are responsible for co-ordinating and responding to location requests received from the LCS entities in the core network or Internal Clients.

When communicating between the serving RNC and the UTRAN Internal LCS Applications (ILA), the messages and protocols are the same as those used over the Iur interface.

The Iur interface is also used to communicate between the LCS Entities in the serving RNC and those in other RNC. The location method, for example, may require measurements by several LMU or Node-B, some of which may be associated with other RNC. Commands and responses from these LCS Entities are communicated over the Iur interface. In some cases, the LCS Entities in the serving RNC may make use of entities associated with other RNC. For example, a calculating function (PCF) may be used in another RNC if the serving RNC is too busy or does not contain the function or database information required by the chosen location method.

The Iur interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the RNC.

Iur shall be used for LCS signalling whenever it is available, even in the case when the RNCs connected to different 3G-MSCs or 3G-SGSN.

Within UTRAN, Iur supports inter-RNC soft handover. Inter-RNC handover should also include LCS, meaning that whenever an inter-RNC soft handover occurs, Iur should be able to support the functionality of the LCS entities in RNCs, including PCF, PRRM, PSMF, and LSOF.

In addition, in case of SRNC relocation Iur should support the relocation mechanism in order for DRNC to be able to handle the responsibility of SRNC in LCS process. That is, to transfer the PCF, PRRM, PSMF, and LSOF functionality from SRNC to DRNC. Iur shall be used also to collect RTD and other LCS information from base stations under different RNCs that are not involved in handover.

### 6.6.2.1 Signalling between SRNC and DRNC

Signalling between SRNC and DRNC is used to obtain LCS information specific to a UE that has an ~~active link~~UE context to the DRNC.

The signalling between SRNC and DRNC is done by using ~~Dedicated Measurement~~ RNSAP procedures specified in [14]

### 6.6.2.2 Signalling between SRNC and CRNC

Signalling between SRNC and CRNC is used to obtain LCS information and request LCS related transmissions or other radio operation (e.g. IPDLs) that is needed by SRNC for a certain location method. The requested information may be e.g. GPS assistance data in case a reference GPS receiver is not available at the SRNC or RTD measurement results that may be provided by LMUs associated to the CRNC.

The procedures used for the signalling between SRNC and CRNC are not specified yet.

## 6.6.3 Iub Interface

LCS operations at the Iub interface are defined in [15].

The Iub interface is used to communicate among the LCS entities associated with the serving RNC, the Node-B and the associated Location Measurement Units (LMU).

This interface passes the request for measurements, the measurement results and requests for LCS related transmissions or other radio operations needed by the location method (e.g. broadcast of parameters needed for a UE based location method). Measurement requests and results ~~may be~~are signalled by using ~~the Dedicated and Common Measurement~~NBAP procedures.

The Iub interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the Node-B or the LMU.

### 6.6.3.1 Signalling between RNC and associated LMU

Signalling exchanges between an RNC and a LMU under the control of that RNC will be specified in the NBAP protocol for associated LMUs.

The protocol layers employed to enable signalling between the RNC and an associated LMU are defined in 25.430. The LMU signalling information elements are included directly in the NBAP protocol, defined in 25.433.

# 6.6.4 Uu Interface

LCS operations at the Uu interface are generally defined in [1]. This specification defines in more detail the procedures needed for messaging for each individual location method.

The Uu interface is used to communicate among the LCS entities associated with the RNC, the UEs and the stand-alone Location Measurement Units (LMU) (the Uu interface is also used to communicate between the LCS entities in the core network and the UE. Those communications are beyond the scope of this specification).

This interface may pass measurement requests and results to and from the UE or the stand-alone LMU.

The Uu interface may also pass location requests from internal or external LCS Applications at the UE.

> NOTE: These requests may require the services of the LCS entities associated with the core network to authenticate clients and subscriber subscriptions to aspects of the LCS.

The Uu interface may also be used for broadcast of information that may be used by the UE or stand-alone LMU for their LCS operations. This may, for example, include timing and code information about nearby Node-B transmissions that may assist the UE or LMU in making their measurements.

The Uu interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the UE or the remote LMU.

## 6.6.4.1 Signalling between S-RNC and Target UE

LCS related signalling between an S-RNC and a target UE is supported by the RRC protocol.

The location Request to UE signalling flow is generic for all UE based or assisted location methods (OTDOA and Network Assisted GPS).
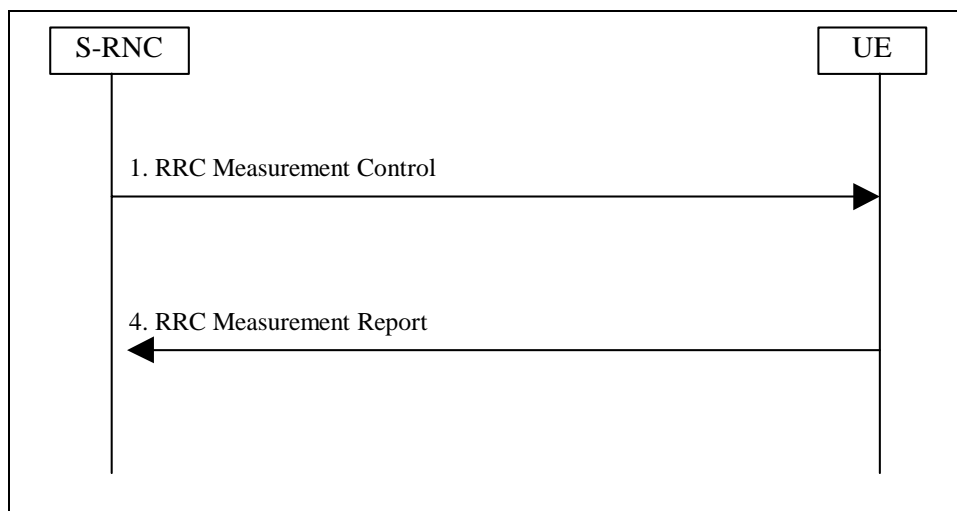


**Figure 6.1: OTDOA /GPS Location Message Flow**

1. The S-RNC determines possible assistance data and sends a MEASUREMENT CONTROL request to the UE.

2. Provided that location request meets the privacy criteria, the UE performs the requested measurements. If the UE is able to calculate its own location, and this is requested, the UE computes a location estimate based on measurements. Any assistance data necessary to perform these operations will either be provided in the MEASUREMENT CONTROL request or be available from broadcast sources. The resulting measurements or location estimate are returned to UTRAN in a MEASUREMENT REPORT response. If the UE cannot fulfil the request, a MEASUREMENT CONTROL FAILURE message is returned.

### 6.6.4.1.1 Assistance Data Delivery to UE

The assistance data signalling flow illustrated here is generic for UE based location methods, including OTDOA and Network Assisted GPS. Note that if the assistance data is sent as part of a broadcast message, then no assistance data acknowledgement is required.
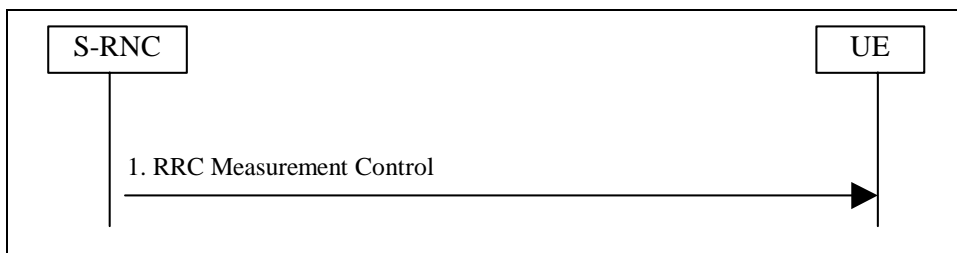


**Figure 6.2: OTDOA or GPS Assistance Data Delivery Flow**

1. The S-RNC determines assistance data and sends it in the RRC MEASUREMENT CONTROL message to the UE.

### 6.6.4.1.2 Error Handling

The error handling for signalling on the Uu interface is handled by the RRC protocol.

### 6.6.4.1.3 Broadcast of Assistance Data

In the UE Based OTDOA or Network Assisted GPS methods, where the measurements and/or location calculation is done in the UE, assistance data may be broadcast to the UE.

The assistance data to be broadcast for UE Based OTDOA contains the Relative Time Difference (RTD) values (e.g. in case of a non-synchronised network) and base station co-ordinates. In addition, the broadcast data may contain other information to simplify the OTDOA measurements. The length of the message depends on how many neighbours are included in the assistance data. Part of the broadcast message (e.g. the serving and neighbour base station geographic co-ordinates) may be ciphered.

The assistance data to be broadcast for assisted GPS contains DGPS corrections, ephemeris and clock corrections, as well as almanac and other data. Part of the broadcast message may be ciphered.

The broadcast channel that is used for the OTDOA and GPS assistance data makes use of the common UTRAN broadcast service.

### 6.6.4.1.4 Signalling Flow for Assistance Data Broadcast Using the Common UTRAN Broadcast Service

The assistance data broadcast to UEs can be signalled via the RRC Measurement Control message as shown in subclause 6.6.4.2 or it can be broadcast by the UTRAN within the system information.
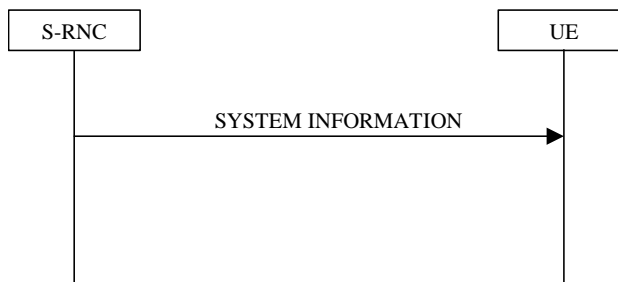


**Figure 6.3: Broadcast of system information**

## 6.6.4.1.5 LCS Assistance Data Ciphering

To allow control of access to the assistance data, parts of the broadcast assistance data may be ciphered. Ciphering is done with a specific ciphering key delivered by the core network for this purpose. The management of the key is described in the System Aspects Stage 2 ([1]).

## 6.6.4.1.6 LCS Assistance Data Ciphering Algorithm

The algorithm used for ciphering the LCS assistance data is the standard 56-bit Data Encryption Standard (DES) algorithm.

The deciphering of broadcast assistance messages is done in the UEs. The deciphering will utilize the deciphering keys delivered during the location update request.

The RNC ciphers the parts of the LCS Broadcast Data message to be protected using the 56-bit DES algorithm and a ciphering keys (56 bits) and Ciphering Serial Number (16 bits) for the broadcast location area.

The ciphered part is variable in length with one bit resolution. By using the LCS Broadcast Data message header, the UEs can determine what part of message is ciphered.

Inputs to the 56-bit DES algorithm are the following:

-   56-bit key K (deciphering key);

-   16-bit Ciphering Serial Number from broadcast message which is denoted here by IV (Initialization Vector);

-   plain-text bits (the ciphered part of broadcast message).

The ciphering process is illustrated in the following diagram. Ciphering is done by producing a mask bit stream which is then "XORed" bit-by-bit to the plain-text data to obtain the cipher-text data. First, the Initialization Vector (IV) is concatenated with 0-bits in order to achieve a 64-bit block $I_1$. This block is then encrypted by the DES algorithm using the key K. Output is a 64-bit block $I_2$. This constitutes the first 64 bits of the mask bit stream. If the message is longer than 64 bits, then more bits are needed. These are produced by encrypting $I_2$ again by the DES algorithm using the key K. The output is a 64-bit block $I_3$. This is the next 64 bits of the mask bit stream. This iteration is continued until enough bits are produced. The unnecessary bits from the last 64-bit block $I_j$ are discarded. The figure below illustrates the first two mask bit generations and the two ciphered 64-bit blocks.
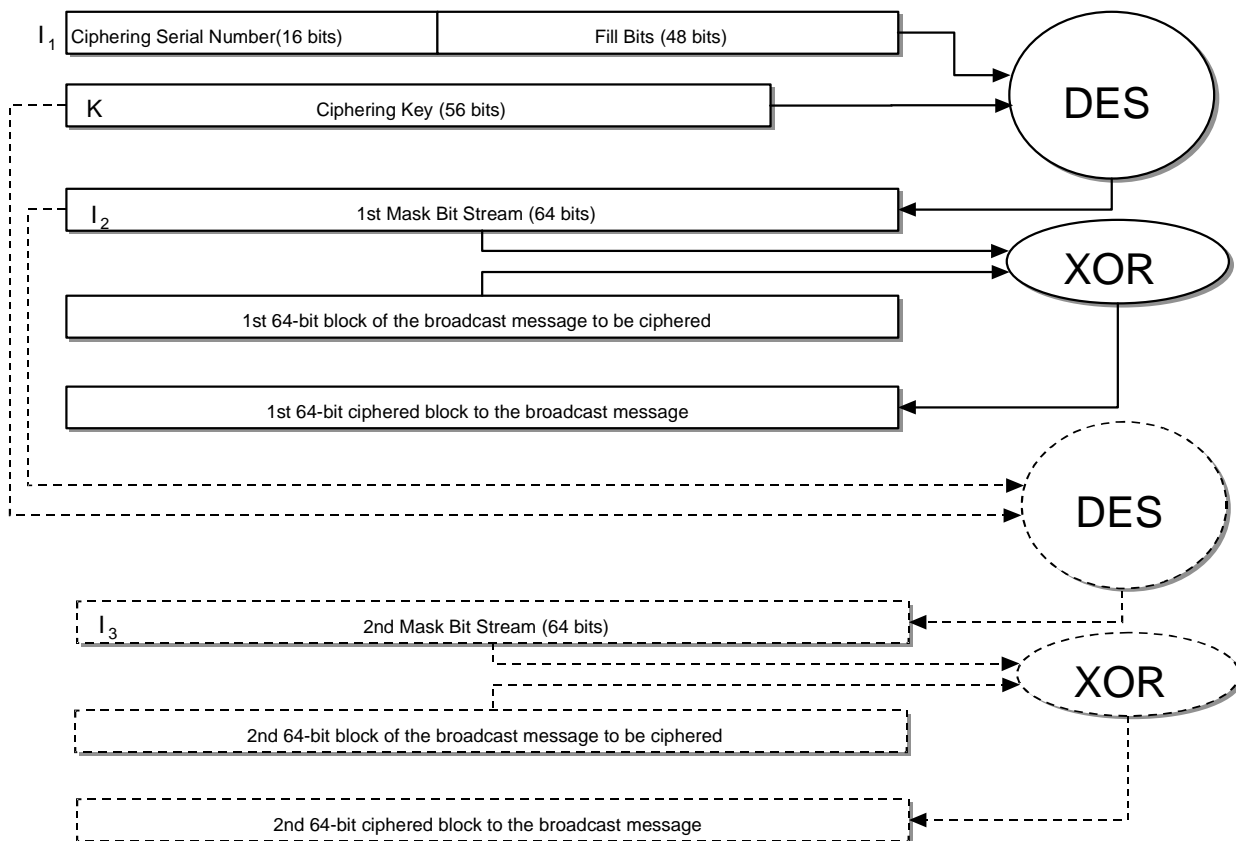
**Figure 6.4: Data Assistance Ciphering Algorithm**

Deciphering is done similarly. The same mask bit stream is produced and these are XORed, bit-by-bit, to the cipher-text data bits. The result will be the plain-text data.

## 6.6.4.2    Signalling between RNC and stand-alone LMU

The use of stand-alone LMUs is FFS. If it is decided to have stand-alone LMUs in the standard, the signalling will be performed with the new protocol LLP. If no need is seen for the stand-alone LMUs the LLP protocol will not be defined and it will be removed from 25.305.

The following figures illustrate the protocol layers used to support signalling between an RNC and a Stand-Alone LMU over the Uu interface.

### 6.6.4.2.1 Signalling using a signalling bearer



**Figure 6.5: Signalling between an RNC and a Stand-Alone LMU using a signalling bearer**

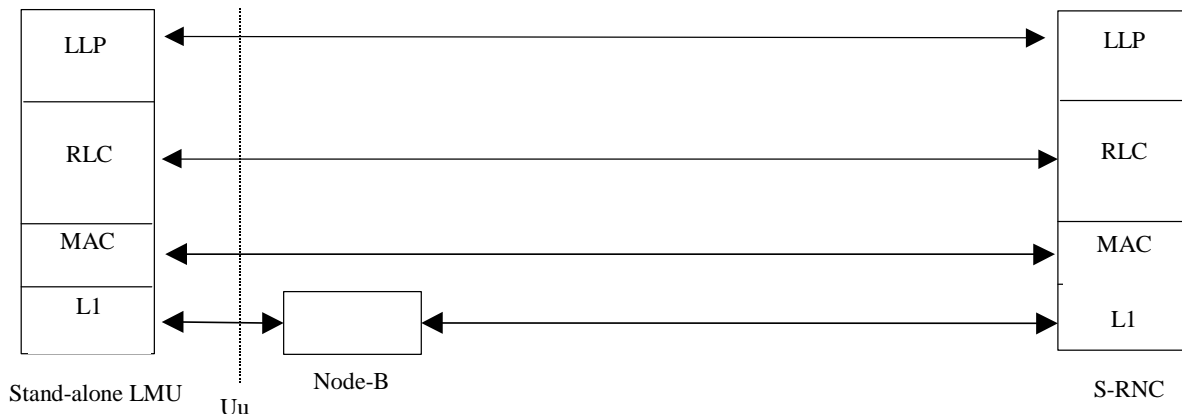### 6.6.4.2.2 Signalling using a radio bearer



**Figure 6.6: Signalling between an RNC and a Stand-Alone LMU using a radio bearer**

# CHANGE REQUEST

*Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.*

| **25.305** | CR | **030r1** | Current Version: | 3.3.0 |
|---|---|---|---|---|

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑*        *↑ CR number as allocated by MCC support team*

For submission to: **TSG-RAN #10**    for approval **X**    strategic ☐ *(for SMG*
*list expected approval meeting # here*    for information ☐    non-strategic ☐ *use only)*
↑

*Form: CR cover sheet, version 2 for 3GPP and SMG*        *The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

**Proposed change affects:**        (U)SIM ☐    ME ☐    UTRAN / Radio **X**    Core Network ☐
*(at least one should be marked with an X)*

**Source:**    TSG-RAN WG2                **Date:**  9 October, 2000

**Subject:**    LCS functionality during SRNS relocation

**Work item:**

**Category:**    F  Correction                            **X**   **Release:**  Phase 2         ☐
A  Corresponds to a correction in an earlier release    ☐         Release 96      ☐
*(only one category*    B  Addition of feature              ☐         Release 97      ☐
*shall be marked*    C  Functional modification of feature    ☐         Release 98      ☐
*with an X)*    D  Editorial modification            ☐         Release 99      **X**
                                                Release 00      ☐

**Reason for change:**    This CR clarifies the functionality of the Iur Interface regarding LCS in case of a SRNS relocation.

**Clauses affected:**    6.6.2, 7.4, 7.4.1 (new)

**Other specs affected:**

| | | | |
|---|---|---|---|
| Other 3G core specifications | ☐ | → | List of CRs: |
| Other GSM core specifications | ☐ | → | List of CRs: |
| MS test specifications | ☐ | → | List of CRs: |
| BSS test specifications | ☐ | → | List of CRs: |
| O&M specifications | ☐ | → | List of CRs: |

**Other comments:**

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<--------- double-click here for help and instructions on how to create a CR.

# 6 Signalling protocols and interfaces

NOTE: This clause describes the information flows, the detailed messages and protocols are described in other clauses.

## 6.1 LCS signalling between SRNC and MSC/SGSN

LCS signalling between SRNC and MSC/SGSN is handled through the Iu interface, which is described in clause 6.6.3.

## 6.2 SRNC signalling to a target UE

SRNC signalling to a target UE is described in clause 6.6.4.1.

## 6.3 Controlling RNC signalling to a standalone LMU

Controlling RNC signalling to a standalone LMU is described in clause 6.6.4.2.

## 6.4 Controlling RNC signalling to an associated LMU

Controlling RNC signalling to an associated LMU is handled through the Iub interface, which is described in clause 6.6.1.

## 6.5 RNC-to-RNC signalling for LCS support

The RNC-to-RNC signalling for LCS support is handled through the Iur interface, which is described in clause 6.6.2.

## 6.6 Interfaces

There are four interfaces through which the LCS entities communicate. These are the Iu, the Iur, Iub and the Uu.

NOTE: the interfaces between the Internal or External LCS applications and the 3G-MSC or 3G-SGSN are outside the scope of the present document.

### 6.6.1 Iu Interface

The Iu interface is used to communicate between the LCS functional entities in the Core Network and the LCS entities in the UTRAN. Further specification of the messages and operations for LCS across the Iu interface may be found in reference [1].

### 6.6.2 Iur Interface

LCS operations at the Iur interface are defined in [14].

The Iur interface is used to communicate between the LCS functional entities associated with the serving RNC and other RNC in the UTRAN. The Iur interface is also used to communicate between the serving RNC and the Internal LCS Applications in the UTRAN. The LCS entities associated with the serving RNC are responsible for co-ordinating and responding to location requests received from the LCS entities in the core network or Internal Clients.

When communicating between the serving RNC and the UTRAN Internal LCS Applications (ILA), the messages and protocols are the same as those used over the Iur interface.

The Iur interface is also used to communicate between the LCS Entities in the serving RNC and those in other RNC. The location method, for example, may require measurements by several LMU or Node-B, some of which may be associated with other RNC. Commands and responses from these LCS Entities are communicated over the Iur interface. In some cases, the LCS Entities in the serving RNC may make use of entities associated with other RNC. For example, a calculating function (PCF) may be used in another RNC if the serving RNC is too busy or does not contain the function or database information required by the chosen location method.

The Iur interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the RNC.

Iur shall be used for LCS signalling whenever it is available, even in the case when the RNCs connected to different 3G-MSCs or 3G-SGSN.

Within UTRAN, Iur supports inter-RNC soft handover. Inter-RNC handover should also include LCS, meaning that whenever an inter-RNC soft handover occurs, Iur should be able to support the functionality of the LCS entities in RNCs, including PCF, PRRM, PSMF, and LSOF.

~~In addition, in case of SRNC relocation Iur should support the relocation mechanism in order for DRNC to be able to handle the responsibility of SRNC in LCS process. That is, to transfer the PCF, PRRM, PSMF, and LSOF functionality from SRNC to DRNC.~~ Iur shall be used also to collect RTD and other LCS information from base stations under different RNCs that are not involved in handover.

## 6.6.3 Iub Interface

LCS operations at the Iub interface are defined in [15].

The Iub interface is used to communicate among the LCS entities associated with the serving RNC, the Node-B and the associated Location Measurement Units (LMU).

This interface passes the request for measurements, the measurement results and requests for LCS related transmissions or other radio operations needed by the location method (e.g. broadcast of parameters needed for a UE based location method).

The Iub interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the Node-B or the LMU.

### 6.6.3.1 Signalling between RNC and associated LMU

Signalling exchanges between an RNC and a LMU under the control of that RNC will be specified in the NBAP protocol for associated LMUs.

The protocol layers employed to enable signalling between the RNC and an associated LMU are defined in 25.430. The LMU signalling information elements are included directly in the NBAP protocol, defined in 25.433.

## 6.6.4 Uu Interface

LCS operations at the Uu interface are generally defined in [1]. This specification defines in more detail the procedures needed for messaging for each individual location method.

The Uu interface is used to communicate among the LCS entities associated with the RNC, the UEs and the stand-alone Location Measurement Units (LMU) (the Uu interface is also used to communicate between the LCS entities in the core network and the UE. Those communications are beyond the scope of this specification).

This interface may pass measurement requests and results to and from the UE or the stand-alone LMU.

The Uu interface may also pass location requests from internal or external LCS Applications at the UE.

NOTE: These requests may require the services of the LCS entities associated with the core network to authenticate clients and subscriber subscriptions to aspects of the LCS.

The Uu interface may also be used for broadcast of information that may be used by the UE or stand-alone LMU for their LCS operations. This may, for example, include timing and code information about nearby Node-B transmissions that may assist the UE or LMU in making their measurements.

The Uu interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the UE or the remote LMU.

## 6.6.4.1      Signalling between S-RNC and Target UE

LCS related signalling between an S-RNC and a target UE is supported by the RRC protocol.

The location Request to UE signalling flow is generic for all UE based or assisted location methods (OTDOA and Network Assisted GPS).
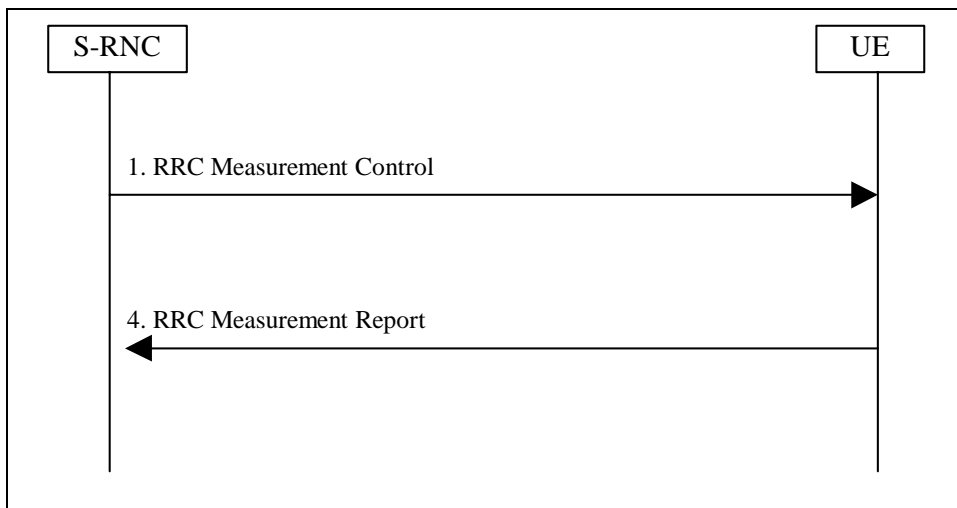


**Figure 6.1: OTDOA /GPS Location Message Flow**

1. The S-RNC determines possible assistance data and sends a MEASUREMENT CONTROL request to the UE.

2. Provided that location request meets the privacy criteria, the UE performs the requested measurements. If the UE is able to calculate its own location, and this is requested, the UE computes a location estimate based on measurements. Any assistance data necessary to perform these operations will either be provided in the MEASUREMENT CONTROL request or be available from broadcast sources. The resulting measurements or location estimate are returned to UTRAN in a MEASUREMENT REPORT response. If the UE cannot fulfil the request, a MEASUREMENT CONTROL FAILURE message is returned.

### 6.6.4.1.1      Assistance Data Delivery to UE

The assistance data signalling flow illustrated here is generic for UE based location methods, including OTDOA and Network Assisted GPS. Note that if the assistance data is sent as part of a broadcast message, then no assistance data acknowledgement is required.
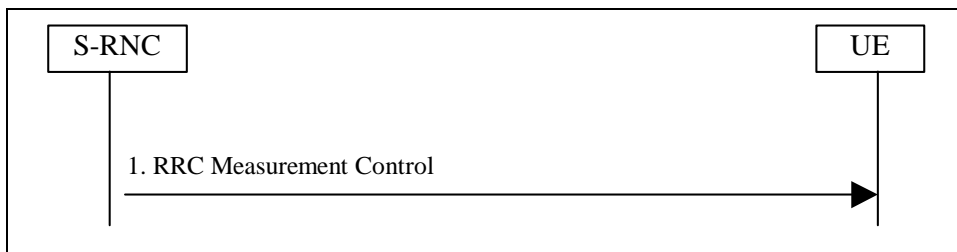


**Figure 6.2: OTDOA or GPS Assistance Data Delivery Flow**

1. The S-RNC determines assistance data and sends it in the RRC MEASUREMENT CONTROL message to the UE.

### 6.6.4.1.2   Error Handling

The error handling for signalling on the Uu interface is handled by the RRC protocol.

### 6.6.4.1.3	Broadcast of Assistance Data

In the UE Based OTDOA or Network Assisted GPS methods, where the measurements and/or location calculation is done in the UE, assistance data may be broadcast to the UE.

The assistance data to be broadcast for UE Based OTDOA contains the Relative Time Difference (RTD) values (e.g. in case of a non-synchronised network) and base station co-ordinates. In addition, the broadcast data may contain other information to simplify the OTDOA measurements. The length of the message depends on how many neighbours are included in the assistance data. Part of the broadcast message (e.g. the serving and neighbour base station geographic co-ordinates) may be ciphered.

The assistance data to be broadcast for assisted GPS contains DGPS corrections, ephemeris and clock corrections, as well as almanac and other data. Part of the broadcast message may be ciphered.

The broadcast channel that is used for the OTDOA and GPS assistance data makes use of the common UTRAN broadcast service.

### 6.6.4.1.4	Signalling Flow for Assistance Data Broadcast Using the Common UTRAN Broadcast Service

The assistance data broadcast to UEs can be signalled via the RRC Measurement Control message as shown in subclause 6.6.4.2 or it can be broadcast by the UTRAN within the system information.
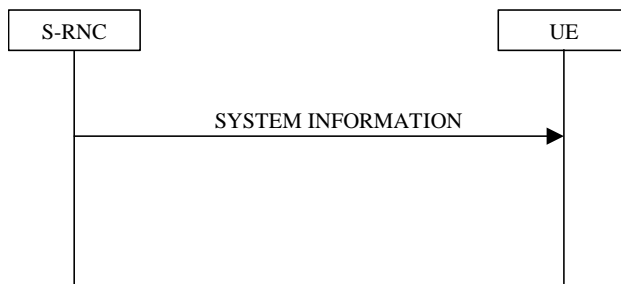
**Figure 6.3: Broadcast of system information**

### 6.6.4.1.5	LCS Assistance Data Ciphering

To allow control of access to the assistance data, parts of the broadcast assistance data may be ciphered. Ciphering is done with a specific ciphering key delivered by the core network for this purpose. The management of the key is described in the System Aspects Stage 2 ([1]).

### 6.6.4.1.6	LCS Assistance Data Ciphering Algorithm

The algorithm used for ciphering the LCS assistance data is the standard 56-bit Data Encryption Standard (DES) algorithm.

The deciphering of broadcast assistance messages is done in the UEs. The deciphering will utilize the deciphering keys delivered during the location update request.

The RNC ciphers the parts of the LCS Broadcast Data message to be protected using the 56-bit DES algorithm and a ciphering keys (56 bits) and Ciphering Serial Number (16 bits) for the broadcast location area.

The ciphered part is variable in length with one bit resolution. By using the LCS Broadcast Data message header, the UEs can determine what part of message is ciphered.

Inputs to the 56-bit DES algorithm are the following:

-	56-bit key K (deciphering key);

-	16-bit Ciphering Serial Number from broadcast message which is denoted here by IV (Initialization Vector);

-	plain-text bits (the ciphered part of broadcast message).

The ciphering process is illustrated in the following diagram. Ciphering is done by producing a mask bit stream which is then "XORed" bit-by-bit to the plain-text data to obtain the cipher-text data. First, the Initialization Vector (IV) is concatenated with 0-bits in order to achieve a 64-bit block $I_1$. This block is then encrypted by the DES algorithm using the key K. Output is a 64-bit block $I_2$. This constitutes the first 64 bits of the mask bit stream. If the message is longer than 64 bits, then more bits are needed. These are produced by encrypting $I_2$ again by the DES algorithm using the key K. The output is a 64-bit block $I_3$. This is the next 64 bits of the mask bit stream. This iteration is continued until enough bits are produced. The unnecessary bits from the last 64-bit block $I_j$ are discarded. The figure below illustrates the first two mask bit generations and the two ciphered 64-bit blocks.
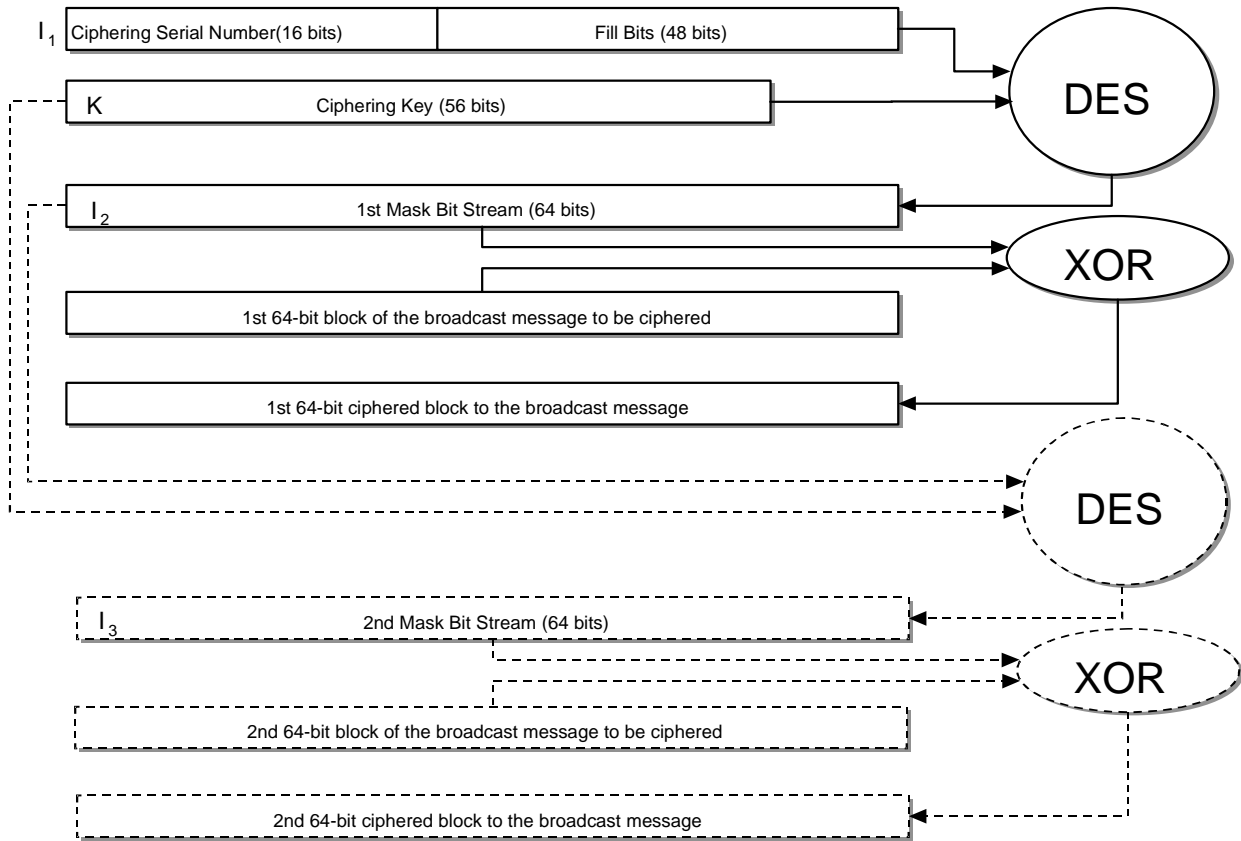


**Figure 6.4: Data Assistance Ciphering Algorithm**

Deciphering is done similarly. The same mask bit stream is produced and these are XORed, bit-by-bit, to the cipher-text data bits. The result will be the plain-text data.

### 6.6.4.2    Signalling between RNC and stand-alone LMU

The use of stand-alone LMUs is FFS. If it is decided to have stand-alone LMUs in the standard, the signalling will be performed with the new protocol LLP. If no need is seen for the stand-alone LMUs the LLP protocol will not be defined and it will be removed from 25.305.

The following figures illustrate the protocol layers used to support signalling between an RNC and a Stand-Alone LMU over the Uu interface.
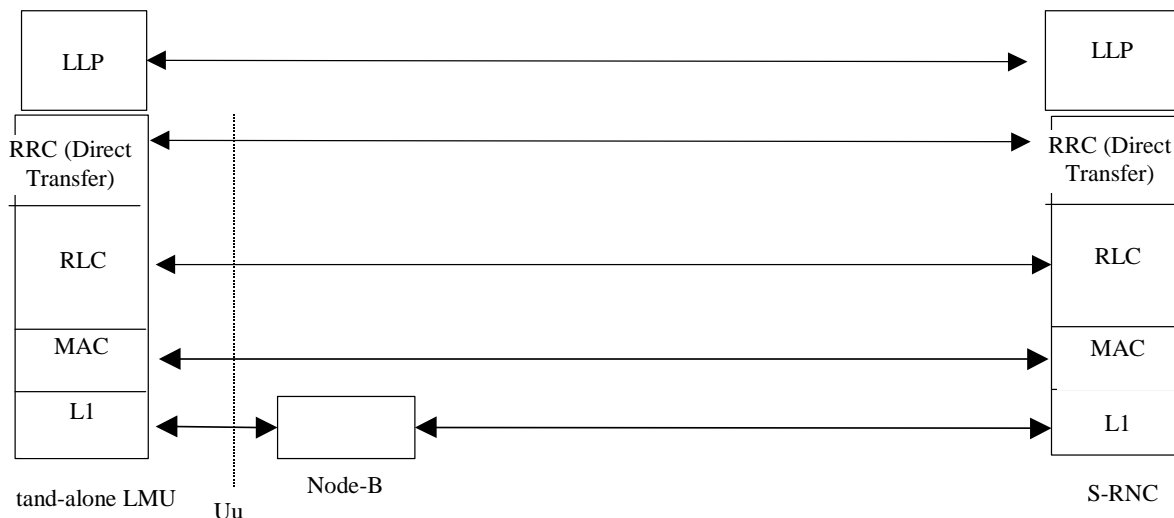
### 6.6.4.2.1 Signalling using a signalling bearer



**Figure 6.5: Signalling between an RNC and a Stand-Alone LMU using a signalling bearer**
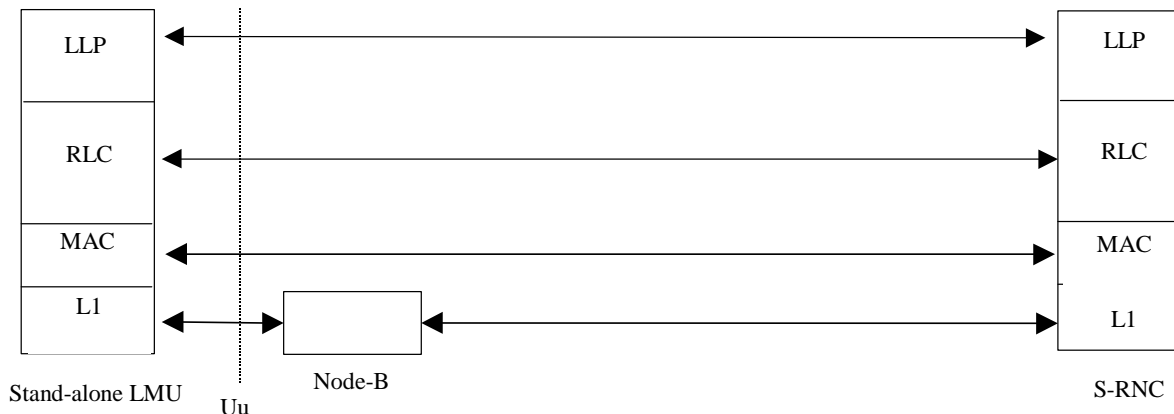
### 6.6.4.2.2 Signalling using a radio bearer



**Figure 6.6: Signalling between an RNC and a Stand-Alone LMU using a radio bearer**

# 7 General UMTS location procedures

## 7.1 General network location procedures

The General network location procedure in UTRAN start with a request over Iu from the CN. UTRAN then determines the UE location by selecting a suitable location method. UTRAN then responds to the request with the estimated location and possible an associated accuracy.

## 7.2    Common procedures to support access to a LMU

NOTE:    7.2 and 7.3 will be considered if stand-alone LMUs are included.

## 7.3    Common control procedures for LMUs

## 7.3.1    Reset procedure

## 7.3.2    Status query procedure

## 7.3.3    Status update procedure

## 7.4 Common procedures supporting LCS interaction between RNCs

In the case that LCS information is needed from an associated LMU in a Node B that is not controlled by the SRNC information transfer is needed on the Iur interface. This information is the same information that is signalled between an associated LMU and the corresponding controlling RNC in the case when Iur support is not needed.

The SRNC requests the information it requires (e.g. GPS timing of cell measurements) from the controlling RNC of the Node B which has the associated LMU. The controlling RNC in turn requests the information from the Node B and upon success returns the results to the SRNC.

Similarly when the SRNC needs a Node B measurement on a UE when that Node B is not controlled by that SRNC there needs to be support on the Iur. One example is the RTT measurement.

Other information that may need to be signalled over the Iur includes LMU parameters (geographical position, covered cells etc.). NOTE: Confirmation or FS is needed by R3 experts.

NOTE:    LCS during SRNS relocation is unclear.

## 7.4.1    Signalling in case of SRNS relocation

In case of SRNC relocation the PCF, LSCF and LSOF functionality may be transferred in order for DRNC to be able to handle the responsibility of SRNC in LCS process. Therefor the Source RNC may transfer the following information to the Target RNC :

– location method dependant information necessary for position calculation as specified in 9.7 and 10.6

– last known position, time stamp and accuracy of the position calculation

– LCS capabilities of the UE

Additionally the location service requests that are stored in the Source RNC shall be transferred from Source to Target RNC.

The old SRNC shall decide whether it is sensible to transfer any of the above mentioned information during SRNS relocation. The new SRNC may either use these information to continue the location procedure or stop the location attempt and start a new one.

## 7.4.1    Signalling in case of SRNS relocation

In case of SRNC relocation the PCF, LSCF and LSOF functionality may be transferred in order for DRNC to be able to handle the responsibility of SRNC in LCS process. Therefore the Source RNC may transfer the following information to the Target RNC :

- last known position, time stamp and accuracy of the position calculation

- LCS capabilities of the UE

NOTE: If it is possible to transfer the location service requests that are stored in the Source RNC during SRNS relocation is ffs.

If there is a location procedure going on in order to estimate the position of the UE and a SRNS relocation occurs, the location procedure shall be stopped in the old SRNC. After SRNS relocation, the new SRNC then decides if a new location procedure should be started. In the UE, the location procedure is going on and LCS information (e.g. measurement results) may be sent back to UTRAN if the UE was requested to do so. The new SRNC then decides whether it wants to use these information or discard them.

# 7.5　　Exception procedures

## 7.5.1　Procedures in the SRNC

When a location attempt fails due to failure of a position method itself (e.g. due to inaccurate or insufficient position measurements and related data) and the SRNC is unable to instigate another positioning attempt (e.g. due to a requirement on response time), the SRNC may return a Location response over the Iu interface containing a less accurate location estimate. If a less accurate estimate is not available or will not meet the accuracy requirement, the SRNC may instead return a Location response message containing no location estimate and indicating the cause of failure.

NOTE: Need to check that Iu has enough flexibility

When a location attempt is interrupted by some other unrecoverable error event inside the SRNC, the SRNC shall immediately terminate the location attempt and return a Location Response message containing the reason for the location attempt cancellation. In that case, any dialogue previously opened with an LMU for the purpose of instigating position measurements for the UE being located may also be aborted by the SMLC.

## 7.5.2 Procedures in a LMU

An LMU shall return an error indication to its controlling RNC when location measurements previously ordered by the RNC cannot be provided due to any error condition.

## 7.5.3　　Procedures in the target UE

A target UE shall terminate any positioning procedure or the transfer of RRC positioning assistance data without sending any response to the SRNC if any LCS RRC message is received from the SRNC that starts some other RRC management procedure. The new RRC procedure shall then be executed by the UE.

# 7.6　　Radio interface timing procedures

The Radio Interface Timing determination system consists of functions in LMUs and in the SRNC. The system runs continuously offering cell timing information for mobile station location.

## 7.6.1　　LMU Functions

The Radio Interface Timing functionality in the LMU should be capable of performing the following functions:

- The LMU performs necessary air interface measurements from signals transmitted by Node Bs

- If the LMU contains a common reference clock, e.g. GPS TOW, it time stamps reception of Node B signals.

- If there is no reference clock available, the LMU may make Relative Time Difference measurements, i.e. measures the time difference between arrival of SFNs

- The LMU may perform some processing of measurements, like averaging and filtering, using parameters delivered to it, or in their absence using default settings

## 7.6.2 SRNC Functions

The SRNC must be capable of performing the following functions related to Radio Interface Timing determination:

- The SRNC sends to LMUs requests for Radio Interface Timing measurement information.

- The SRNC will communicate regularly with LMUs; thus, the SRNC can monitor operation of LMUs. If a LMU fails to send Radio Interface Timing information, the SRNC shall try to restart the LMU, and if this restarting fails, the SRNC shall inform O&M system. SRNC can use also diagnostics messages to query the status of LMUs.

- The SRNC receives Radio Interface Timing measurement results from LMUs.

- The SRNC stores or queries extra information required for Node B synchronization determination, like base station and LMU coordinates, Node B identity information.

- The SRNC determines synchronization differences between different downlink signals using LMU measurements and other information.

- Synchronization information is delivered for UE location purposes.

## 7.6.3 LMU-SRNC Interactions

The request for Radio Interface Timing measurement information from the SRNC to a LMU contains the following parameters:

- Measurement type. This indicates whether the SRNC wants the LMU to perform Absolute Time Difference (ATD) (e.g. GPS time stamp of signal) or Relative Time Difference (RTD) measurements.

- Measurement result reporting frequency. This indicates how often the LMU should send Radio Interface Timing measurement results.

- Measurement duration. This indicates how long the LMU should make measurements and report results.

- Instructions about filtering of raw measurement data.

- Instructions about Primary CPICH signals to be measured. The LMU unit can measure autonomously a certain number of most strongly received signals. Another possibility is that the SRNC tells which Node B signals it should measure.

- In the RTD case, which common Primary CPICH the LMU should use as a reference in the measurements.

- Instruction of how the measurement quality should be reported.

The Radio Interface Timing measurement response from a LMU to the SRNC contains:

- Identity of the Node B at which the asssociated LMU is residing

- Primary CPICH info of the measured signals.

- If the LMU can perform ATD measurements, and it is requested to do them, the ATD measurements of the requested CPICH signals is returned.

- If the LMU can perform RTD measurements, and it is requested to do them, the RTD measurements of the requested CPICH signals is returned.

- The SFN of the last frame measured, for each measurement.

- The quality of each measurement, according to the requested quality type

**Note: There are no changes in the following sections. They are only included to show the changes between the originial and the revised version!**

# 8        Cell ID based location method

In the Cell ID based method, the S-RNC determines the identification of the cell providing coverage for the target UE. This subsection outlines the procedures for this location method. Sub-section 8.1 provides procedures for the determination of the cell ID depending on the operational status of the target UE. Sub-section 8.2 discusses the relation between the LCS location service and the Support of Localised Service Area (SoLSA) feature. Sub-section 8.3 provides a procedure for the mapping of the Cell ID to a corresponding Service Area Identifier (SAI) to be returned to the LCS application in the core network. The general flow to determine the cell ID is shown in figure 8.1.
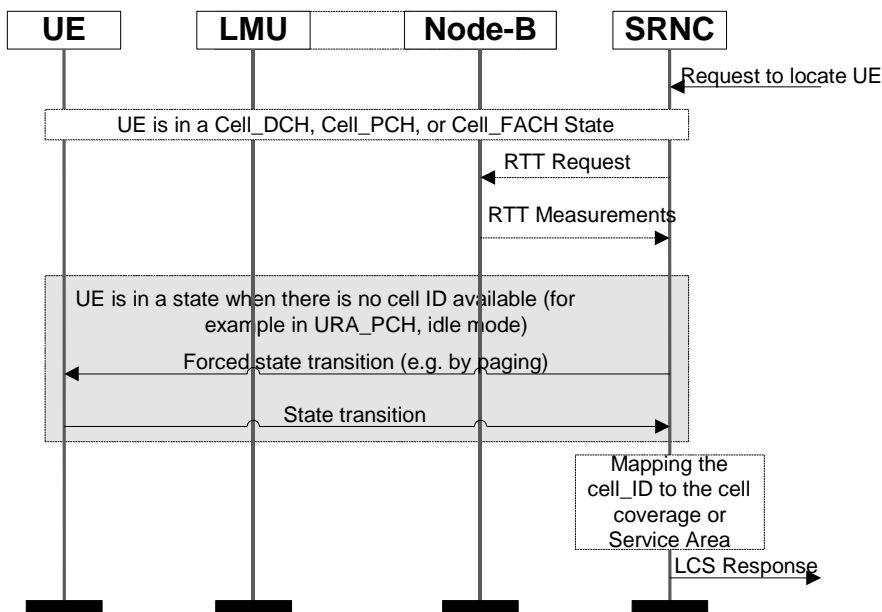


**Figure 8.1: Cell ID Based Method**

## 8.1        Cell ID determination

In order for the S-RNC to determine the cell ID when an LCS request is received, additional operations may be needed depending on the operational status of the UE.

Figure 8.1 illustrates the procedure for the cell ID based location method when the UE is in different RRC states. When the LCS request is received from the core network the S-RNC checks the state of the target UE. If the UE is in a state where the cell ID is available, the target cell ID is chosen as the basis for the UE location. In states where the cell ID is not available, the UE is paged, so that S-RNC can establish the cell with which the target UE is associated. In order to improve the accuracy of the LCS response the S-RNC may also request RTT or RX Timing Deviation measurements from the Node B or LMU associated with the cell ID. The S-RNC may also map the cell ID to a corresponding Service Area Identifier (SAI) to match the service coverage information available in the core network.

The cell ID based method shall determine the location of the UE regardless of the RRC state, including URA_PCH, Cell_PCH, Cell_DCH, Cell_FACH, cell reselection, inter-system modes, as well as an idle mode.

### 8.1.1        UE Cell ID is not known

For UE for which the cell ID is not known at the time the LCS request is received at the S-RNC, the UE may be paged to locate its current cell ID. If the UE is in an idle mode and there is a need for it to be paged, then the paging may be initiated either by the core network or by the S-RNC in the UTRAN access network. For example, the UE can be forced to perform a transition to a Cell_FACH state to define the cell ID of its current cell.

If the UE is in an idle mode, Cell_PCH state or in any other state when there is a need to page for the UE to obtain the cell ID, the Core Network may initiate paging, authentication and ciphering, as specified in TS 23.171.

Alternatively, the cell ID may be determined as the one that was used during the last active connection to the UE. This determination should be accompanied by the time-of-day of the last connection in the cell.

## 8.1.2 UE Cell ID is known

### 8.1.2.1 UE not in Soft handover

The cell ID may be determined as the cell that is providing an active connection for the UE at the time of receiving the LCS request at the S-RNC.

### 8.1.2.2 UE in Soft handover

In order for the S-RNC to provide the geographical co-ordinates of a target UE in soft handover, the S-RNC combines the information about all cells associated with the UE.

In soft handover, the UE may have several signal branches connected to different cells, reporting different cell IDs. A reference cell ID may be determined by the S-RNC based on the coverage area of each cell. The reference cell ID may be selected based on one or more of the following principles:

- the cell ID may be selected based on the parameters defining the quality of the received signal branches. That is, the cell ID with the best quality signal branch is selected as the reference cell ID;

- the cell ID may be selected that was used during connection set-up between the UE and the serving Node B;

- the cell ID of the cell most recently associated with the UE may be selected;;

- the cell ID of the latest "new" cell that the UE has started to receive, but has not yet been handed over to may be selected;

- the cell ID may be selected as the cell to which UE has the shortest distance (to the Node-B site);

- the cell ID may be selected as the cell that provides an active connection for the UE at the time of receiving theLCS request at the S-RNC.

The selection may also be based on measurements of Round Trip Time, power levels and received signal strengths in UE and related Node B or LMU.

Other relevant mechanisms such as Idle Period Downlink, (IPDL) or Site Selection Diversity Transmit power control (SSDT) should also be taken into account when applying the cell ID selection procedure for UE in a soft handover mode.

## 8.2 Localised Service Area

The Support of Localised Service Area (SoLSA) feature is quite close to the location service in principle, but SoLSA is based, for example, on radio network cell coverage and cell configuration. SoLSA has been standardised in GSM and is being developed for UTRAN. Some SoLSA service features like Exclusive Access and LSA only Access may be less applicable in UTRAN due to the 1 frequency reuse.

It should be noted that the Service Area concept described in this specification is different from the Localised Service Area concept defined for SoLSA.

## 8.3 Mapping the Cell ID to Geographic Co-ordinates or a Service Area

A UTRAN cell ID should be mapped to geographical coordinates or a Service Area Identifier (SAI) before being sent from UTRAN to the core network. The Service Area Identifier may include one or several cells. The mapping may be accomplished either in the S-RNC, in a Network Management System (NMS, including Network Management Unit, NEMU) or by co-operation of various access network elements.

The core network may request the geographical co-ordinates or the SAI, or both for the target UE. The SAI may be used for routing of corresponding Emergency calls, or for CAMEL services to correspond to the usage of Cell ID in the core network of GSM. However, the MSC shall not send the Service Area Identity to GMLC.

Although the mapping of the cell(s) associated with the target UE into geographical co-ordinates by the S-RNC is not standardised, the response to the core network location request with geographical co-ordinates shall be as defined in TS 23.032.

It should be noted that the Service Area concept is different from the Localised Service Area concept used for SoLSA services.

In order to determine a cell coverage estimate and to map it to the geographical coordinates or Service Area parameter Identity, the S-RNC may use parameters such as the best reference signal, Round Trip Time (RTT) in FDD [17] or Rx Timing Deviation [18] and knowledge of the UE timing advance in TDD, as well as antenna beam direction parameters.

Alternatively, the service area coverage of a cell may be determined by using a reference signal power budget. Based on the reference signal power budget it is possible to obtain, for example, the base station transmitted power, isotropic path loss, coverage threshold at coverage area border for a given location probability, and a cell radius for an indoor and outdoor coverage.

The S-RNC may use a reference signal link budget based cell radius estimate, in conjunction with the cell identifier, to make a coverage estimation for the cell(s) related to the target UE.

Additionally, the S-RNC may compare the received power levels with the power budget, whereby more accurate information of the location of the UE may be provided.

Also, the interaction between neighbouring cell coverage areas may be used to determine a more exact location of the UE.

# 9       OTDOA location method

The primary standard OTDOA measurement is the "SFN-SFN observed time difference" observed at the UE (see [17 and [18]. These measurements, together with other information concerning the surveyed geographic location of the transmitters and the relative time difference (RTD) of the actual transmissions of the downlink signals may be used to calculate an estimate of the location of the UE. Each OTDOA measurement for a pair of downlink transmissions describes a line of constant difference (a hyperbola (see note 1)) along which the UE may be located. The UE's location is determined by the intersection of these lines for at least two pairs of base stations. The accuracy of the location estimates made with this technique depends on the precision of the timing measurements, the relative location of the base stations involved (see note 2), and is also subject to the effects of multipath radio propagation. This is illustrated in the figure 9.1.

NOTE 1:   This is really a figure in three dimensions, a hyperboloid. For convenience here, this will be simplified to the hyperbola representing the intersection of this surface with the surface of the earth. For location service in three dimensions the hyperboloid must be considered.

NOTE 2:   The geometry of the base station locations may affect the accuracy of the location estimate. The best results are when the base stations equally surround the UE. If they do not, there is a reduction in accuracy, which is sometimes termed the Geometric Dilution of Position (GDP).

The primary OTDOA measurements (made by the UE) are sent to the Position Calculation Function (PCF) in the serving RNC. These measures are sent via signalling over the Uu, Iub (and Iur) interfaces between the UE and the SRNC (PCF). The calculation function makes use of the measurements, the known locations of the transmitter sites and the relative time difference of the transmissions to estimate the UE's location.
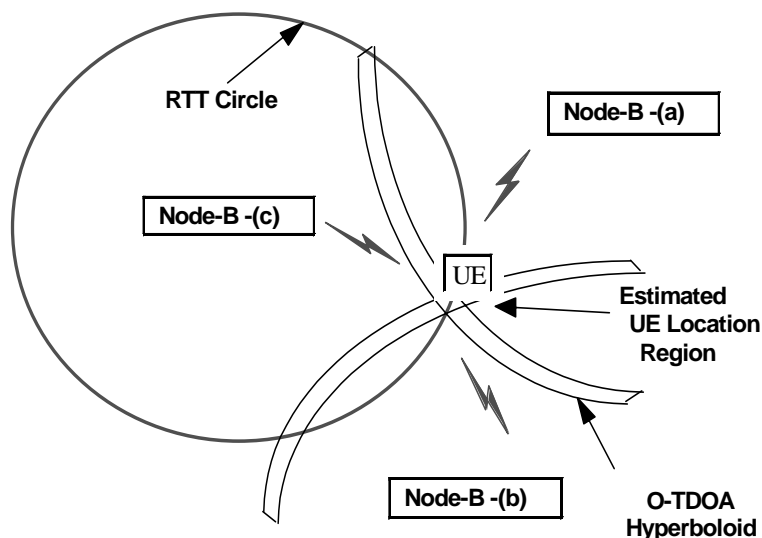
**Figure 9.1: OTDOA Location Method**

The OTDOA method may be operated in two modes: UE assisted OTDOA and UE based OTDOA. The two modes differ in where the actual location calculation is carried out. In the *UE assisted* mode, the UE measures the difference in time of arrival of several cells and signals the measurement results to the network, where a network element (the Position Calculation Function (PCF)) carries out the location calculation. In the *UE based* mode, the UE makes the measurements and also carries out the location calculation, and thus requires additional information (such as the location of the measured base stations) that is required for the location calculation. The signalling requirements for the two OTDOA modes are described in a later subclause. As the LCS involves measurements, there is always uncertainty in the results. Physical conditions, errors and resolution limits in the apparatus all contribute to uncertainty. To minimise the uncertainty in the LCS result, it is important that as many measurements of TDOA (and assistance data as RTT in FDD and Rx Timing Deviation in TDD) as are possible for a UE are provided to the PCF. Thus it is important that the standard method for LCS not be restricted to rely on a single measure. The UE thus provides SFN-SFN observed time difference measurements for as many cells as it can receive. The cellsto be measured shall include those in the "cell reselection and monitoring set" and those in the "cell selection set".

In order to support the OTDOA method, the locations of the UTRAN transmitters needs to be accurately known by the calculation function (PCF). This information may be measured by appropriate conventional surveying techniques (see note 3). The surveyed location should be the electrical centre of the transmitting antenna (and not the location of the radio equipment building). The use of antenna diversity, beamforming or beam steering techniques may cause the effective antenna location to change with time and this information will need to be communicated to the PCF to assist with its calculations. The methods of measuring the location of the UTRAN transmitters are outside the scope of the present document.

NOTE 3: These surveying methods may, for example, make use of a GPS receiver.

In order to support the OTDOA method, the relative time difference (RTD) of the downlink transmissions must also be known by the calculation function (PCF). If the UTRAN transmitters are unsynchronised, the RTD will change over time as the individual clocks drift. Thus, measurements of RTD may need to be made regularly and the calculation function updated appropriately. The measurement of the RTD is outside the scope of the present document (see note 4).

NOTE 4: One convenient method is to make use of an LMU at a fixed location. This unit measures the observed time differences of all the local transmitters and reports these to the PCF. These measures may then be converted (translated) into the actual (absolute) relative time difference for each of the transmitters by making use of the known location of the LMU and the transmitters.

In some conditions a sufficient number of cells may not be available for measure at the UE. This may occur, for example, if the UE is located quite close to the UTRAN transmitter and its receiver is blocked by the strong local transmissions. This is referred to as the "hearability" problem.

# 9.1 Use of Idle Periods (FDD only)

For realising location based services the support of physical layer is a prerequisite, so that the measurements required for the terminal location calculation can be carried out. In UTRAN there are several factors that must be taken into account while considering the physical layer procedures related to location services:

- hearability: a basic consequence of a CDMA radio system is that a terminal near its serving base station cannot hear other base stations on the same frequency. In order to calculate terminal location the terminal should be able to receive at least three base stations. To facilitate this some special means are required;

- asynchronous network causes significant uncertainty to the time-difference-of-arrival (TDOA) measurements. To compensate for the effects of this, the relative time difference (the synchronicity) between base station transmissions must be measured, and used for correcting TDOA measurement;

- capacity loss: signalling related to location calculation may take capacity from other services. This capacity loss should be minimised.

Based on the results of the work done in ARIB SWG2/ST9 (see reference [21]) a solution for the above mentioned hearability problem is the IPDL (Idle Period DownLink) method. In this method each base station ceases its transmission for short periods of time (idle periods). During an idle period of a base station, terminals within the cell can measure other base stations and the hearability problem is reduced. Also, during idle periods the real time difference measurements can be carried out. Because the IPDL method is based on forward link (downlink) the location service can be provided efficiently to a large number of terminals simultaneously.

The specification and operation of the IPDL technique are provided in the following subclause.

## 9.1.1 Operation and specification of idle periods

The operation and specification of idle periods can be found in TS 25.214 (reference [16]).

# 9.2 Relative Time Difference (RTD)

In order to calculate the estimate of the location of the UE, the calculation function needs to know:

- the OTDOA measurements;

- the surveyed geographic locations of the base stations that have had their signals measured; and

- the actual relative time difference between the transmissions of the base stations at the time the OTDOA measurements were made.

The accuracy of each of these measurements contributes to the overall accuracy of the location estimate. The measurement of the RTD is described in the following.

There are several approaches to determining the RTD. One is to synchronise the transmissions of the base stations. In this technique the RTD are known constant values (see NOTE) that may be entered in the database and used by the calculation function when making a location estimate. The synchronisation must be done to a level of accuracy of the order of tens of nanoseconds (as 10 nanoseconds uncertainty contributes 3 metres error in the location estimate). Drift and jitter in the synchronisation timing must also be well controlled as these also contribute uncertainty in the location estimate. Synchronisation to this level of accuracy is currently only readily available through satellite based time-transfer techniques. Generally in the TDD operating mode, the base stations are synchronised.

NOTE: The transmission times may all be aligned to a common reference (such as UTC) in which case all RTD have a common value. However, in a more general case the transmissions may have a fixed offset with reference to UTC, and thus the RTD values are non-zero and may be stored in the database for use by the calculation function.

Alternatively (typically in FDD mode), the base stations may be left to free run within some constraint of maximum frequency error. In this scenario, the RTD will change (slowly) with time. The rate of change will depend on the frequency difference and jitter between base stations. If, for example, the maximum frequency difference between two base stations is $\pm 10^{-9}$, then the start of transmission of a 10 millisecond code sequence will drift through a cycle in about 1 390 hours (or 57 days). With this relatively slow rate of drift the RTD can be measured by fixed units at known

locations (these are LMUs, Location Measurement Units) and stored in the database for use by the calculation function. The jitter and drift of the individual oscillators in each base station may cause the change of timing to slow, remain constant or reverse direction over time. Ongoing measurements of the RTD may be made to assure the most current values are available for the calculation function. The RTD measurement units may be co-located with the base stations or installed at other convenient locations in the UTRAN coverage area, and report their results through the UTRAN signalling channels.

## 9.3    Time of Day (ToD)

If there are frequency drifts between the (unsynchronised) Node Bs, as noted in the previous subclause, the OTDOA measurements must be reported together with the time-of-day they were made (timestamp). This is necessary so that the appropriate value of the RTD may be used by the calculation function.

In order to assure less than a 20 nanosecond uncertainty in the RTD value, the time of day must be known to better than 10 seconds (if the maximum frequency difference between the base stations is $\pm 10^{-9}$ ). The method by which the ToD is measured is the system the frame number, which provides a 10 millisecond resolution and can be unambiguous up to 40.95 seconds..

## 9.4    Base Station Synchronisation

It is preferable that the location methods do not require the base station network to be synchronised. The needed level of synchronisation accuracy for LCS is not by any means straightforward to achieve. The necessary information of Relative Time Differences (RTD) between base stations can be measured by dedicated units (LMU, Location Measurement Unit) and distributed in the network (e.g. as broadcast information). Also, the measurements of RTD may benefit from the Idle Period DownLink (IPDL) option.

In the TDD operating mode the base stations will typically be synchronised and this may be of assistance to the LCS technique.

## 9.5    OTDOA-IPDL and OTDOA Modes

There are two modes of operation for the OTDOA-IPDL and OTDOA methods. In the *UE assisted* mode, the UE measures the difference in time of arrival of several cells and signals the measurement results to the network, where a network element (the Position Calculation Function (PCF)) carries out the location calculation. In the *UE based* mode, the UE makes the measurements and also carries out the location calculation, and thus requires additional information (such as the location of the measured base stations) that is required for the location calculation. This information is provided by the Location System Information Function (LSIF).

Table 9.1 lists the required information for both UE assisted and UE based modes. The required information can be signalled to the UE either in a broadcast channel or partly also as dedicated signalling.

**Table 9.1: Information required for UE assisted and UE based OTDOA- IPDL and OTDOA in the UTRAN (LSIF) to UE direction ('Yes' = information required, 'No' = Information not required)**

| Information | UE assisted | UE based |
|---|---|---|
| Intra frequency Cell Info (neighbour list). | Yes | Yes |
| Ciphering information for LCS (see note) | No | Yes |
| Measurement control information (idle period locations) | Yes | Yes |
| Sectorisation of the neighbouring cells | No | Yes |
| Measured RTD values for Cells mentioned at Intra frequency Cell Info | No | Yes |
| RTD accuracy | No | Yes |
| Measured roundtrip delay for primary serving cell | No | Yes |
| Geographical location of the primary serving cell. | No | Yes |
| Relative neighbour cell geographical location | No | Yes |
| Accuracy range of the geographic location values | No | Yes |
| NOTE:    The idea behind LCS specific ciphering information is e.g. that the operator can sell information that the UE needs for calculating its location. For reference in the GSM world see [3]. | | |

The information required from UE to UTRAN (PSMF/PCF) is listed in table 9.2.

**Table 9.2: Information required for UE assisted and UE based OTDOA- IPDL and OTDOA in the UE to UTRAN (PSMF/PCF) direction**

| Information | UE assisted | UE based |
|---|---|---|
| OTDOA measurement results | Yes | No |
| OTDOA measurement accuracy | Yes | No |
| UE geographical location | No | Yes |
| Location accuracy indicator (based on the signalled and measurement accuracies) | No | Yes |

# 9.6     OTDOA network location procedures

The following diagram illustrates the operations for the OTDOA-LCS when the request for location information is initiated by an LCS application signalled from the Core Network. As these operations are internal to the RNC, this diagram is to illustrate information flow and implementations may use alternate arrangements.

This illustration only includes the information flow related to LCS operations and does not indicate other operations that may be required, for example, to establish a signalling connection between the UE and the SRNC. Also not illustrated is the signalling used to initiate the location service request (from the Location Client Function) from the Core Network or a UE based application.
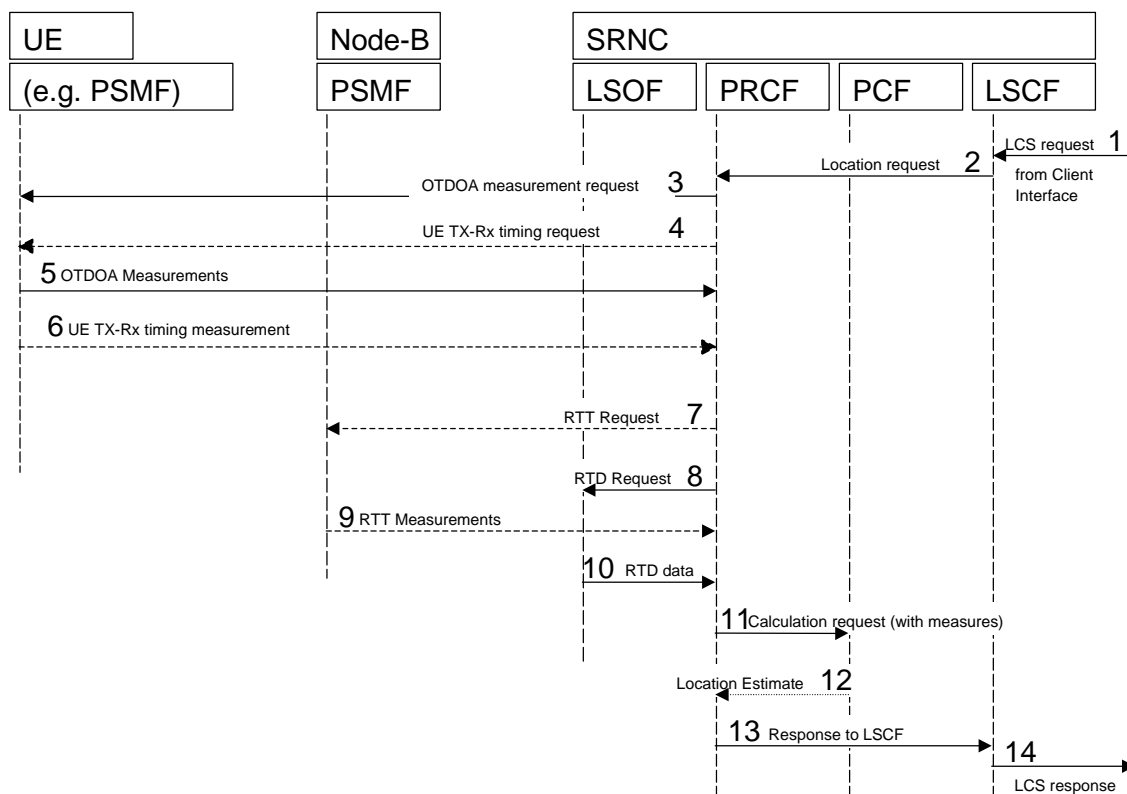
**Figure 9.2: OTDOA Signalling Operations**

1. The operation begins with an authenticated request for location information about a UE from an application in the core network being received at the LSCF. The LSCF acts as interface between the Core Network and the LCS entities in the UTRAN.

2. The LSCF considers the request and the capabilities of the UE and the network and forwards the request to the appropriate PRCF in the Serving RNC.

3. The PRCF requests from the UE the measurement of the OTDOA for the signals in the active and neighbourhood sets. These measurements may be made while the UE is in the idle state or while it is connected.

4.  If it is considered advantageous to do so, the PRCF requests the UE TX-Rx timing difference information from the UE.

5.  The UE returns the OTDOA measures to the PRCF. The PRCF receives the OTDOA information and co-ordinates obtaining other information to support the calculation request (not illustrated).

6.  The UE returns the UE TX-Rx timing difference information to the PRCF, together with a time stamp of when the value was obtained.

7.  If there are insufficient OTDOA measures, or it is otherwise considered advantageous to do so, the PRCF requests the RTT measure for the UE from the PSMF in the serving Node-B.

8.  The PRCF requests the RTD measures for the associated transmitters from the LSOF (database). These may be stored locally if they are constant over time, otherwise they must be updated to represent the RTD timing at the time-of-day the OTDOA measurements were made.

9.  The PSMF in the Node-B returns the RTT measures to the PRCF if they were requested.

10. The LSOF returns the RTD information to the PRCF.

11. The PRCF passes the OTDOA, RTD and, if necessary, RTT information to the PCF and requests a location calculation. The calculation may include a co-ordinate transformation to the geographic system requested by the application.

12. The PCF returns the location estimate to the PRCF. This estimate includes the location, the estimated accuracy of the results and the time of day of the estimate.

13. The PRCF passes the location estimate to the LSCF.

14. The LSCF passes the location estimate to the Core Network.

## 9.7        Information to be transferred during SRNS relocation

The following information may be transferred from Source to Target RNC if a OTDOA location procedure is going on and a SRNS relocation is performed:

- Intra frequency cell info (neighbour list) of the neighbour cells associated to the old SRNC

- Sectorisation of the neighbour cells associated with the old SRNC

- Relative neighbour cell geographical location of the neighbour cells associated with the old SRNC to the serving cell

- Accuracy range of the geographic location values

- Measured RTD values for cells mentioned in Intra frequency cell info

- RTD accuracy

- RTT or Rx Timing Deviation

- OTDOA measurement results

- OTDOA measurement accuracy

# 10        Network assisted GPS location method

When GPS is designed to inter-work with the UTRAN, the network assists the UE GPS receiver to improve the performance in several respects. These performance improvements will:

-   reduce the UE GPS start-up and acquisition times; the search window can be limited and the measurements sped up significantly;

- increase the UE GPS sensitivity; location assistance messages are obtained via UTRAN so the UE GPS can operate also in low SNR situations when it is unable to demodulate UE GPS signals;

- allow the UE to consume less handset power than with stand-alone GPS ; this is due to rapid start-up times as the GPS can be in idle mode when it is not needed.

The Network assisted GPS methods rely on signalling between possibly reduced complexity UE GPS receivers and a continuously operating GPS reference receiver network which has clear sky visibility of the same GPS constellation as the assisted UEs. GPS reference receivers may be connected to the UTRAN to enable derivation of UE assistance signals.
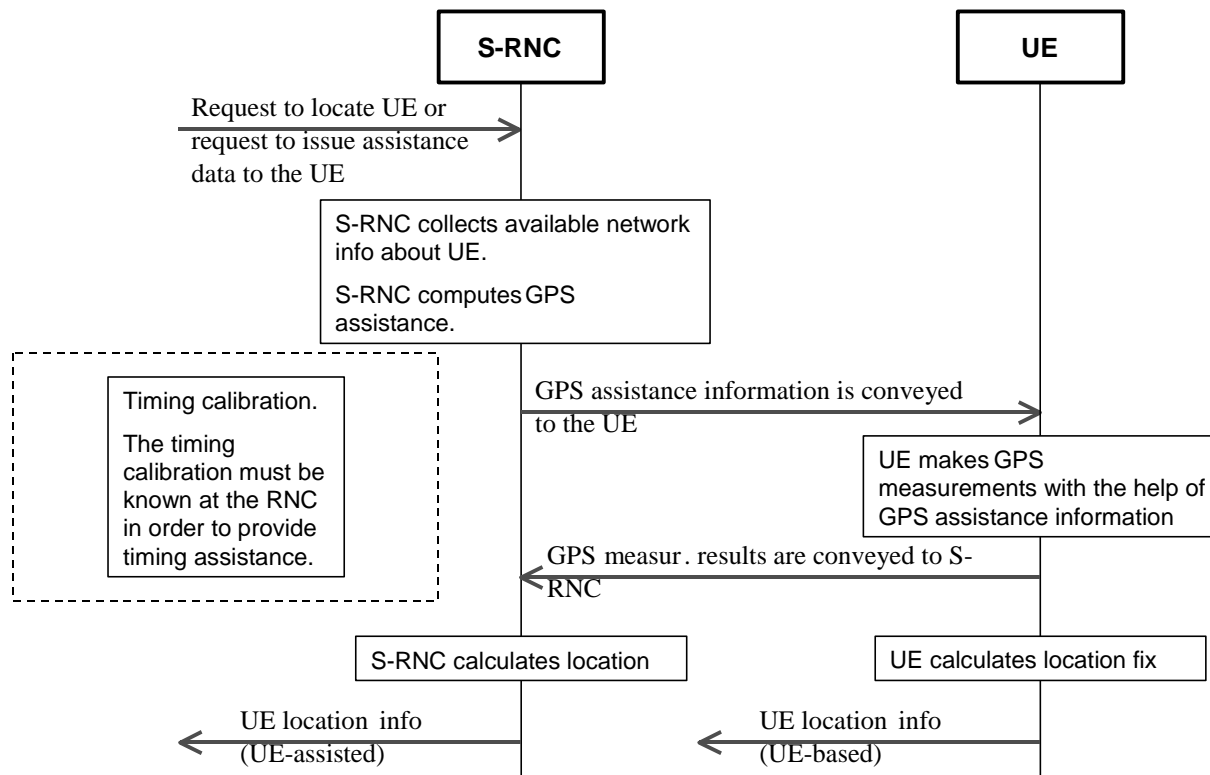
**Figure 10.1: Network assisted GPS methods**

# 10.1 Timing calibration

Timing calibration is achieved by using UE or UTRAN GPS timing measurements as specified in [17].

# 10.2 Timing assistance

The UTRAN may derive the estimated UE location using UTRAN (eg. Cell-ID or IPDL) parameters and may use this information, in conjunction with satellite specific ephemeris data received from the GPS reference receiver network, to derive the estimated times of arrival (code phases) for equivalent GPS satellite signals received by the UE-based GPS receiver functionality. The estimated code phase data may be conveyed, together with $T_{UTRAN-GPS}$ (as specified in [17] and [18]), from the UTRAN to the UE using higher layer signalling. The estimated code phase data value is uncertain to a degree depending on the accuracy of the UTRAN timing calibration and initial location determination methods used.

# 10.3 Data assistance

The UE may receive GPS information through the UTRAN air interface, using higher layer signalling.

When the UE is unable to detect a sufficient number of satellites, the assisted GPS method can be combined with other location methods. Altitude assistance can compensate for one satellite measurement.

The assistance data signalled to the UE may include all information listed below or a selected subset:

- data assisting the measurements; e.g. reference time, visible satellite list, satellite signal Doppler, code phase, Doppler and code phase search windows. This data can be valid for a few minutes (e.g., less than 5 minutes) or longer depending on the code phase and Doppler search window size that can be accommodated by the UE;

- data providing means for location calculation; e.g. reference time, reference location, satellite ephemeris, clock corrections. Satellite ephemeris and clock corrections data can be used for up to six hours.

NOTE: Certain types of GPS Assistance data may be derived, wholly or partially, from other types of GPS Assistance data.

If DGPS is utilised, then differential corrections may also be transmitted. If Selective Availability is turned off, these corrections can be valid for a few minutes or more. The DGPS data is valid for a large geographical area, so one centrally located reference receiver can be used to service this large region.

# 10.4    UE search

Provided that timing and/or data assistance is available in the UE they should be applied in the GPS signal searchprocedure. UE search procedure involves a three-dimensional search for a satellite PRN (pseudorandom) code, time of arrival of a signal and the associated carrier Doppler.

"Modulation wipe-off" is defined here to mean a removal of the GPS navigation data bit modulation to GPS signals received at the UE, through the application of UTRAN timing and data assistance provided from the UTRAN to the UE. This process allows the UE to coherently integrate received GPS signals beyond 1 data bit period (i.e., 20 milliseconds).

# 10.5    Location determination

Computation of the location fix can either be performed in the network infrastructure (UE-assisted) or in the UE (UE-based).

There are two types of network assisted GPS methods, namely UE-based and UE-assisted, which differ according to where the actual location calculation is carried out.

## 10.5.1    UE-based method

The UE-based method maintains a full GPS receiver functionality in the UE, and the location calculation is carried out by the UE, thus allowing stand-alone location fixes.

If the location was requested by an application in the network, then the calculated location is signalled to the proper network element.

The following information may be signalled from the UTRAN (LSIF) to the UE:

- number of satellites for which assistance is provided;

- reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]);

- 3-d reference location (specified in [17]);

- ionospheric corrections;

- satellite ID for identifying the satellites for which the assistance is provided;

- ephemeris and clock corrections to accurately model the orbit of the particular satellite and information when this becomes valid;

- UTC offset;

- DGPS corrections;

- almanac data;

- real-time integrity (e.g., a list of unusable satellites).

The following information may be signalled from the UE to the UTRAN (LSIF):

- reference time for GPS (specified in [17] and [18]);

- serving cell information;

- Latitude/Longitude/Altitude/Error ellipse;

- velocity estimate of the UE;

- satellite ID for which the measurement data is valid;

- Whole/Fractional chips for information about the code-phase measurements;

- $C/N_0$ of the received signal from the particular satellite used in the measurements;

- doppler frequency measured by the UE for the particular satellite signal;

- pseudorange RMS error;

- multipath indicator.

## 10.5.2 UE-assisted method

In the UE-assisted method, the UE employs a reduced complexity GPS receiver functionality. This carries out the pseudorange (code phase) measurements. These are signalled, using higher layer signalling, to the specific network element that estimates the location of the UE and carries out the remaining GPS operations. In this method, accurately timed code phase signalling (as specified in [17] and [18]) is required on the downlink. If DGPS is performed in the UE, then differential corrections must be signalled to it. On the other hand, DGPS corrections can be applied to the final result in the network to improve the location accuracy without extra signalling to the UE.

The following information may be signalled from the UTRAN (LSIF) to the UE:

- number of satellites for which assistance is provided;

- reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]);

- satellite ID for identifying the satellites for which the assistance is provided;

- doppler ($0^{th}$ order term);

- Doppler Search Window width;

- doppler ($1^{st}$ order term);

- code phase;

- code phase centre and Search Window width;

- ephemeris;

- azimuth;

- elevation.

The following information may be signalled from the UE to the UTRAN (LSIF):

- reference time for GPS ($T_{UE-GPS}$) (specified in [17] and [18]);

- number of Pseudoranges;

- SVID;

- satellite C/No;

- doppler;

- satellite Code Phase;

- multipath indicator;

- pseudorange RMS Error.

Additional parameters, such as round trip time (RTT) in FDD or Rx Timing Deviation in TDD, UE receiving transmitting time (UE RxTx), SFN-SFN observed time difference and CPICH Ec/No, may be used to improve the performance of UE-assisted GPS. All the additional parameters are defined in [17] and [18] and can be made available through RRC signalling. Furthermore, to those UE technologies requiring externally provided sensitivity and time aiding data, some navigation bits may be sent from UTRAN to UE for sensitivity assistance and time recovery.

## 10.6 Information to be transferred during SRNS relocation

The following information may be transferred from Source to Target RNC if a UE assisted location procedure using the GPS method is going on and a SRNS relocation is performed:

- reference time for GPS ($T_{UTRAN-GPS}$);

- ionospheric corrections;

- ephemeris

- DGPS corrections;

- almanac data;

- azimuth

- elevation

**3GPP TSG-RAN WG2 Meeting #16**

**Bejing, China; October 9-13, 2000**

*Document* **R2-002005**

*e.g. for 3GPP use the format   TP-99xxx*
*or for SMG, use the format   P-99-xxx*

# CHANGE REQUEST

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| | | | | | |
|---|---|---|---|---|---|
| **25.305** | **CR** | **031** | Current Version: | **3.3.0** | |

*GSM (AA.BB) or 3G (AA.BBB) specification number* ↑

↑ *CR number as allocated by MCC support team*

For submission to: TSG-RAN #10
*list expected approval meeting # here* ↑

| for approval | **X** | strategic | | *(for SMG* |
|---|---|---|---|---|
| for information | | non-strategic | | *use only)* |

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**Proposed change affects:**    (U)SIM ☐    ME **X**    UTRAN / Radio **X**    Core Network ☐
*(at least one should be marked with an X)*

| | | | |
|---|---|---|---|
| **Source:** | TSG-RAN WG2 | **Date:** | October 9, 2000 |

| | |
|---|---|
| **Subject:** | UE Search correction from R2-001721 (CR 021r3) |

| | |
|---|---|
| **Work item:** | |

**Category:**

*(only one category shall be marked with an X)*

| | | | | **Release:** | | |
|---|---|---|---|---|---|---|
| F | Correction | **X** | | Phase 2 | | |
| A | Corresponds to a correction in an earlier release | | | Release 96 | | |
| B | Addition of feature | | | Release 97 | | |
| C | Functional modification of feature | | | Release 98 | | |
| D | Editorial modification | | | Release 99 | **X** | |
| | | | | Release 00 | | |

| | |
|---|---|
| **Reason for change:** | A change from the approved R2-001721 (CR 021r3) concerning clause 10.4 (UE Search) has not been incorporated into the latest version of 25.305.   This goal of this CR is to indicate the remaining change that needs to be incorporated into 25.305. |

| | |
|---|---|
| **Clauses affected:** | 10.4 |

| **Other specs affected:** | Other 3G core specifications | ☐ | → List of CRs: | |
|---|---|---|---|---|
| | Other GSM core specifications | ☐ | → List of CRs: | |
| | MS test specifications | ☐ | → List of CRs: | |
| | | ☐ | → List of CRs: | |
| | O&M specifications | ☐ | → List of CRs: | |

| | |
|---|---|
| **Other comments:** | |

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*< NEXT MODIFIED SECTION >*

# 10.4    UE search

Provided that timing, frequency, and/or data assistance is available in the UE they should be applied in the GPS signal searchprocedure. UE search procedure involves a three-dimensional search for a satellite PRN (pseudorandom) code, time of arrival of a signal and the associated carrier Doppler.

"Modulation wipe-off" is defined here to mean a removal of the GPS navigation data bit modulation to GPS signals received at the UE, through the application of UTRAN timing and data assistance provided from the UTRAN to the UE. This process allows the UE to coherently integrate received GPS signals beyond 1 data bit period (i.e., 20 milliseconds).

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| **25.305** | **CR** | **032r2** | Current Version: | 3.3.0 |
|---|---|---|---|---|

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑*          *↑ CR number as allocated by MCC support team*

For submission to: **TSG-RAN #10**    for approval **X**        strategic ☐    *(for SMG*
*list expected approval meeting # here*    for information ☐    non-strategic ☐    *use only)*
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**Proposed change affects:**    (U)SIM ☐    ME ☐    UTRAN / Radio **X**    Core Network ☐
*(at least one should be marked with an X)*

| **Source:** | TSG-RAN WG2 | | **Date:** | October 5, 2000 |
|---|---|---|---|---|

| **Subject:** | Signaling Between RNC and Stand-Alone LMU |
|---|---|

| **Work item:** | |
|---|---|

**Category:**    F    Correction                                                      **X**    **Release:**    Phase 2    ☐
A    Corresponds to a correction in an earlier release    ☐              Release 96    ☐
*(only one category*    B    Addition of feature    ☐              Release 97    ☐
*shall be marked*    C    Functional modification of feature    ☐              Release 98    ☐
*with an X)*    D    Editorial modification    ☐              Release 99    **X**
Release 00    ☐

| **Reason for change:** | To provide descriptions for signaling between RNC and stand-alone LMUs using RRC protocol |
|---|---|

| **Clauses affected:** | 6.6.4.2, 6.6.4.2.1, 6.6.4.2.2, 7.2, 7.3, 7.3.1, 7.3.2, 7.3.3 |
|---|---|

**Other specs**    Other 3G core specifications    ☐    → List of CRs:
**affected:**    Other GSM core    ☐    → List of CRs:
specifications
MS test specifications    ☐    → List of CRs:
☐    → List of CRs:
O&M specifications    ☐    → List of CRs:

| **Other comments:** | |
|---|---|

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### 6.6.4.2     Signalling between RNC and stand-alone LMU

Signaling exchanges between an RNC and a stand-alone LMU under the control of that RNC will be specified in the RRC protocol for stand-alone LMUs. This does not preclude a stand-alone LMU from also communicating with other networks (e.g. GSM) through interfaces (e.g. LLP protocol) that are not part of the present document.

Each update of the LMU measurement (including the initial one) is triggered by a LCS request from the client that is internal to UTRAN. The request may be made directly to the UTRAN LCS entities as the internal clients are considered to be "pre-authorised" (section 5) or comes from CN with authentication.

The following figure illustrate the protocol layers used to support signaling between an RNC and a stand-alone LMU over the Uu interface.

The protocol layers employed to enable signaling between the RNC and a stand-alone LMU are defined in 25.331. The LMU signaling information elements are included directly in the RRC protocol, also defined in 25.331.
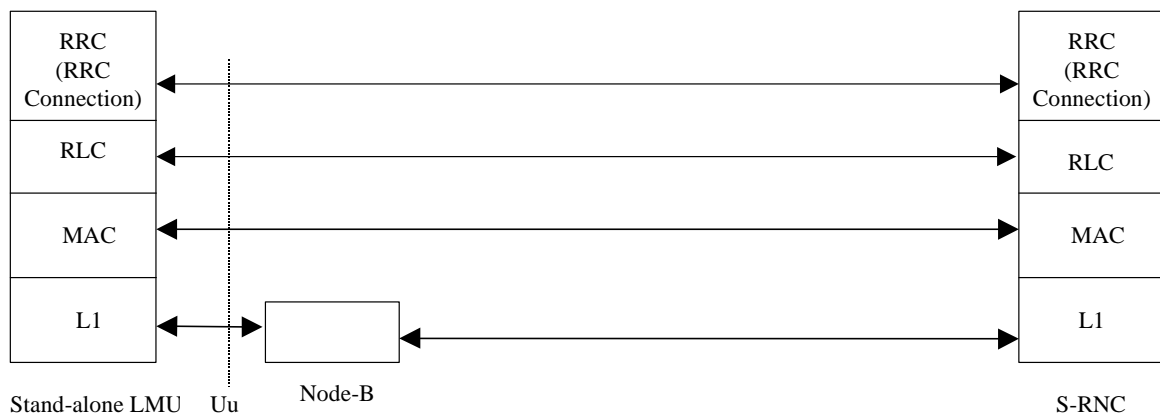


**Figure 6.5: Signalling between an RNC and a Stand-Alone LMU using a signalling bearer**

## 7.2     Common procedures to support access to a LMU

Void.

## 7.3 Common control procedures for LMUs

Void.

# CHANGE REQUEST

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| | | | | Current Version: | 3.3.0 |
|---|---|---|---|---|---|
| **25.305** | **CR** | **033r5** | | | |

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑*          *↑ CR number as allocated by MCC support team*

| For submission to: | TSG-RAN #10 | for approval | **X** | strategic | | *(for SMG* |
|---|---|---|---|---|---|---|
| *list expected approval meeting # here* ↑ | | for information | | non-strategic | | *use only)* |

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**Proposed change affects:**          (U)SIM ☐     ME **X**     UTRAN / Radio **X**     Core Network ☐

*(at least one should be marked with an X)*

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| **Source:** | TSG-RAN WG2 | **Date:** | 13 Nov 2000 |
|---|---|---|---|

| **Subject:** | Use of RTT measurements in the Assisted GPS procedure |
|---|---|

| **Work item:** | |
|---|---|

| **Category:** | F | Correction | **X** | **Release:** | Phase 2 | |
|---|---|---|---|---|---|---|
| | A | Corresponds to a correction in an earlier release | | | Release 96 | |
| *(only one category* | B | Addition of feature | | | Release 97 | |
| *shall be marked* | C | Functional modification of feature | | | Release 98 | |
| *with an X)* | D | Editorial modification | | | Release 99 | **X** |
| | | | | | Release 00 | |

| **Reason for change:** | The A-GPS procedure agreed in CR 033r3 demonstrates the optional incorporation of RTT measurement into the position calculation process. This CR clarifies that it is possible to incorporate more than one RTT measurement into the position calculation. |
|---|---|

| **Clauses affected:** | 10.6 |
|---|---|

| **Other specs affected:** | Other 3G core specifications | | → List of CRs: | |
|---|---|---|---|---|
| | Other GSM core specifications | | → List of CRs: | |
| | MS test specifications | | → List of CRs: | |
| | | | → List of CRs: | |
| | O&M specifications | | → List of CRs: | |

| **Other comments:** | Changes specific to CR 033r4 are limited to steps 3, 4, and 5 of the procedure. |
|---|---|

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# 10.6 Network Assisted GPS positioning~~Location~~ Procedure

The diagram in Figure 10.1 illustrates the operations for the network assisted GPS when the request for ~~location~~position information is initiated by a LCS application signaled from the Core Network. A detailed description of the ~~location~~ positioning procedures is given as follows. Note that the procedure is for illustration purpose and actual implementations may~~can~~ vary.

1. The operation begins with an authenticated request for ~~location~~positioning information about a UE from an application in the core network being received at the SRNC~~LSCF~~. The SRNC~~LSCF~~ acts as interface between the Core Network and the ~~LCS~~UP entities in the UTRAN.

2. The ~~LSCF~~SRNC considers the request and the capabilities of the UE and the network ~~and forwards the request to the appropriate PRCF in the Serving RNC~~.

3. Depending on UE's request, the SRNC~~PRCF~~ sends to the UE certain assistance information, which may include part of the following information: the reference time for GPS, the satellite IDs, the Doppler frequency, the search window and its centre, the ephemeris and clock corrections, the almanac, and other information specified in 10.5.1 and 10.5.2.

   ▪ For UE-based method (10.5.1), jump to step 7~~10~~.

   ▪ For UE-assisted method (10.5.2), the ~~PRCF~~SRNC may optionally requests the following information before sending the assistance message(s) to the UE: the LMU update*~~, and~~ the RTT measurements (related to the UE from the ~~PSMFs of~~in the serving Node-Bs in the active set) to compensate for the one-way propagation delays. The LMU (associated or stand-alone) returns the information containing the time difference between the Node -B and the GPS to the CRNC~~PRCF~~. The ~~PSMF of a~~ in the serving Node-B returns its~~the~~ RTT measurement to the CRNC~~PRCF~~. If the CRNC is not the SRNC, the CRNC forwards these information to SRNC.

4. The SRNC~~PRCF~~ requests from the UE the measurement of GPS satellite pseudoranges and other information specified in 10.5.2. These measurements may be made while the UE is either idle or connected. ~~If it is considered advantageous to do so, t~~The ~~PRCF~~SRNC may request SFN-SFN Observed Time Difference measurements and Rx-Tx timing difference information from the UE to support the processing related to the RTT measurements ~~of the serving Node B~~.

~~If it is considered advantageous to do so (to cover the cases wherein the UE is blocked from receiving GPS signals), the PRCF requests from the UE of measurements of SFN-SFN Observed Time Difference for the signals in the active and neighbourhood sets and the UE Rx-Tx timing difference information. These measurements may be made while the UE is either idle or connected.~~

5. The UE returns to the SRNC~~PRCF~~ the measurement of GPS satellite pseudoranges and other information specified in 10.5.2 . If requested, the UE may also return the SFN-SFN measurements and the Rx-Tx time difference information, together with a time stamp of when these values were obtained ~~if requested~~.

~~The UE returns the measurements of SFN-SFN Observed Time and UE Rx-Tx timing difference information to the PRCF if requested.~~

6. The ~~PRCF forwards all the measurements to the L~~PCF ~~where the~~ UE position is calculated in the SRNC ~~using both the GPS information and the network information~~.

7. If there are~~is~~ insufficient information to yield a UE ~~location~~positioning estimate, ~~or the information gathering process is failed at some point, or it is otherwise considered advantageous to do so,~~ the SRNC~~PRCF~~ may starts a new process from step 3.

8. In case of UE based method, ~~The PCF (or The UE, if UE-based method)~~ UE returns the ~~location~~position estimate to the SRNC~~PRCF~~. This estimate includes the position~~location~~, the estimated accuracy of the results and the time ~~of day~~ of the estimate.

~~The PRCF passes the location estimate to the LSCF.~~

9.   The SRNC~~LSCF~~ passes the ~~location~~ position estimate to the CN~~Core Network~~.

*Note: The LMU update (of the time difference between the GPS and the Node-B) may~~can~~ be performed on a per-request basis (with respect to each ~~LCS~~UP request) or be performed timely that is independent of individual ~~LCS~~UP request. The latter is preferable when there are large volume of ~~LCS~~UP requests.

**3GPP TSG-RAN WG2 Meeting #16**
**Bejing, China; October 9-13, 2000**

*Document* **R2-002100**

*e.g. for 3GPP use the format TP-99xxx*
*or for SMG, use the format P-99-xxx*

# CHANGE REQUEST

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| | | | | | |
|---|---|---|---|---|---|
| **25.305** | **CR** | **034r1** | Current Version: | 3.3.0 |

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑*

*↑ CR number as allocated by MCC support team*

For submission to: **TSG-RAN #10**  
*list expected approval meeting # here*  
*↑*

| for approval | **X** |
|---|---|
| for information | |

| strategic | |
|---|---|
| non-strategic | |

*(for SMG use only)*

*Form: CR cover sheet, version 2 for 3GPP and SMG*     *The latest version of this form is available from:* ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

**Proposed change affects:**     (U)SIM ☐     ME **X**     UTRAN / Radio **X**     Core Network ☐
*(at least one should be marked with an X)*

**Source:**     TSG-RAN WG2     **Date:** October 9, 2000

**Subject:**     LCS Assistance Data Delivery

**Work item:**

**Category:**     F   Correction     **X**     **Release:**
*(only one category shall be marked with an X)*

| | | |
|---|---|---|
| A | Corresponds to a correction in an earlier release | |
| B | Addition of feature | |
| C | Functional modification of feature | |
| D | Editorial modification | |

| Phase 2 | |
|---|---|
| Release 96 | |
| Release 97 | |
| Release 98 | |
| Release 99 | **X** |
| Release 00 | |

**Reason for change:**     Basic point-to-point and broadcast assistance data delivery signalling descriptions were intermingled and confused.

**Clauses affected:**     6.6.4.1.1,   6.6.4.1.4

**Other specs affected:**

| | | | |
|---|---|---|---|
| Other 3G core specifications | | → | List of CRs: |
| Other GSM core specifications | | → | List of CRs: |
| MS test specifications | | → | List of CRs: |
| | | → | List of CRs: |
| O&M specifications | | → | List of CRs: |

**Other comments:**     Change for revision 1 indicated with yellow shading.

------------------                 *< NEXT MODIFIED SECTION >*                 -------------------

### 6.6.4.1.1        Assistance Data Delivery to UE

The assistance data signalling flow illustrated here is generic for <u>the point-to-point delivery of</u> ~~location~~<u>positioning related assistance data to the UE</u>UE ~~based location methods~~, including OTDOA and Network~~-a-~~ Assisted GPS. ~~Note that if the assistance data is sent as part of a broadcast message, then no assistance data acknowledgement is required.~~
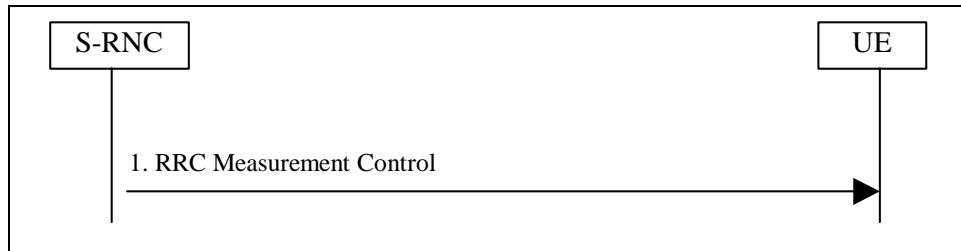


**Figure 6.2: OTDOA or GPS Assistance Data Delivery Flow**

1.   The S-RNC determines assistance data and sends it in the RRC MEASUREMENT CONTROL message to the UE.

-------------------------------------------------------------------------------------------------------------------

------------------                 *< NEXT MODIFIED SECTION >*                 -------------------

### 6.6.4.1.4        Signalling Flow for Assistance Data Broadcast Using the Common UTRAN Broadcast Service

~~The assistance data broadcast to UEs can be signalled via the RRC Measurement Control message as shown in subclause 6.6.4.2 or it can be broadcast by the UTRAN within the system information.~~   <u>The UTRAN</u> ~~can~~<u>may broadcast location related assistance data to UEs within the system information.</u>



**Figure 6.3: Broadcast of system information**

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# CHANGE REQUEST

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| **25.305** | **CR** | **035r2** | Current Version: | 3.3.0 |
|---|---|---|---|---|

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑*          *↑ CR number as allocated by MCC support team*

| For submission to: | TSG-RAN #10 | for approval | **X** | strategic | | *(for SMG* |
|---|---|---|---|---|---|---|
| *list expected approval meeting # here ↑* | | for information | | non-strategic | | *use only)* |

*Form: CR cover sheet, version 2 for 3GPP and SMG*   *The latest version of this form is available from:* ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

**Proposed change affects:**   (U)SIM ☐   ME **X**   UTRAN / Radio **X**   Core Network ☐
*(at least one should be marked with an X)*

| **Source:** | TSG-RAN WG2 | | **Date:** | 13 Nov 2000 |
|---|---|---|---|---|

| **Subject:** | Description for frequency reference |
|---|---|

| **Work item:** | |
|---|---|

| **Category:** | F | Correction | **X** | **Release:** | Phase 2 | |
|---|---|---|---|---|---|---|
| | A | Corresponds to a correction in an earlier release | | | Release 96 | |
| *(only one category* | B | Addition of feature | | | Release 97 | |
| *shall be marked* | C | Functional modification of feature | | | Release 98 | |
| *with an X)* | D | Editorial modification | | | Release 99 | **X** |
| | | | | | Release 00 | |

| **Reason for change:** | During the RAN2 #17 UP Ad Hoc meeting, it was decided to add a description of the term "frequency reference" that is associated with the UE search process.  This CR provides this description. |
|---|---|

| **Clauses affected:** | 10.4, Annex A |
|---|---|

| **Other specs affected:** | Other 3G core specifications | | → List of CRs: | |
|---|---|---|---|---|
| | Other GSM core specifications | | → List of CRs: | |
| | MS test specifications | | → List of CRs: | |
| | | | → List of CRs: | |
| | O&M specifications | | → List of CRs: | |

| **Other comments:** | The agreed CR 031 to 25.305 specifies that timing, frequency, and/or data assistance should be applied in the UE search for GPS satellite signals (clause 10.4). |
|---|---|

help.doc

<--------- double-click here for help and instructions on how to create a CR.

## 10.1 Timing calibration

Timing calibration is achieved by using UE or UTRAN GPS timing measurements as specified in [17].

## 10.2 Timing assistance

The UTRAN may derive the estimated UE location using UTRAN (eg. Cell-ID or IPDL) parameters and may use this information, in conjunction with satellite specific ephemeris data received from the GPS reference receiver network, to derive the estimated times of arrival (code phases) for equivalent GPS satellite signals received by the UE-based GPS receiver functionality. The estimated code phase data may be conveyed, together with $T_{UTRAN-GPS}$ (as specified in [17] and [18]), from the UTRAN to the UE using higher layer signalling. The estimated code phase data value is uncertain to a degree depending on the accuracy of the UTRAN timing calibration and initial location determination methods used.

## ~~10.X Frequency assistance~~

~~The UE may use a frequency reference obtained from the UTRAN air interface to minimize the frequency search associated with acquiring GPS satellite signals. With this potentially significant frequency bias removed, the span of the carrier Doppler searched for a particular satellite signal need only account for minor residual uncertainties related to UE dynamics and initial position uncertainty. Furthermore, this same frequency reference may be used to maintain the UE's estimate of GPS time between positioning events, thus making accurate GPS time immediately available within the UE to support rapid reacquisition of satellite signals.~~

## 10.3 Data assistance

The UE may receive GPS information through the UTRAN air interface, using higher layer signalling. When the UE is unable to detect a sufficient number of satellites, the assisted GPS method can be combined with other location methods. Altitude assistance can compensate for one satellite measurement. The assistance data signalled to the UE may include all information listed below or a selected subset:

- data assisting the measurements; e.g. reference time, visible satellite list, satellite signal Doppler, code phase, Doppler and code phase search windows. This data can be valid for a few minutes (e.g., less than 5 minutes) or longer depending on the code phase and Doppler search window size that can be accommodated by the UE;

- data providing means for location calculation; e.g. reference time, reference location, satellite ephemeris, clock corrections. Satellite ephemeris and clock corrections data can be used for up to six hours.

   NOTE:   Certain types of GPS Assistance data may be derived, wholly or partially, from other types of GPS Assistance data.

If DGPS is utilised, then differential corrections may also be transmitted. If Selective Availability is turned off, these corrections can be valid for a few minutes or more. The DGPS data is valid for a large geographical area, so one centrally located reference receiver can be used to service this large region.

## 10.4 UE search

Provided that timing assistance,~~and/or~~ data assistance, and/or frequency reference (see Annex A) is available in the UE, they should be applied in the GPS signal search procedure. The UE search procedure involves a three-dimensional search for a satellite PRN (pseudorandom) code, time of arrival of a signal and the associated carrier Doppler.
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# Annex A (informative): Definitions and Terms

This annex provides definitions and terms for the general LCS. Not all of these are applicable to the UTRAN environment.

**CAMEL:** CAMEL is a network functionality, which provides the mechanisms of Intelligent Network to a mobile user.

**Current Location:** after a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp is referred to as the 'current location' at that point in time.

**Deferred location request:** a location request where the location response (responses) is (are) not required immediately.

**Frequency reference**: the frequency reference of the UE obtained from the UTRAN radio interface that may~~is~~ be used to minimize the frequency search associated with acquiring GPS satellite signals. When the UE acquisition process is aligned to this reference, the carrier Doppler uncertainty that must be searched for a particular satellite signal need only account for minor residual uncertainties related to UE dynamics and initial position. This frequency reference may also be used to maintain the UE's estimate of GPS time between positioning events, thus making accurate GPS time ~~immediately~~ available within the UE to support ~~rapid~~ reacquisition of satellite signals.

**Global Positioning System:** the Global Positioning System (GPS) consists of three functional elements: Space Segment (satellites), User Segment (receivers), and Control Segment (maintenance etc.). The GPS receiver estimates its own location based on the observed times of arrival of the satellite signals.

**Immediate location request:** a location request where a single location response only is required immediately.

**Initial Location:** in the context of an originating emergency call the location estimate and the associated time stamp at the commencement of the call set-up is referred to as 'initial location'.

**Last Known Location:** the current location estimate and its associated time stamp for Target MS stored in the LCS Server is referred to as the 'last known location' and until replaced by a later location estimate and a new time stamp is referred to as the 'last known location'.

**LCS (LoCation Services):** LCS is a service concept in system (e.g. GSM or UMTS) standardisation. LCS specifies all the necessary network elements and entities, their functionalities, interfaces, as well as communication messages, due to implement the location service functionality in a cellular network.

> NOTE: LCS does not specify any location based (value added) services except locating of emergency calls.

**LCS Client:** a software and/or hardware entity that interacts with a LCS Server for the purpose of obtaining location information for one or more Mobile Stations. LCS Clients subscribe to LCS in order to obtain location information. LCS Clients may or may not interact with human users. The LCS Client is responsible for formatting and presenting data and managing the user interface (dialogue). The LCS Client may reside in the Mobile Station (MS).

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*CR-Form-v3*

# CHANGE REQUEST

⌘     **25.305 CR 036**     ⌘ rev **r2** ⌘ Current version: **3.3.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

**Proposed change affects:** ⌘   (U)SIM ☐   ME/UE **X**   Radio Access Network **X**   Core Network ☐

| | | |
|---|---|---|
| ***Title:*** | ⌘ | Editorial cleanup |
| ***Source:*** | ⌘ | TSG-RAN WG2 |

| | | | |
|---|---|---|---|
| ***Work item code:*** ⌘ | | ***Date:*** ⌘ | 14 Nov 2000 |

| | | | |
|---|---|---|---|
| ***Category:*** | ⌘ **F** | ***Release:*** ⌘ | R99 |

Use <u>one</u> of the following categories:
**F** (essential correction)
**A** (corresponds to a correction in an earlier release)
**B** (Addition of feature),
**C** (Functional modification of feature)
**D** (Editorial modification)
Detailed explanations of the above categories can
be found in 3GPP TR 21.900.

Use <u>one</u> of the following releases:
2       (GSM Phase 2)
R96     (Release 1996)
R97     (Release 1997)
R98     (Release 1998)
R99     (Release 1999)
REL-4   (Release 4)
REL-5   (Release 5)

| | |
|---|---|
| ***Reason for change:*** ⌘ | align the specification on current UTRAN vocabulary |

| | |
|---|---|
| ***Summary of change:*** ⌘ | -editorial cleanup using current UTRAN vocabulary<br><br>-move the functional description in annex<br><br>-clarifications on SRNC and CRNC functionality related to UP are added |

| | |
|---|---|
| ***Consequences if not approved:*** ⌘ | |

| | |
|---|---|
| ***Clauses affected:*** ⌘ | all sections |

| | | | |
|---|---|---|---|
| ***Other specs affected:*** | ⌘ ☐ | Other core specifications ⌘ | |
| | ☐ | Test specifications | |
| | ☐ | O&M Specifications | |

| | |
|---|---|
| ***Other comments:*** ⌘ | |

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1)  Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2)  Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://www.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2000-09 contains the specifications resulting from the September 2000 TSG meetings.

3)  With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text.  Delete those parts of the specification which are not relevant to the change request.

# 3GPP TS 25.305 V3.3.0 (2000-09)

**3rd Generation Partnership Project;**
**Technical Specification Group Radio Access Network;**
**Stage 2 Functional Specification of UE Positioning~~Location~~**
**~~Services~~**
**in UTRAN**
**(Release 1999)**

Keywords

Location Service, LCS, Positioning, UP
Digital cellular telecommunications system,
Universal Mobile Telecommunications System
LCS, (UMTS), UTRA, UTRAN, IMT-2000,
Functional description stage 2

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# Contents

*3GPP*

# Foreword

This Technical Specification (TS) has been produced by the 3$^{rd}$ 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:

Version x.y.z

where:

x   the first digit:

1   presented to TSG for information;

2   presented to TSG for approval;

3   or greater indicates TSG approved document under change control.

y   the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z   the third digit is incremented when editorial only changes have been incorporated in the document.

# 1 Scope

The present document specifies the stage 2 of the UE Positioning (UP) function ~~LoCation Services (LCS) feature~~ of~~in~~ UTRAN, which provides the mechanisms to support the calculation of the geographical location of a UE. ~~mobile~~ UE position knowledge can be used for example in support of Radio Resource Management functions, location based services for operators, subscribers and third party service providers.~~location services for operators, subscribers and third party service providers.~~

The purpose of this stage2 specification is to define the UTRAN UP~~LCS~~ architecture, functional entities and operations to support positioning~~location~~ methods. This description is confined to the ~~aspects of LCS within the~~ UTRAN Access Stratum. It ~~and~~ does not define nor describe how the results of the UE position calculation can be utilised in the~~the LCS entities or operations within the~~ Core Network e.g. LCS or in UTRAN e.g. RRM.

UP~~Location Services~~ may be considered as a network provided enabling technology consisting of standardised service capabilities, which enable the provision of location applications. The application(s) may be service provider specific. The description of the numerous and varied possible location applications which are enabled by this technology are outside the scope of the present document. However, clarifying examples of how the functionality being described may be used to provide specific location services may be included.

This stage 2 specification covers the UTRAN UP~~LCS~~ functional model and entities, the positioning~~location~~ methods, state descriptions, and message flows.

# 2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies.

## 2.1 Normative references

[1]     3G TS 23.171: "Functional stage 2 description of location services in UMTS".

[2]     GSM 01.04 (ETR 350): "Digital cellular telecommunication system (Phase 2+); Abbreviations and acronyms".

[3]     Technical Specification Group Services and System Aspects Service aspects; Terminology and Vocabulary within TSG-S1: Report and Recommendations, 28.7.99.

[4]     GSM 02.71: "Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Service description, Stage 1".

[5]     GSM 03.71: "Digital cellular telecommunications system (Phase 2+); Location Services (LCS); (Functional description) - Stage 2".

[6]     GSM 03.32: "Universal Geographical Area Description".

[7]     3G TS 22.100: "UMTS phase 1 Release 99".

[8]     3G TS 22.101: "Service principles".

[9]     3G TS 22.105: "Services and Service Capabilities".

[10]        3G TS 22.115: "Charging and Billing".

[11]        3G TS 22.121: "The Virtual Home Environment".

[12]        3G TS 23.110: "UMTS Access Stratum; Services and Functions".

[13]        3G TS 25.413: "UTRAN Iu interface RANAP signalling".

[14]        3G TS 25.423: "UTRAN Iur interface RNSAP signalling".

[15]        3G TS 25.433: "UTRAN Iub interface NBAP signalling".

[16]        3G TS 25.214: "Physical layer procedures (FDD)"

[17]        3G TS 25.215: "Physical layer – Measurements (FDD)".

[18]        3G TS 25.225: "Physical layer – Measurements (TDD)".

[19]        3G TS 25.331: "RRC protocol specification".

[20]        3G TS 23.032: "Universal Geographical Description (GAD)".

[21]        3G TS 25.430: "UTRAN Iub interface: General aspects and Principles".

[22]        3G TS 23.171: "Functional stage 2 description of location services in UMTS".

## 2.2     Informative references

[2123]        Third generation (3G) mobile communication system; Technical study report on the location services and technologies, ARIB ST9 December 1998.

[2224]        The North American Interest Group of the GSM MoU ASSOCIATION: Location Based Services, Service Requirements Document of the Services Working Group.

# 3        Definitions and abbreviations

## 3.1     Definitions

For the purposes of the present document, the terms and definitions given in 3G TS 22.101 and some of the terms and definitions in annex A apply.

## 3.2     Abbreviations

For the purposes of the present document, ~~the GSM-related abbreviations given in GSM 01.04 and the UMTS-related abbreviations given in UMTS TS 22.101 apply.~~ the following abbreviations apply

| | |
|---|---|
| 3G-MSC | 3rd Generation MSC |
| 3G-SGSN | 3rd Generation SGSN |
| ARIB | Association of Radio Industries and Business |
| ATD | Absolute Time Difference |
| CAMEL | Customised Application For Mobile Network Enhanced Logic |
| CN | Core Network |
| CRNC | Controlling RNC |
| DL | Downlink |
| DRNC | Drift RNC |
| GMLC | Gateway MLC |
| GPRS | General Packet Radio System |
| GPS | Global Positioning System |
| HLR | Home Location Register |
| IPDL | Idle Period Downlink |

| | |
|---|---|
| LBS | Location Based Services |
| LCCF | Location Client Control Function |
| LCF | Location Client Function |
| LCS | LoCation Services |
| LMU | Location Measurement Unit |
| LSCF | Location System Control Function |
| LSOF | Location System Operation Function |
| MLC | Mobile Location Center |
| MSC | Mobile services Switching Centre |
| OTDOA | Observed Time Difference Of Arrival |
| PCF | Position Calculation Function |
| PLMN | Public Land Mobile Network |
| PRCF | Positioning Radio Co-ordination Function |
| PRRM | Positioning Radio Resource Management |
| PSMF | Positioning Signal Measurement Function |
| QoS | Quality of Service |
| RAN | Radio Access Network |
| RANAP | Radio Access Network Application Part |
| RNC | Radio Network Controller |
| RRM | Radio Resource Management |
| RTD | Real Time Difference |
| RTT | Round Trip Time |
| SAI | Service Area Identifier |
| SGSN | Serving GPRS Support Node |
| SIM | Subscriber Identity Module |
| SMLC | Serving MLC |
| SMS | Short Message Service |
| SRNC | Serving RNC |
| SSDT | Site Selection Diversity Transmit |
| TOA | Time Of Arrival |
| U-….. | UMTS-(LCS functional block) |
| UE | User Equipment |
| UL | Uplink |
| UMTS | Universal Mobile Telecommunication System |
| UP | UE Positioning |
| USIM | User Service Identity Module |
| UTC | Universal Time Coordinates |
| UTRAN | Universal Terrestrial Radio Access Network |
| WCDMA | Wideband Code Division Multiple Access |

# 4      Main concepts and requirements

A general description of location services and the service requirements is given in the specification 3G TS 22.071 [4].

By measuring radio signals the capability to determine the geographic positionlocation of the user equipment (UE) shall be provided. The positionlocation information may be requested by and reported to a client (application) associated with the UE, or by a client within or attached to the Core NetworkCN. The locationposition information may also be utilised internally by UTRAN, for example, for location assisted handover or to support other features such as home location billing. The locationposition information shall be reported in standard formats, such as those for cell based or geographical co-ordinates, together with the time-of-day and the estimated errors (uncertainty) of the locationposition of the UE.

It shall be possible for the majority of the UE (active or inactiveidle) within a network to use the feature without compromising the radio transmission or signalling capabilities of the UTRAN.

The uncertainty of the locationposition measurement shall be UTRAN design (implementation) dependent at the choice of the network operator. The uncertainty may vary between networks as well as from one area within a network to another. The uncertainty may be hundreds of metres in some areas and only a few metres in others. In the event that the locationposition measurement is also a UE–assisted process, the uncertainty may also depend on the capabilities of the

UE. In some jurisdictions, there is a regulatory requirement for location service accuracy that is part of an emergency service. Further details of the accuracy requirements can be found in [4].

The uncertainty of the ~~location~~position information is dependent on the method used, the ~~location~~position of the UE within the coverage area and the activity ~~idle or active state~~ of the UE. Several design options of the UTRAN system (e.g. size of cell, adaptive antenna technique, path loss estimation, timing accuracy, Node B~~base station~~ surveys) shall allow the network operator to choose a suitable and cost effective UP method~~location service feature~~ for their market.

There are many different possible uses for the ~~location~~ positioning information. The ~~location~~ positioning functions ~~feature~~ may be used internally by the UTRAN ~~network (or attached networks)~~, by value-added network services, by the UE itself or through the network, and by "third party" services. The feature may also be used by an emergency service (which may be mandated or "value-added"), but the location service is not exclusively for emergencies.

The UTRAN is a new radio system design without a pre-existing deployment of UE operating according to the ~~air~~ radio interface. This freedom from legacy equipment enables the location service feature design to make use of appropriate techniques to provide the most accurate results. The technique must also be a cost-effective total solution, must allow evolution to meet evolving service requirements and be able to take advantage of advances in technology over the lifetime of UTRAN deployments.

## 4.1     Assumptions

As a basis for the operation of ~~LCS~~ UP in UTRAN the following assumptions apply:

- the UE shall~~must~~ support SFN-SFN observed time difference type 2 measurements, thus support of N~~n~~etwork-based OTDOA without idle periods is mandatory in the UE.

- both, TDD and FDD will be supported in release '99;

- the provision of the UP function~~location service~~ in UTRAN is optional through support of the specified method(s) in ~~Node B~~Node B and the ~~C~~RNC;

- ~~LCS~~ UP is applicable to any target UE whether or not the UE supports LCS, but with restrictions on use ~~choice~~ of ~~location~~certain positioning method depending on UE capability as defined in 25.926.~~or notification of a location request to the UE user when LCS or individual location methods, respectively, are not supported by the UE~~;

- RNC contains SMLC functionality and ~~LCS~~UP information is transported between RNCs via the Iur interface;

- ~~LCS shall be applicable for both circuit switched and packet switched services;~~

- the ~~location~~ positioning information may be used for internal system operations to improve system performance;

- ~~there are~~ different types of LMU are defined, e.g. a standalone LMU and/or LMU integrated in Node B;

- the ~~location process~~UP architecture and functions shall include the option to accommodate several techniques of measurement and processing to ensure evolution to follow changing service requirements and to take advantage of advancing technology.

## 4.2     Location Services Categories

Void.

~~Generally there are four categories of usage of the location service:~~

- ~~the **Commercial LCS** (or **Value Added Services**);~~

- ~~the **Internal LCS**;~~

- ~~the **Emergency LCS**;~~

- ~~the **Lawful Intercept LCS**.~~

These location services categories are further defined in [1] and [4].

# 4.3 ~~Locating~~ UE Positioning Methods

The ~~LCS feature~~UTRAN may utilises one or more ~~location~~positioning methods in order to determine the ~~location~~ position of an User Equipment (UE) ~~or Mobile Stations~~. ~~Locating~~ Positioning the UE involves two main steps:

- signal measurements; and

- ~~location~~ Position estimate computation based on the measurements.

The signal measurements may be made by the UE, the Node B or a ~~dedicated location measuring unit~~ (LMU). The basic signals measured are typically the UTRA radio transmissions, however, some methods may make use of other transmissions such as general radio navigation signals.

In addition the ~~location service~~positioning function should not be limited to a single method or measurement. That is, it should be capable of utilising other standard methods and measurements, as are available and appropriate, to meet the required service needs of the location service client. This additional information could consist of readily available UTRAN measurements such as RTT in FDD or Rx Timing deviation measurement and knowledge of the UE timing advance, in TDD.

The ~~location~~ position estimate computation may be made ~~in~~ by the UE or by ~~a calculation function located in~~ the UTRAN.

# 4.4 Standard ~~LCS~~UP Methods

The standard ~~LCS~~ positioning methods supported within ~~UMTS~~ UTRAN are:~~:~~

- cell ID based method;

- OTDOA method that may be assisted by ~~with~~ network configurable idle periods (the idle period configurability is to be specified in the specification);~~ and~~

- network~~-~~ assisted GPS methods.

    NOTE: ~~GPS based solutions are being standardised in T1P1; it is intended that the UTRAN navigational assisted solution will be synergistic with the work in T1P1.~~

## 4.4.1 Cell ID Based Method

In the cell ID based (i.e. cell coverage) method, the ~~location~~ position of an UE is estimated with the knowledge of its serving ~~node B~~Node B. The information about the serving ~~node B~~Node B and cell may be obtained by paging, locating area update, cell update, URA update, or routing area update.

The cell coverage based ~~location~~positioning information can be indicated as the Cell Identity of the used cell, the Service ~~A~~area ~~I~~identity or as the geographical co-ordinates of a ~~location~~position related to the serving cell. The ~~location~~position information shall include a QoS estimate (e.g. regarding achieved accuracy).

When geographical co-ordinates are used as the ~~location~~position information, the estimated ~~location~~position of the UE can be a fixed geographical ~~location~~position within the serving cell (e.g. ~~location~~position of the serving ~~node B~~Node B), the geographical centre of the serving cell coverage area, or some other fixed ~~location~~position within the cell coverage area. The geographical ~~location~~position can also be obtained by combining information on the cell specific fixed geographical ~~location~~position with some other available information, such as the signal ~~Round Trip Time~~ (RTT) in FDD (~~as specified in~~ [17]) or Rx Timing deviation measurement (~~as specified in~~ [18]) and knowledge of the UE timing advance, in TDD.

The operation of the cell ID based ~~location~~positioning method is described in clause 8.

## 4.4.2 OTDOA-IPDL Method with network configurable idle periods

The OTDOA-IPDL ~~(Observed Time Difference Of Arrival with optional Idle Periods in the DownLink)~~ method involves measurements made by the UE and LMU of the UTRAN frame timing (e.g. SFN-SFN observed time difference). These measures are then sent to <u>the SRNC</u>~~a Position Calculation Function (PCF) in the Serving RNC~~ where the <u>position</u>~~location~~ of the UE is calculated.

The simplest case of OTDOA-IPDL is without idle periods. In this case the method can be referred to as simply OTDOA.

The Node B~~s~~ may provide idle periods in the downlink, in order to potentially improve the hearability of <u>neighbouring Node B</u>~~other Cells~~. The support of these idle periods in the UE is optional. Support of idle periods in the UE means that its OTDOA performance will improve when idle periods are available.

~~Optionally, a PCF may be included in the UE, in which case the calculation of the location from the measurements may alternatively be performed in the UE.~~<u>Alternatively, the UE may perform the calculation of the location using measurements and assistance data.</u>

The detailed description of the OTDOA-IPDL ~~location~~<u>positioning</u> method and its operation are described in clause 9.

## 4.4.3 Network<u>-a</u> ~~A~~ssisted GPS Methods

These methods make use of UEs which are equipped with radio receivers capable of receiving <u>GPS</u> signals ~~from the Global Positioning System (GPS)~~.

The operation of the network<u>-a</u>~~ a~~ssisted GPS methods is described in clause 10.

# 5 UTRAN <u>UP</u>~~LCS~~ Architecture

Figure 5.1 shows the general arrangement of the ~~Location Service~~<u>UE positioning</u> feature <u>in UTRAN.</u>~~including the assumed Core Network architecture for LCS . This illustrates, generally, the relation of LCS Clients and servers in the core network with the UTRAN. The definition and operation of LCS entities operating in the core network is outside the scope of the present document. The LCS entities~~<u>SRNC</u> ~~within the UTRAN communicate with the Core Network (CN) across the Iu interface.~~ Communication among the UTRAN ~~LCS~~ <u>UP</u> entities makes use of the messaging and signalling capabilities of the UTRAN <u>interfaces (Iub, Iur)</u>.

~~As part of their service or operation, the LCS Clients may request the location information of User Equipment (UE) (UE without a valid SIM/USIM) or mobile stations. There may be more than one LCS client. These may be associated with the core network, associated with the UTRAN, operated as part of a UE application or accessed by the UE through its access to an application (e.g. through the Internet).~~

~~Within the UTRAN, typically T~~the ~~serving S~~RNC, receives authenticated requests for <u>UE positioning</u>~~LCS~~ information from the ~~core network~~<u>CN</u> across the Iu interface. ~~LCS entities then~~ <u>RNCs</u> manage the UTRAN resources, including ~~the Node-B~~<u>Node B</u>s ~~(base stations)~~, LMU~~s~~, the UE and calculation functions, to estimate the ~~location~~<u>position</u> of the UE and return the result to the CN. <u>SRNC may also make use of the UP function for internal purpose e.g. position based handover.</u>
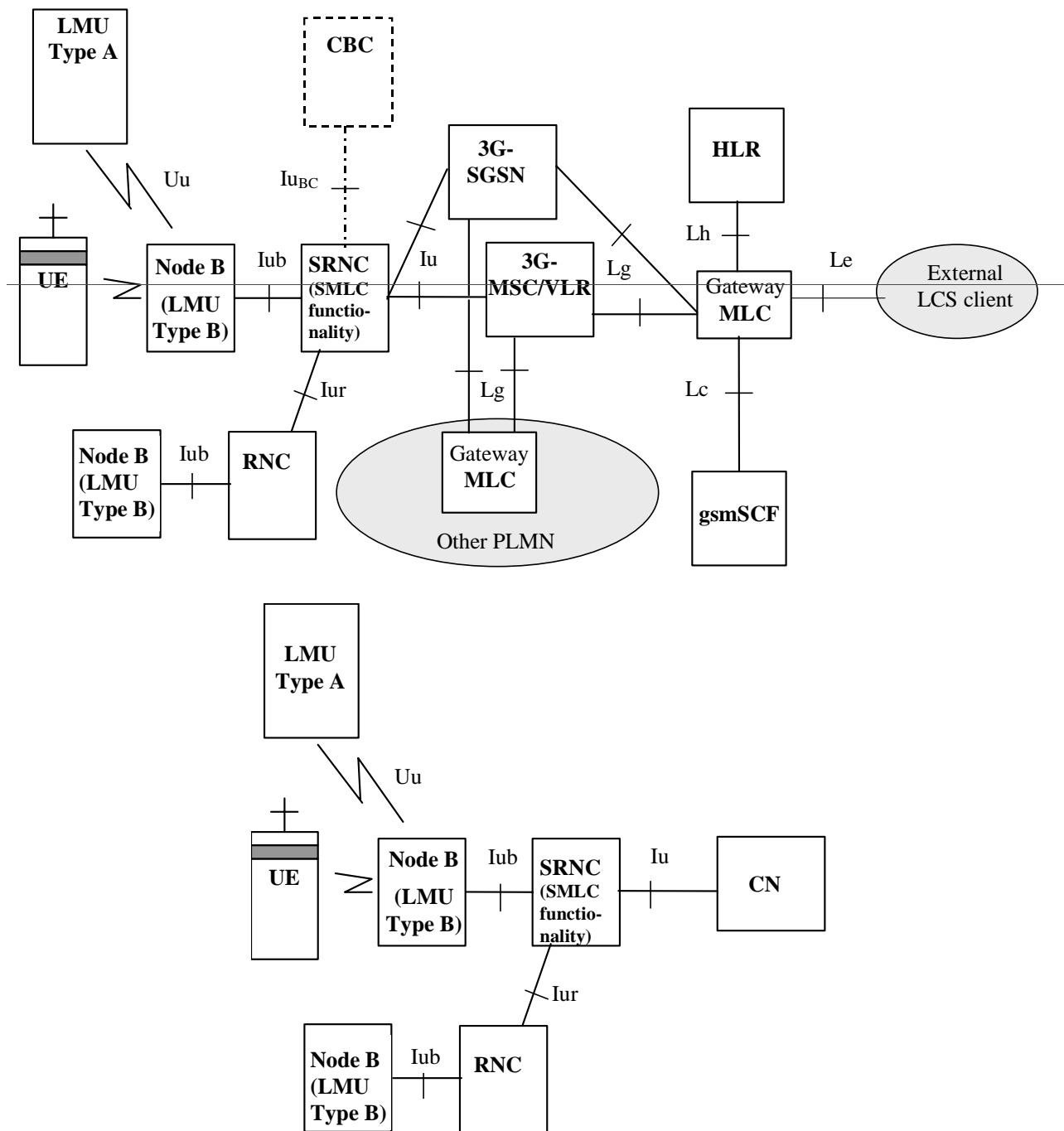
**Figure 5.1: General arrangement of UP~~LCS~~ in UMTS**

# 5.1 ~~LCS~~ UP Operations

The schematic functional description of LCS operations in UMTS is defined in [1].

Upon request from the ~~UMT,S~~ Core Network ~~LCS entities~~ or for internal operations, ~~the UTRAN~~a RNC ~~LCS functional~~UP ~~entities~~function ~~will~~should:

- request measurements, typically from the UE and one or more ~~Node-B~~Node B ~~radio apparatus~~;

- send the measurement results to the appropriate calculating function within UTRAN;

- receive the result from the calculating function within UTRAN;

- perform any needed co-ordinate transformations;

- send the results to the LCS entities in the ~~core network~~CN or to application entities within UTRAN.

In the event that the client is internal to UTRAN the request may be made directly to the UTRAN ~~LCS~~UP entities as the internal clients are considered to be "pre-authorised".

As part of its operation, the UTRAN ~~LCS~~UP calculating function may require additional information. This may be obtained by the function directly by communication with a database, or it may be through a request to UTRAN ~~LCS~~UP entities that will mediate the request and return of information from the appropriate database (or databases if more than one is needed to fulfil the requests).

There may possibly also be available independent information that is able to supply the ~~location~~positioning information directly, or may be able to supply auxiliary information to the calculation function. The UTRAN ~~LCS~~UP co-ordination function, as part of its activity to supervise the location process, may query the UE or other elements of the UTRAN to determine their capabilities and use this information to select the mode of operation.

This general operation is outlined in the following (generic) sequence diagram figure 5.2. This figure is not intended to show the complete ~~LCS~~UP operation for UTRAN, but to simply to outline the basis for operation.
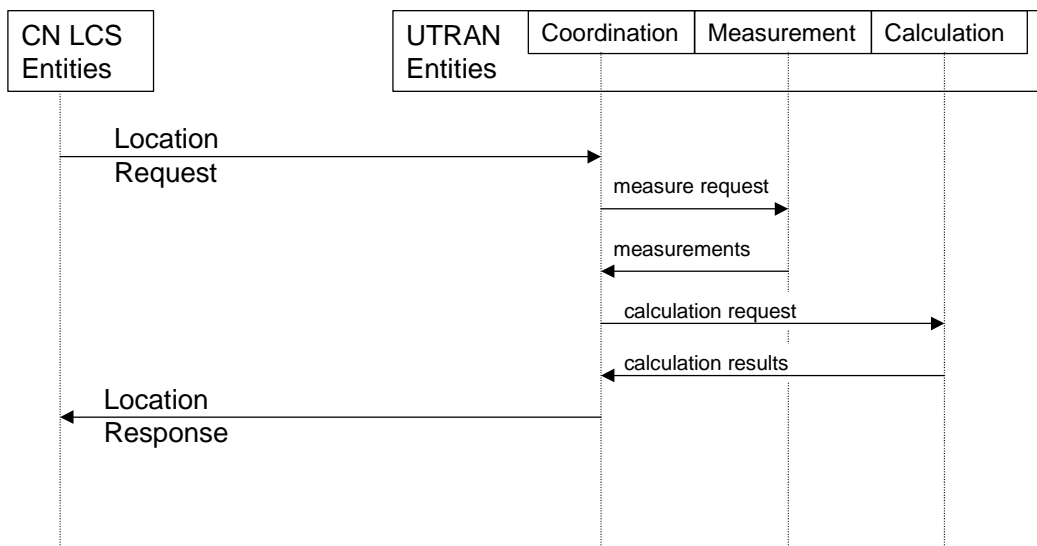


**Figure 5.2: General sequence for ~~LCS~~UP operation**

# 5.2 ~~High-Level Functions~~

~~Several functional groupings may be defined to describe the LCS. These groupings occur in both the Core Network and the UTRAN. The overall LCS functional grouping is described in reference [1]. Each grouping encompasses a number of functional components and functions.~~

~~The functions within the UTRAN are described in more detail in the following subclauses of the present document.~~

~~Within UTRAN the functional entities may be grouped as follows:~~

   ~~- the Internal Client group;~~

   ~~- the UTRAN System Handling group;~~

   ~~- the Positioning group.~~

# 5.1.1~~5.2.1~~ Co-ordination, Measurement and Calculation Functions

The~~se~~ UTRAN functions for UP~~(including functions in the System handling and Positioning groups)~~ provide the co-ordination, measurement and calculation functions needed to provide a ~~location~~position estimate. The functions

interface with the requesting application and select the appropriate ~~location~~positioning method and speed of response. The functions co-ordinate the operations of the radio and measurement equipment to transmit the needed signals and to make the needed measurements. The measurements may be made by the~~Node-B~~ Node B, ~~radio apparatus associated with the Node-B or separate Location Measurement Units~~ by the (LMU~~)~~. The LMU ~~that~~ may be associated with the Node B~~Node-B~~, independently located or remote (i.e. communicating over the Uu interface).

The functions may also access databases or other sources of information appropriate for the ~~location~~positioning method. The functions also provide the calculation functions appropriate for the ~~location~~positioning method to estimate the UE ~~location~~position and the accuracy of the report. The functions may also make co-ordinates translations to the geographic co-ordinates system requested by the application. The functions also may record information on the usage of the ~~LCS~~UP that may be used for administrative purposes (e.g. forwarded to a billing function in the ~~Core Network~~CN). If needed by the ~~location~~positioning method, the functions will ensure the broadcast of information and gather and update information concerning UTRAN operating parameters (e.g. timing of Node -B transmissions) needed for ~~LCS~~UP operations.

These entities are mainly concerned with the ~~location~~positioning method, controlling the radio equipment and performing the calculations to determine the ~~location~~position and thus may be associated with the RNC in the UTRAN ~~access network~~. These functions may receive location requests from either the ~~core network~~CN or from applications internal to the UTRAN.

The UTRAN ~~LCS~~UP entities may also request the subscription and authorisation functions in the ~~core network~~CN to authenticate an application or a UE subscription or to verify the subscriber privacy parameters.

These RNC functions communicate with the ~~core network~~CN across the Iu interface, with other RNC entities ~~in the UTRAN~~ across the Iur interface and with the Node-B and LMU across the Iub interface and with the UE and the remote LMU across the Uu interface.

# 5.2     High-Level Functions

Void.

# 5.3     UTRAN ~~LCS~~ UP Functional Entities

Void.

~~The diagram of the UTRAN LCS UP functional entities is shown in figure 5.3. In this arrangement, the LCS clients in the core network communicate with the UTRAN LCS entities across the Iu interface. The LCS RNC Handling Entities and the Positioning Handing Entities work together with the UE to measure and calculate the location information for the requested target UE. These entities within the UTRAN are described in more detail in the following subclauses.~~

~~The figure shows the general arrangement of the Location Service feature in UTRAN. LCS entities are added to the UTRAN to provide the location service. Communication among these entities makes use of the messaging and signalling capabilities of the UTRAN across the Iu, Iur, Iub and Uu interfaces. A Location Measurement Unit (LMU) is also added to the UTRAN to make measurements as needed by the selected location method.~~

~~This figure does not include elements of the next generation mobile Core Network, but focuses on those that participate with the LCS functions in the UTRAN. The association of the LCS entities within the Core Network (CN) (e.g. with 3G-MSC or 3G-SGSN) is outside the scope of the present document and is not illustrated in the diagram.~~

~~Within the UTRAN, the LCS Entities may be associated with, or part of the RNC, the Node-B and the UE. Internal LCS Applications may also be part of the RNC and the UE.~~

~~The mobile position calculation function (PCF) is logically associated with the Serving RNC in UTRAN.~~

~~The LCS UP in UMTS also makes use of the standardised Iur interface between RNCs, when base station information, measurements and results are collected.~~

~~The functional model presented in the figure includes functional entities for UE utilising either or both circuit switched (CS) and packet switched (PS) services. This model also supports of all the entities needed for different location methods (e.g. network based, mobile based, mobile assisted, and network assisted (see note 1) methods) exploiting either uplink or downlink measurements.~~

NOTE 1: In this approach mobile station may use the GPS technique but still make use of auxiliary information from the serving network.

Implementations may often associate the UTRAN LCS Entities with an RNC (as illustrated in the figure). However, for networks with a small volume of LCS requests, the LCS Entities in the UTRAN may also be implemented as a separate element (server) which interfaces with the RNCs, and the Node-B/LMUs.

**Figure 5.3: UTRAN LCS Functional Entities**

## 5.3.1 Internal Client Group

### 5.3.1.1 Internal UTRAN Location Client Function (U-LCF)

The Location Client Function (U-LCF) represents a logical interface between the internal UTRAN LCS applications and the LCS RNC Handling entities (e.g. the Location System Control Function (U-LSCF) in the RNC).

NOTE: There is not necessarily a requirement for a LCCF (Location Client Control Function) for the UTRAN Internal Client as is described for external clients in reference [1] (the system stage specification).

The UTRAN may make use of location information for internal operations such as location assisted handover. In such a case, a U-LCF representing the internal UTRAN LCS application may communicate with the U-LSCF to request and receive the location information.

## 5.3.2 UTRAN System Handling group

### 5.3.2.1 UTRAN Location System Control Function (U-LSCF)

The UTRAN Location System Control Function in RNC is responsible for co-ordinating location requests within the RNC handling entity. This function manages call-related and non-call-related location requests and allocates network resources for handling them. This function "insulates" the Location clients in the Core Network from the detailed operation of the location method in order that the UTRAN may be used by several types of core network and with several location methods.

The U-LSCF provides flow control between simultaneous location requests. Simultaneous location requests must be queued in a controlled manner to account for priority requests (e.g. for Emergency Clients). The details of the flow control, priority selection and queuing are beyond the scope of the present document.

The U-LSCF will select the appropriate location method based on the availability of resources and parameters of the location request. The U-LSCF co-ordinates resources and activities needed to obtain data (e.g. base station geographic co-ordinates) needed for the location method. It also records LCS RNC usage data for the location service request that may be passed to a Location System Recording Function (U-LSRF) or OA&M function in the Core Network.

If the location technique requires the broadcast of system information, the LSCF initiates and maintains this activity through the Position Radio Co-ordination Function (U-PRCF). Broadcast information (such as the geographic co-ordinates of the base stations) may be required, for example, to support a Position Calculation Function (U-PCF) located in the mobile unit (UE). These broadcasts may also include other information (such as currently observable satellites) that may assist a UE in the use of external location services.

The information to be broadcast is selected based on the location techniques offered for use by the LCS and the needs of the UE. This broadcast information may be specially coded (i.e. encrypted) to ensure its availability only to subscribers of the service. The use of broadcasts or other methods for signalling to the UE or the LMU may be selected based on the chosen location method.

The information to be broadcast could include, for example:

- identification and spreading codes of the neighbouring base stations (the channels that are used for measurements);

- Relative Time Difference (RTD), i.e. the timing offsets, asynchrony between base stations, could be based on measurement results obtained by LMUs;

- roundtrip delay estimates in connected mode;

- the geographic location, co-ordinates, of the neighbouring base stations;

- the idle period places within the frame structure for multiple base stations;

- the local time-of-day.

Some of this information may be broadcast to support other UTRAN operations (e.g. handover). The function of the LSCF is to ensure information is broadcast when needed for the LCS operations and the LSCF may make use of other UTRAN processes to do so.

If there are frequency differences between the (unsynchronised) base stations, the OTDOA measurements must be reported together with the time-of-day they were made (timestamp). This is necessary so that the appropriate value of the RTD may be used by the calculation function.

### 5.3.2.2 UTRAN Location System Operations Function (U-LSOF)

The Location System Operations Function (LSOF) is responsible for provisioning of data, location capabilities, data related to clients and subscription (LCS client data and UE data), fault management and performance management of LCS within the RNC.

An LSOF may be associated with each entity. The LSOF interacts with Internal (OAM) Clients for administration and maintenance of the data.

## 5.3.3 Positioning group

### 5.3.3.1 UTRAN Position Radio Co-ordination Function (U-PRCF)

The UTRAN Position Radio Control Function manages a location request for a UE through overall co-ordination and scheduling of resources to perform location measurements. This function interfaces with the U-PSMF, the U-PRRM and the U-PCF. The U-PRCF determines the location method to be used based on the location request, the QoS, the capabilities of the UTRAN, and the UE's capabilities. The U-PRCF also manages the needed radio resources through the U-PRRM. It determines which U-PSMFs are to be involved, what to measure, and obtains processed signal measurements from the U-PSMF.

Some location methods may involve measurements made at the UE. In this case the U-PRCF interfaces with the UE to obtain the measurements (or the location results if they have been determined by the UE). Some location methods may involve measurements or information from several sources, including radio units at several Node-B (or other Location

Measurement Units (LMU)) and involve a series of transmissions and receptions. The U-PRCF entity also provide ancillary measurements in case of network-assisted location method. Ancillary information may be extracted from navigating systems like GPS.

The U-PRCF forwards the signal measurement data to the U-PCF.

It is the function of the U-PRCF to co-ordinate the sequence of activities and compensate for failures (if they occur) to provide the location estimate.

### 5.3.3.2        UTRAN Position Calculation Function (U-PCF)

The UTRAN Position Calculation Function is responsible for calculating the location of the UE (mobile unit). This function applies an algorithmic computation on the collected signal measurements to compute the final location estimate and accuracy.

The U-PCF may also support conversion of the location estimate between different geographic reference systems. It may obtain related data (e.g.: base station geographic co-ordinates) needed for the calculation. There may be more than one calculating function available within, or associated with, the calculation function of the UTRAN.

In the cell ID based location method, the U-PCF shall determine the geographical co-ordinates corresponding to the cell(s) associated with the the target UE.

The Position Calculation Function is also responsible for estimating the accuracy of the location estimate. This accuracy estimate should include, for example, the effect of geometric dilution of precision (GDOP), the capabilities of the signal measuring hardware, the effects of multipath propagation and the effects of timing and synchronisation unknowns. The accuracy should be returned as a measure of distance in the same units as the location estimate. The accuracy zone may be reported as the axis and orientation of an ellipse surrounding the location estimate.

### 5.3.3.3        UTRAN Position Signal Measurement Function (U-PSMF)

The UTRAN Position Signal Measurement Function (U-PSMF) is responsible for performing and gathering uplink or downlink radio signal measurements for use in the calculation of a UE's location. These measurements can be location related or ancillary.

There may be one or more PSMF within a UTRAN and they may be located at the UE, the Node-B, or a separate Location Measurement Unit (LMU). The PSMF, generally, may provide measurement of signals (i.e. satellite signals) in addition to measurements of the UTRA radio transmissions. The measurements to be made will depend on the selected location method.

### 5.3.3.4        UTRAN Position Radio Resource Management (U-PRRM)

The UTRAN Position Radio Resource Management entity is responsible for managing the effect of LCS operations on the overall performance of the radio network. This may ensure, for example, that the operation of the U-PSMF does not degrade the QoS of other calls. The U-PRRM handles following functions:

- controlling the variation of the UL and DL signal power level due to the LCS application;

- calculating the DL and UL power/interference due to UE location operations;

- to admit/reject the new LCS requests;

- co-operating with Admission Control, and entities of the RRM (such as power control) to provide the system stability in terms of radio resources;

- controlling the RTD measurement mechanism. It may also forward the results of the RTD; ATD (or any similar timing parameter) measurements to the PRCF (or PCF);

- controlling the IPDL mechanism for location measurements. This may include the overall control of the periodical measurement fulfilment. Co-ordination among RNC (e.g. to assure non-overlapping idle periods) will be communicated through the Iur interface.

# 5.4 Assignment of LCS Functional Entities to UTRAN Elements

Void.

~~The preceding figure 5.3 and the following table 5.1 show the generic configuration for different location methods, including network-based, mobile-based, mobile-assisted and network-assisted methods. With this approach both the network and the mobiles are able to measure the timing of signals and compute the mobile's location estimate. Depending on the applied location method it is possible to utilise the corresponding configuration containing all needed entities. For instance, if a network-based location method is applied, the entities that are involved in measuring the mobile's signal and calculating its location estimate are allocated to the network elements of the access stratum. On the other hand, in case mobile-based or network-assisted methods are used these entities should be allocated to the mobile station.~~

~~**Table 5.1: Example Allocation of LCS Functional Entities to Network Elements**~~

| ~~U-~~ | ~~UE~~ | ~~Node-B~~ | ~~LMU~~ | ~~RNC~~ |
|---|---|---|---|---|
| ~~LCF~~ | ~~X~~ | | | ~~X~~ |
| ~~LSCF~~ | | | | ~~X~~ |
| ~~PRCF~~ | | | | ~~X~~ |
| ~~PCF~~ | ~~X~~ | | | ~~X~~ |
| ~~PRRM~~ | | | | ~~X~~ |
| ~~PSMF~~ | ~~X~~ | ~~X~~ | ~~X~~ | |
| ~~LSOF~~ | ~~X~~ | ~~X~~ | ~~X~~ | ~~X~~ |

# 5.5 Functional Description of UTRAN UP related~~LCS Network~~ elements

## 5.5.1 Radio Network Controller (RNC)

### 5.5.1.1 Serving RNC

The ~~Serving RNC~~ (SRNC) is a network element of UTRAN and contains functionality required to support LCS in one PLMN.

The SRNC provides the following functionality:

  request of information from other RNC:
    The SRNC may request information regarding UP from other RNCs.

- broadcast of system information:
    The SRNC may broadcast information in support of the selected positioning method. This broadcast information may be specially coded (i.e. encrypted) to ensure its availability only to subscribers of the service.

    The information to be broadcast could include, for example:

  - identification and spreading codes of the neighbouring cells (the channels that are used for measurements);

  - Relative Time Difference (RTD), i.e. the timing offsets, asynchrony between base stations, could be based on measurement results obtained by LMUs;

  - roundtrip delay estimates in connected mode;

  - the geographic location, co-ordinates, of the neighbouring Node B;

  - the idle period places within the frame structure for multiple cells;

  - the local time-of-day.

- flow control of positioning requests:
    If several simultaneous positioning requests are present within one SRNC, the SRNC co-ordinates the positioning requests taking into account priority of the requests (e.g. for Emergency Clients).

- positioning method selection:
  The positioning method selection is based on the location request, QoS, capabilities of UP elements and UE positioning capabilities.

- position calculation:
  The SRNC may calculate the position of a UE and may also support conversion of the location estimate between different geographic reference systems. In case RNC estimates the UE position, it is also responsible to estimate the accuracy of the position estimate. This accuracy estimate should include, for example, the effect of geometric dilution of precision (GDOP), the capabilities of the signal measuring hardware, the effects of multipath propagation and the effects of timing and synchronisation unknowns. The accuracy should be returned as a measure of distance in the same units as the location estimate. The accuracy zone may be reported as the axis and orientation of an ellipse surrounding the location estimate

- storage of UP related data:
  The UP related data stored in RNC consists of UE positioning capabilities, data related to clients and subscribtions.

manages the overall co-ordination and scheduling of resources required for the UP location of a mobile. It also calculates the final locationposition estimate and estimates the achieved accuracy.

The SRNC, of course, also provides CRNC functionality regarding UP for its associated Node Bs and LMUs

The SRNC may control a number of LMUs for the purpose of obtaining radio interface measurements to locate or help locate UEsMS subscribers in the area that it serves. The SRNC is administered with the capabilities and types of measurement produced by each of its LMUs. Signalling between an SRNC and LMU is transferred using the Iub interface, sometimes the Iur interface. The following measurements returned by an LMU to an SRNC have a generic status in being usable for more than one locationpositioning method:

- radio interface timing information.

The SRNC connects to the CN via the Iu interface and GMLC are connected through the 3G-VMSC or 3G-SGSN. When the VMSC and GMLC are in different PLMNs, they are interconnected via the Lg interface.

## 5.5.1.2 Other RNC

### 5.5.1.2.1 Controlling RNC

The CRNCControlling RNC is a UTRAN element that has the role to control Node-BNode Bs. The controlling CRNC may requestask its associated NodeBs and LMUs for LCSUP measurements. The measurement results are delivered from the LMUs to the Controlling CRNC that then forwards the results to the serving SRNC.

The CRNC provides the following functionality:

- resources management:
  When allocating resources the CRNC determines which UTRAN elements are involved and what to measure. The RNC is also responsible for managing the effect of UP operations on the overall performance of the radio network by:

  - controlling the variation of the UL and DL signal power level due to UP;

  - calculating the DL and UL power/interference due to UP;

  - to admit/reject the new positioning requests;

  - co-operating with Admission Control, and entities of the RRM (such as power control) to provide the system stability in terms of radio resources;

  - controlling the IPDL mechanism for OTDOA measurements. This may include the overall control of the periodical measurement fulfilment. Co-ordination among RNC (e.g. to assure non-overlapping idle periods) will be communicated through the Iur interface.

- request UP related measurements from its associated Node Bs and LMUs:
  The measurements requested by CRNC from its associated Node Bs and LMUs is dependant on the positioning

method used. The following measurement returned by a LMU to a CRNC have a general status and may be used for more than one positioning method:

- radio interface timing information

Signalling between Node B or LMU and CRNC is transferred using Iub signalling.

### 5.5.1.2.2 Drift RNC

The DRNCDrift RNC is a UTRAN element that has active link to the UE that shall be located. Drift DRNC may ask its associated NodeBs for LCSUP measurements. The measurement results are delivered from the NodeBs and to the Drift DRNC that then forwards the results to the SRNCserving RNC.DRNC may provide the same UP functionality as CRNC.

## 5.5.2 Node B

Node B is a network element of UTRAN that may provide measurement results for locationposition estimation. It contains a PSMF and makes measurements of radio signals and communicates these measurements to the SRNC.

The Node B may make its measurements in response to requests (e.g. from the SRNC), or it may autonomously measure and report regularly or when there are significant changes in radio conditions (e.g. changes in the RTD).

## 5.5.3 Location measurement unit (LMU)

The LocationLCS Measurement Unit (LMU) entity makes measurements (e.g. of radio signals) and communicates these measurements to athe S-RNCRNC (e.g. the PRCF). The LMU contains a PSMF and may also perform calculations associated with the measurements.

All positioning and assistance measurements obtained by an LMU are supplied to a particular CRNC associated with the LMU. Instructions concerning the timing, the nature and any periodicity of these measurements are either provided by the CRNC or are pre-administered in the CRNC (e.g. using O&M).

The LMU may make its measurements in response to requests (e.g. from the S-RNCCRNC (e.g. the PRCF)), or it may autonomously measure and report regularly (e.g. timing of Node -B transmissions) or when there are significant changes in radio conditions (e.g. changes in the RTD).

There may be one or more LMU associated with the UTRAN and an LCSUP request may involve measurements by one or more LMU. The LMU may be of several types and the S-RNCCRNCs will select the appropriate LMUs depending on the LCSUP method being used.

The LMU may be used, for example, to measure UTRAN transmissions either ULuplink or DLdownlink. These measurements may be made either, for example, to locate the UE or to measure a system parameter needed by the UPLCS system such as the timing offset (RTD) of transmissions of two or more base stationNode Bs. The LMU may also measure other transmissions, such as those of satellite navigation systems (i.e. the Global Position System (GPS)) and either report the measurements for use by the S-RNCCRNC (e.g. the PCF), or report the locationpositioning results as determined by internal calculations of the LMU). The details of the measurements to be made by the LMU will be defined by the chosen LCSUP method.

An LMU makes radio measurements to support one or more locationpositioning methods. These measurements fall into one of two categories:

(a) locationpositioning measurements specific to one UE and used to compute its locationposition;

(b) assistance measurements applicable to all UEs in a certain geographic area.

All location and assistance measurements obtained by an LMU are supplied to a particular S-RNC associated with the LMU. Instructions concerning the timing, the nature and any periodicity of these measurements are either provided by the S-RNC or are pre-administered in the S-RNC (e.g. using O&M).

There are two classes of LMU:

- **Stand-Alone LMU:** communicates with RNCs via the Uu accessed over the UTRAN air interface;

- **Associated LMU:** communicates with RNCs via accessed over the Iub interface.

The associated LMU signalling protocol is the NBAP. The protocol for stand-alone LMU signalling has not been defined yet.

NOTE 1: The stand-alone LMU signalling protocol could be, for example, RRC or LLP, but this is still for further study.

**Stand-Alone LMU**

A stand-alone LMU is accessed exclusively over the UTRAN air interface (Uu interface). There is no other connection from the stand-alone LMU to any other UTRAN network element.

NOTE 2: This does not preclude a stand-alone LMU from also communicating with other access networks (e.g. GSM) through interfaces that are not part of the present document.

A stand-alone LMU has a serving ~~Node-B~~Node B that provides signalling access to ~~itsa controlling~~ ~~S-RNC~~CRNC. A stand-alone LMU also has a serving 3G-MSC, VLR and a subscription profile in an HLR. A stand-alone LMU always has a unique IMSI and supports all radio resource and mobility management functions of the UTRAN ~~air~~radio interface that are necessary to support signalling. A stand-alone LMU shall support those connection management functions necessary to support ~~LCS~~UP signalling transactions with the ~~S-RNC~~CRNC and may support certain call control functions of to support signalling to an ~~S-RNC~~CRNC using a circuit switched data connection.

NOTE 3: A network operator may assign specific ranges of IMSI for its LMUs and may assign certain digits within the IMSI to indicate the associated ~~S-RNC~~CRNC. Certain digits in the IMSI may also be used as a local identifier for an LMU within an ~~S-RNC~~CRNC.

To ensure that a Stand-alone LMU and its associated ~~S-RNC~~CRNC can always access one another, an LMU may be homed (camped) on a particular cell site or group of cell sites belonging to one 3G-MSC. For any Stand-alone LMU with a subscription profile in an HLR, a special profile may be used to indicate the assigned supplementary services (e.g. the SMS-PP MT for data download via the SIM application toolkit, and barring of all incoming and possibly outgoing calls). An identifier in the HLR profile also distinguishes an LMU from a normal UE. All other data specific to an LMU is administered in the LMU and in its associated ~~S-RNC~~CRNC.

**Associated LMU**

An associated LMU is accessed over the Iub interface from an RNC. An associated LMU may make use of the radio apparatus and antennas of its associated ~~Node-B~~Node B. The LMU may be either a logically separate network element addressed using some pseudo-cell ID, or connected to or integrated in a ~~Node-B~~Node B. Signalling to an associated LMU is by means of messages routed through the controlling ~~Node-B~~Node B.

An associated LMU may be separated from the ~~Node-B~~Node B, but still communicate with the ~~S-RNC~~CRNC via the ~~Node-B~~Node B Iub interface. The interface between the associated LMU and its ~~Node-B~~Node B is not part of the present document.

NOTE 4: An associated LMU is not precluded from also communicating with other access networks (e.g. GSM) through interfaces that are not part of the present document.

**Measurements**

The assistance measurements obtained by an LMU ~~have~~ are generic and are usable by more than one ~~location~~positioning method. These include:

- **Radio Interface Timing measurements:** include ~~Absolute Time Differences (ATDs)~~ or ~~Relative Time Differences (RTDs)~~ of the signals transmitted by ~~Node-B~~Node B, where timing differences are measured relative to either some ~~Absolute Time Difference (ATD)~~ or the signals of another ~~Node-B~~Node B (RTD);

- **Inter-System Timing measurements:** include the Absolute Time Difference (ATD) or Relative Time Difference between the UTRAN radio signals transmitted by a ~~Node-B~~Node B and an external system such as the GPS satellite navigation system or GSM.

## 5.5.4    UE

The UE ~~may~~~~interacts with the measurement co-ordination functions to~~ transmit the needed signals for uplink based ~~LCS~~UP measurements and to make measurements of downlink signals. The measurements to be made will be determined by the chosen ~~location~~positioning method.

The UE may also contain LCS applications, or access an LCS application through communication with a network accessed by the UE or an application residing in the UE. This application may include the needed measurement and calculation functions to determine the UE's ~~location~~position with or without assistance of the UTRAN ~~LCS~~UP entities. This is outside of the scope of this specification.

The UE may also, for example, contain an independent ~~location~~positioning function (e.g., GPS) and thus be able to report its ~~location~~position, independent of the UTRAN transmissions. The UE with an independent ~~location~~positioning function may also make use of information broadcast by the UTRAN that assists the function.

# 6 Signalling protocols and interfaces

> NOTE: This clause describes the information flows, the detailed messages and protocols are described in other clauses.

## 6.1 LCS signalling between SRNC and MSC/SGSN

LCS signalling between SRNC and MSC/SGSN is handled through the Iu interface, which is described in clause 6.6.1.~~6.6.3.~~

## 6.2 SRNC signalling to a target UE

SRNC signalling to a target UE is described in clause 6.6.4.1.

## 6.3 Controlling RNC signalling to a standalone LMU

~~Controlling RNC~~CRNC signalling to a standalone LMU is described in clause 6.6.4.2.

## 6.4 Controlling RNC signalling to an associated LMU

~~Controlling RNC~~CRNC signalling to an associated LMU is handled through the Iub interface, which is described in clause 6.6.3.~~6.6.1.~~

## 6.5 RNC-to-RNC signalling for ~~LCS~~UP support

The RNC-to-RNC signalling for ~~LCS~~UP support is handled through the Iur interface, which is described in clause 6.6.2.

## 6.6 Interfaces

There are four interfaces through which the ~~LCS~~UP entities communicate. These are the Iu, ~~the~~ Iur, Iub and ~~the~~ Uu.

> NOTE: the interfaces between the Internal or External LCS applications and the 3G-MSC or 3G-SGSN are outside the scope of the present document.

### 6.6.1 Iu Interface

The Iu interface is used to communicate between the LCS functional entities in the ~~Core Network~~CN and the ~~LCS~~UP entities in the UTRAN. Further specification of the messages and operations for LCS across the Iu interface may be found in reference [1].

### 6.6.2 Iur Interface

~~LCS~~UP operations at the Iur interface are defined in [14].

The Iur interface is used to communicate between the ~~LCS~~UP functional entities associated with the ~~serving RNC~~SRNC and other RNC in the UTRAN. The Iur interface is also used to communicate between the ~~serving RNC~~SRNC and the Internal ~~LCS~~UP Applications in the UTRAN. The ~~LCS~~UP entities associated with the ~~serving RNC~~SRNC are responsible for co-ordinating and responding to ~~positioning~~location requests received from the LCS entities in the ~~core network~~CN or Internal Clients.

When communicating between the ~~serving RNC~~SRNC and the UTRAN Internal ~~LCS~~UP Applications ~~(ILA)~~, the messages and protocols are the same as those used over the Iur interface.

The Iur interface is also used to communicate between the ~~LCS~~UP Entities in the ~~serving~~ SRNC and those in other RNC. The ~~location~~positioning method, for example, may require measurements by several LMU or ~~Node-B~~Node B, some of which may be associated with other RNC. Commands and responses from these ~~LCS~~UP Entities are communicated over the Iur interface. In some cases, the ~~LCS~~UP Entities in the ~~serving RNC~~SRNC may make use of entities associated with other RNC. For example, a calculating function ~~(PCF)~~ may be used in another RNC if the ~~serving RNC~~SRNC is too busy or does not contain the function or database information required by the chosen ~~location~~positioning method.

~~The Iur interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the RNC.~~

Iur shall be used for ~~LCS~~UP signalling whenever it is available, even in the case when the RNCs connected to different 3G-MSCs or 3G-SGSN.

Within UTRAN, Iur supports inter-RNC soft handover. Inter-RNC handover should also include ~~LCS~~UP, meaning that whenever an inter-RNC soft handover occurs, Iur should be able to support the functionality of the ~~LCS~~UP entities in RNCs~~., including PCF, PRRM, PSMF, and LSOF~~.

In addition, in case of SRNC relocation Iur should support the relocation mechanism in order for DRNC to be able to handle the responsibility of SRNC in ~~LCS~~UP process. ~~That is, to transfer the PCF, PRRM, PSMF, and LSOF functionality from SRNC to DRNC.~~ Iur shall be used also to collect RTD and other ~~LCS~~UP information from ~~base station~~Node Bs under different RNCs that are not involved in handover.

## 6.6.3 Iub Interface

~~LCS~~UP operations at the Iub interface are defined in [15].

The Iub interface is used to communicate among the ~~LCS~~UP entities associated with the ~~serving RNC~~CRNC, the ~~Node-B~~Node B and the associated ~~Location Measurement Units~~ (LMU~~)~~.

This interface passes the request for measurements, the measurement results and requests for ~~LCS~~UP related transmissions or other radio operations needed by the ~~location~~positioning method (e.g. broadcast of parameters needed for a UE-~~-~~based ~~location~~positioning method).

~~The Iub interface may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the Node-B or the LMU.~~

### 6.6.3.1 Signalling between RNC and associated LMU

Signalling exchanges between an RNC and a LMU under the control of that RNC will be specified in the NBAP protocol for associated LMUs.

The protocol layers employed to enable signalling between the RNC and an associated LMU are defined in [21]~~25.430~~. The LMU signalling information elements are included directly in the NBAP protocol, defined in [15]~~25.433~~.

## 6.6.4 Uu Interface

~~LCS~~UP operations at the Uu interface are generally defined in [1]. This specification defines in more detail the procedures needed for messaging for each individual ~~location~~positioning method.

The Uu interface is used to communicate among the ~~LCS~~UP entities associated with the RNC, the UEs and the stand-alone ~~Location Measurement Units~~ (LMU~~)~~ (the Uu interface is also used to communicate between the LCS entities in the ~~core network~~CN and the UE. Those communications are beyond the scope of this specification).

This interface may pass measurement requests and results to and from the UE or the stand-alone LMU.

The Uu interface may also pass ~~UP~~location requests from internal or external LCS Applications at the UE. This is part of the NAS procedures and is outside of the scope of this specification.

> NOTE: ~~These requests may require the services of the LCS entities associated with the core network to~~ ~~authenticate clients and subscriber subscriptions to aspects of the LCS.~~

The Uu interface may also be used for broadcast of information that may be used by the UE or stand-alone LMU for their ~~UP~~LCS operations. This may, for example, include timing and code information about nearby ~~Node-B~~Node B transmissions that may assist the UE or LMU in making their measurements.

~~The Uu interface may also pass messages relating to changes or reporting of the data associated with the Location~~ ~~System Operations Function (LSOF) in the UE or the remote LMU.~~

## 6.6.4.1 Signalling between ~~S-RNC~~SRNC and Target UE

~~LCS~~UP related signalling between an ~~S-RNC~~SRNC and a target UE is supported by the RRC protocol as specified in [19].

The ~~location~~positioning ~~r~~Request to UE signalling flow is generic for all UE~~-~~based or UE-assisted ~~location~~positioning methods (OTDOA and Network~~-~~ Assisted GPS).





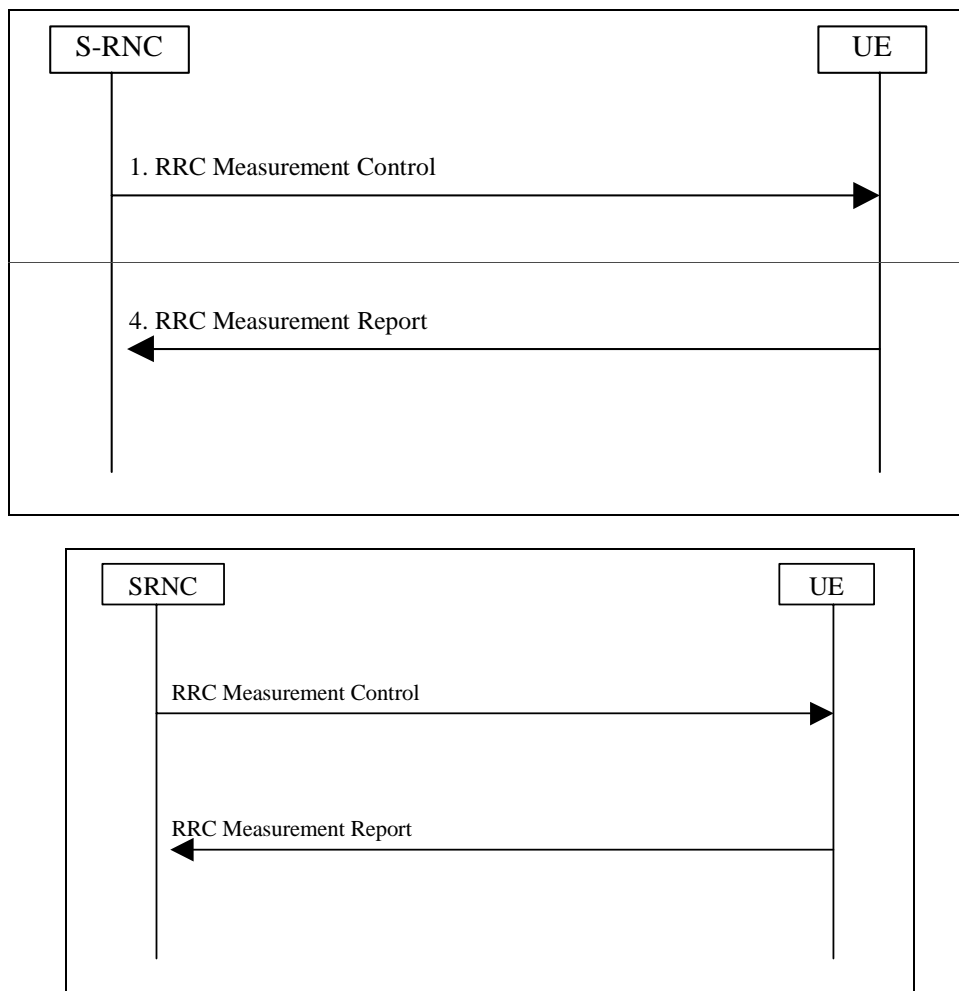**Figure 6.1: OTDOA /GPS ~~Location~~Positioning Message Flow**

1. The ~~S-RNC~~SRNC determines possible assistance data and sends a MEASUREMENT CONTROL request to the UE.

2. Provided that the ~~UP~~location request meets the privacy criteria, the UE performs the requested measurements. If the UE is able to calculate its own ~~location~~position, and this is requested, the UE computes a ~~location~~position

estimate based on measurements. Any assistance data necessary to perform these operations will either be provided in the MEASUREMENT CONTROL request or be available from broadcast sources. The resulting measurements or ~~location~~position estimate are returned to UTRAN in a MEASUREMENT REPORT response. If the UE cannot fulfil the request, a MEASUREMENT CONTROL FAILURE message is returned.

### 6.6.4.1.1 Assistance Data Delivery to UE

The assistance data signalling flow illustrated here is generic for UE-~~-~~based ~~location~~positioning methods, including OTDOA and Network~~-a~~-Assisted GPS. Note that if the assistance data is sent as part of a broadcast message, then no assistance data acknowledgement is required.



**Figure 6.2: OTDOA or GPS Assistance Data Delivery Flow**

1. The ~~S-RNC~~SRNC determines assistance data and sends it in the RRC MEASUREMENT CONTROL message to the UE.

### 6.6.4.1.2 Error Handling

The error handling for signalling on the Uu interface is handled by the RRC protocol in [19].

### 6.6.4.1.3 Broadcast of Assistance Data

In the UE-~~b~~-Based OTDOA or Network~~-a~~-Assisted GPS methods, where the measurements and/or ~~location~~position calculation is done in the UE, UTRAN may broadcast assistance data ~~may be broadcast~~ to the UE.

The assistance data to be broadcast for UE-~~b~~-Based OTDOA contains ~~the Relative Time Difference (RTD)~~ values (e.g. in case of a non-synchronised network) and ~~base station~~Node B co-ordinates. In addition, the broadcast data may contain other information to simplify the OTDOA measurements. The length of the message depends on how many neighbours are included in the assistance data. Part of the broadcast message (e.g. the serving and neighbour ~~base station~~Node B geographic co-ordinates) may be ciphered.

The assistance data to be broadcast for assisted GPS contains DGPS corrections, ephemeris and clock corrections, as well as almanac and other data. Part of the broadcast message may be ciphered.

The broadcast channel that is used for the OTDOA and GPS assistance data makes use of the common UTRAN broadcast service.

### 6.6.4.1.4 Signalling Flow for Assistance Data Broadcast Using the Common UTRAN Broadcast Service

The assistance data broadcast to UEs can be signalled via the RRC Measurement Control message as shown in subclause 6.6.4.2 or it can be broadcast by the UTRAN within the system information.

**Figure 6.3: Broadcast of system information**

### 6.6.4.1.5 ~~LCS~~UP Assistance Data Ciphering

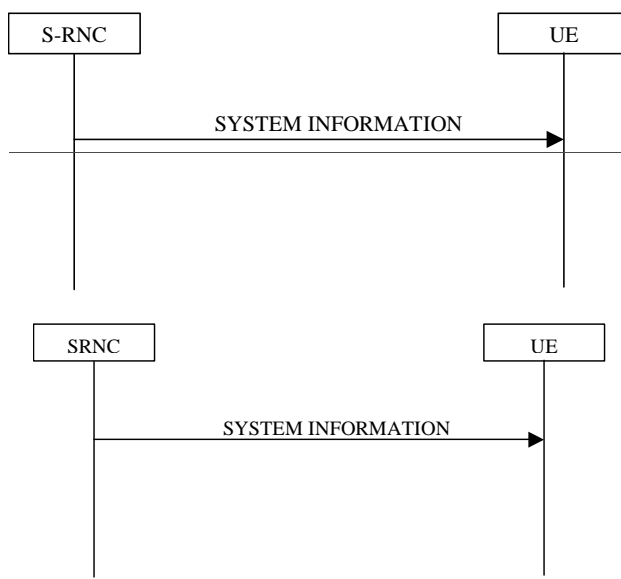To allow control of access to the assistance data, parts of the broadcast assistance data may be ciphered. Ciphering is done with a specific ciphering key delivered by the ~~core network~~CN for this purpose. The management of the key is described in the System Aspects Stage 2 ([1]).

### 6.6.4.1.6 ~~LCS~~UP Assistance Data Ciphering Algorithm

The algorithm used for ciphering the UP~~LCS~~ assistance data is the standard 56-bit Data Encryption Standard (DES) algorithm.

The deciphering of broadcast assistance messages is done in the UEs. The deciphering will utilize the deciphering keys delivered during the location update request. Details can be found in 3GPP TS 24.008.

The RNC ciphers the parts of the ~~LCS~~UP Broadcast Data message to be protected using the 56-bit DES algorithm and a ciphering keys (56 bits) and Ciphering Serial Number (16 bits) for the broadcast location area.

The ciphered part is variable in length with one bit resolution. By using the ~~LCS~~UP Broadcast Data message header, the UEs can determine what part of message is ciphered.

Inputs to the 56-bit DES algorithm are the following:

- 56-bit key K (deciphering key);

- 16-bit Ciphering Serial Number from broadcast message which is denoted here by IV (Initialization Vector);

- plain-text bits (the ciphered part of broadcast message).

The ciphering process is illustrated in the following diagram. Ciphering is done by producing a mask bit stream which is then "XORed" bit-by-bit to the plain-text data to obtain the cipher-text data. First, the Initialization Vector (IV) is concatenated with 0-bits in order to achieve a 64-bit block $I_1$. This block is then encrypted by the DES algorithm using the key K. Output is a 64-bit block $I_2$. This constitutes the first 64 bits of the mask bit stream. If the message is longer than 64 bits, then more bits are needed. These are produced by encrypting $I_2$ again by the DES algorithm using the key K. The output is a 64-bit block $I_3$. This is the next 64 bits of the mask bit stream. This iteration is continued until enough bits are produced. The unnecessary bits from the last 64-bit block $I_j$ are discarded. The figure below illustrates the first two mask bit generations and the two ciphered 64-bit blocks.

**Figure 6.4: Data Assistance Ciphering Algorithm**

Deciphering is done similarly. The same mask bit stream is produced and these are XORed, bit-by-bit, to the cipher-text data bits. The result will be the plain-text data.

## 6.6.4.2 Signalling between RNC and stand-alone LMU

The use of stand-alone LMUs is FFS. If it is decided to have stand-alone LMUs in the standard, the signalling will be performed with the new protocol LLP. If no need is seen for the stand-alone LMUs the LLP protocol will not be defined and it will be removed from 25.305.

The following figures illustrate the protocol layers used to support signalling between an RNC and a Stand-Alone LMU over the Uu interface.

6.6.4.2.1          Signalling using a signalling bearer



**Figure 6.5: Signalling between an RNC and a Stand-Alone LMU using a signalling bearer**

6.6.4.2.2          Signalling using a radio bearer



**Figure 6.6: Signalling between an RNC and a Stand-Alone LMU using a radio bearer**

# 7          General UTRANUMTS locationUP procedures

## 7.1          General procedures in UTRAN for network UPlocation procedures

The General network location UP procedure in UTRAN starts with a request over Iu from the CN. UTRAN then determines the UE positionlocation by selecting a suitable locationpositioning method. UTRAN then responds to the request with the estimated location position and possible an associated accuracy.

## 7.2 Common procedures to support access to a LMU

NOTE: 7.2 and 7.3 will be considered if stand-alone LMUs are included.

## 7.3 Common control procedures for LMUs

### 7.3.1 Reset procedure

### 7.3.2 Status query procedure

### 7.3.3 Status update procedure

## 7.4 Common procedures supporting ~~LCS~~UP interaction between RNCs

In the case that ~~LCS~~the positioning information is needed from an associated LMU in a Node B that is not controlled by the SRNC then the transfer of this information ~~transfer is~~ need~~ed~~ to be supported on the Iur interface. This information is the same information that is signalled between an associated LMU and the corresponding ~~controlling~~ CRNC in the case when Iur support is not needed.

The SRNC requests the information it requires (e.g. GPS timing of cell measurements) from the CRNC~~controlling RNC~~ of the Node B which has the associated LMU. The CRNC~~controlling RNC~~ in turn requests the information from the Node B and upon success returns the results to the SRNC.

Similarly when the SRNC needs a Node B measurement on a UE when that Node B is not controlled by that SRNC there needs to be support on the Iur. One example is the RTT measurement.

Other information that may need to be signalled over the Iur includes LMU parameters (geographical position, covered cells etc.). NOTE: Confirmation or FS is needed by R3 experts.

NOTE: ~~LCS~~UP during SRNS relocation is unclear.

## 7.5 Exception procedures

### 7.5.1 Procedures in the SRNC

When a ~~location~~positioning attempt fails due to failure of a position method itself (e.g. due to inaccurate or insufficient position measurements and related data) and the SRNC is unable to instigate another positioning attempt (e.g. due to a requirement on response time), the SRNC may return a Location response over the Iu interface containing a less accurate ~~location~~ position estimate. If a less accurate estimate is not available or will not meet the accuracy requirement, the SRNC may instead return a Location response message containing no ~~location~~ position estimate and indicating the cause of failure.

NOTE: Need to check that Iu has enough flexibility

When a ~~location~~positioning attempt is interrupted by some other unrecoverable error event inside the SRNC, the SRNC shall immediately terminate the ~~location~~positioning attempt and return a Location Response message containing the reason for the ~~location~~positioning attempt cancellation. In that case, any dialogue previously opened with an LMU for the purpose of instigating position measurements for the UE being located may also be aborted by the SMLC.

### 7.5.2 Procedures in a LMU

An LMU shall return an error indication to its CRNC~~controlling RNC~~ when ~~location~~positioning measurements previously ordered by the RNC cannot be provided due to any error condition.

## 7.5.3 Procedures in the target UE

A target UE shall terminate any positioning procedure or the transfer of RRC positioning assistance data without sending any response to the SRNC if any ~~LCS~~UP RRC message is received from the SRNC that starts some other RRC management procedure. The new RRC procedure shall then be executed by the UE.

# 7.6 Radio interface timing procedures

The Radio Interface Timing determination system consists of functions in LMUs and in the SRNC. The system runs continuously offering cell timing information for UP~~mobile station location~~.

## 7.6.1 LMU Functions

The Radio Interface Timing functionality in the LMU should be capable of performing the following functions:

- The LMU performs necessary ~~air~~radio interface measurements from signals transmitted by Node Bs

- If the LMU contains a common reference clock, e.g. GPS TOW, it time stamps reception of Node B signals.

- If there is no reference clock available, the LMU may make RTD~~Relative Time Difference~~ measurements, i.e. measures the time difference between arrival of SFNs

- The LMU may perform some processing of measurements, like averaging and filtering, using parameters delivered to it, or in their absence using default settings

## 7.6.2 C~~S~~RNC Functions

The C~~S~~RNC must be capable of performing the following functions related to Radio Interface Timing determination:

- The C~~S~~RNC sends to LMUs requests for Radio Interface Timing measurement information.

- The C~~S~~RNC will communicate regularly with LMUs; thus, the C~~S~~RNC can monitor operation of LMUs. If a LMU fails to send Radio Interface Timing information, the C~~S~~RNC shall try to restart the LMU, and if this restarting fails, the C~~S~~RNC shall inform O&M system. C~~S~~RNC can use also diagnostics messages to query the status of LMUs.

- The C~~S~~RNC receives Radio Interface Timing measurement results from LMUs.

- The C~~S~~RNC stores or queries extra information required for Node B synchronization determination, like ~~base station~~Node B and LMU coordinates, Node B identity information.

- The C~~S~~RNC determines synchronization differences between different downlink signals using LMU measurements and other information.

- Synchronization information is delivered for UP~~UE location~~ purposes.

## 7.6.3 LMU-C~~S~~RNC Interactions

The request for Radio Interface Timing measurement information from the C~~S~~RNC to a LMU contains the following parameters:

- Measurement type. This indicates whether the C~~S~~RNC wants the LMU to perform ~~Absolute Time Difference~~ (ATD~~)~~ (e.g. GPS time stamp of signal) or ~~Relative Time Difference~~ (RTD~~)~~ measurements.

- Measurement result reporting frequency. This indicates how often the LMU should send Radio Interface Timing measurement results.

- Measurement duration. This indicates how long the LMU should make measurements and report results.

- Instructions about filtering of raw measurement data.

- Instructions about Primary CPICH signals to be measured. The LMU unit can measure autonomously a certain number of most strongly received signals. Another possibility is that the ~~CS~~RNC tells which Node B signals it should measure.

- In the RTD case, which common Primary CPICH the LMU should use as a reference in the measurements.

- Instruction of how the measurement quality should be reported.

The Radio Interface Timing measurement response from a LMU to the ~~CS~~RNC contains:

- Identity of the Node B at which the as~~s~~sociated LMU is residing

- Primary CPICH info of the measured signals.

- If the LMU can perform ATD measurements, and it is requested to do them, the ATD measurements of the requested CPICH signals is returned.

- If the LMU can perform RTD measurements, and it is requested to do them, the RTD measurements of the requested CPICH signals is returned.

- The SFN of the last frame measured, for each measurement.

- The quality of each measurement, according to the requested quality type

# 8 Cell ID based ~~location~~positioning method

In the Cell ID based method, the ~~S-RNC~~SRNC determines the identification of the cell providing coverage for the target UE. This subsection outlines the procedures for this ~~location~~positioning method. Sub-section 8.1 provides procedures for the determination of the cell ID depending on the operational status of the target UE. Sub-section 8.2 discusses the relation between the LCS location service and the Support of Localised Service Area (SoLSA) feature. Sub-section 8.3 provides a procedure for the mapping of the Cell ID to a corresponding ~~Service Area Identifier (~~SAI~~)~~ to be returned to the LCS application in the ~~core network~~CN. The general flow to determine the cell ID is shown in figure 8.1.

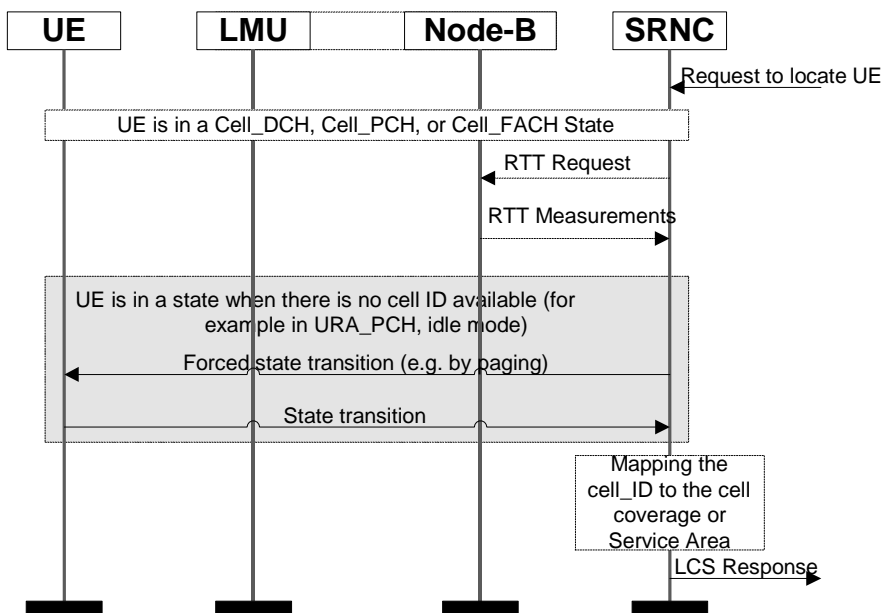

**Figure 8.1: Cell ID Based Method**

## 8.1 Cell ID determination

In order for the ~~S-RNC~~SRNC to determine the cell ID when an ~~LCS~~UP request is received, additional operations may be needed depending on the operational status of the UE.

Figure 8.1 illustrates the procedure for the cell ID based ~~location~~positioning method when the UE is in different RRC states. When the LCS request is received from the ~~core network~~CN the ~~S-RNC~~SRNC checks the state of the target UE. If the UE is in a state where the cell ID is available, the target cell ID is chosen as the basis for the ~~UP~~UE location. In states where the cell ID is not available, the UE is paged, so that ~~S-RNC~~SRNC can establish the cell with which the target UE is associated. In order to improve the accuracy of the LCS response the ~~S-RNC~~SRNC may also request RTT or RX Timing Deviation measurements from the Node B or LMU associated with the cell ID. The ~~S-RNC~~SRNC may also map the cell ID to a corresponding ~~Service Area Identifier (~~SAI~~)~~ to match the service coverage information available in the ~~core network~~CN.

The cell ID based method shall determine the ~~location~~position of the UE regardless of the UE RRC mode (i.e. connected or idle).~~state, including URA_PCH, Cell_PCH, Cell_DCH, Cell_FACH, cell reselection, inter-system modes, as well as an idle mode.~~

## 8.1.1 UE Cell ID is not known

For UE for which the cell ID is not known at the time the ~~LCS~~UP request is received at the ~~S-RNC~~SRNC, the UE may be paged to locate its current cell ID. If the UE is in an idle mode and there is a need for it to be paged, then the paging may be initiated either by the ~~core network~~CN or by the ~~S-RNC~~SRNC in ~~the~~ UTRAN ~~access network~~. For example, the UE can be forced to perform a transition to a Cell_FACH state to define the cell ID of its current cell.

If the UE is in an idle mode, ~~Cell_PCH state~~ or in ~~any other~~ a RRC connected state when there is a need to page for the UE to obtain the cell ID, the ~~Core Network~~CN may initiate paging, authentication and ciphering, as specified in [22]~~TS 23.171~~.

Alternatively, the cell ID may be determined as the one that was used during the last active connection to the UE. This determination should be accompanied by the time-of-day of the last connection in the cell.

## 8.1.2 UE Cell ID is known

### 8.1.2.1 UE not in Soft handover

The cell ID may be determined as the cell that is providing an active connection for the UE at the time of receiving the ~~LCS~~UP request at the ~~S-RNC~~SRNC.

### 8.1.2.2 UE in Soft handover

In order for the ~~S-RNC~~SRNC to provide the geographical co-ordinates of a target UE in soft handover, the ~~S-RNC~~SRNC combines the information about all cells associated with the UE.

In soft handover, the UE may have several signal branches connected to different cells, reporting different cell IDs. A reference cell ID may be determined by the ~~S-RNC~~SRNC based on the coverage area of each cell. The reference cell ID may be selected based on one or more of the following principles:

- the cell ID may be selected based on the parameters defining the quality of the received signal branches. That is, the cell ID with the best quality signal branch is selected as the reference cell ID;

- the cell ID may be selected that was used during connection set-up between the UE and the serving Node B;

- the cell ID of the cell most recently associated with the UE may be selected;;

- the cell ID of the latest "new" cell that the UE has started to receive, but has not yet been handed over to may be selected;

- the cell ID may be selected as the cell to which UE has the shortest distance (to the ~~Node B~~Node B site);

- the cell ID may be selected as the cell that provides an active connection for the UE at the time of receiving the ~~LCS~~UP request at the ~~S-RNC~~SRNC.

The selection may also be based on RTT measurements ~~of Round Trip Time~~, power levels and received signal strengths in UE and related Node B or LMU.

Other relevant mechanisms such as ~~Idle Period Downlink, (~~IPDL~~)~~ or ~~SSDT~~Site Selection Diversity Transmit power control ~~(SSDT)~~ should also be taken into account when applying the cell ID selection procedure for UE in a soft handover mode.

## 8.2 Localised Service Area

The Support of Localised Service Area (SoLSA) feature is quite close to the location service in principle, but SoLSA is based, for example, on cell radio ~~network cell~~ coverage and cell configuration. SoLSA has been standardised in GSM and is being developed for UTRAN. Some SoLSA service features like Exclusive Access and LSA only Access may be less applicable in UTRAN due to the 1 frequency reuse.

It should be noted that the Service Area concept described in this specification is different from the Localised Service Area concept defined for SoLSA.

## 8.3 Mapping the Cell ID to Geographic Co-ordinates or a Service Area

A UTRAN cell ID should be mapped to geographical coordinates or a ~~Service Area Identifier (~~SAI~~)~~ before being sent from UTRAN to the ~~core network~~CN. The Service Area Identifier may include one or several cells. The mapping may be accomplished either in the ~~S-RNC~~SRNC, in a Network Management System (~~NMS~~, including Network Management Unit~~, NEMU)~~ or by co-operation of various access network elements.

The ~~core network~~CN may request the geographical co-ordinates or the SAI, or both for the target UE. The SAI may be used for routing of corresponding Emergency calls, or for CAMEL services to correspond to the usage of Cell ID in the core network of GSM. However, the MSC shall not send the Service Area Identity to GMLC.

Although the mapping of the cell(s) associated with the target UE into geographical co-ordinates by the ~~S-~~SRNC is not standardised, the response to the ~~core network~~CN location request with geographical co-ordinates shall be as defined in [20]~~TS 23.032~~.

It should be noted that the Service Area concept is different from the Localised Service Area concept used for SoLSA services.

In order to determine a cell coverage estimate and to map it to the geographical coordinates or Service Area parameter Identity, the ~~SRNC~~S-RNC may use parameters such as the best reference signal, ~~Round Trip Time (~~RTT~~)~~ in FDD [17] or Rx Timing Deviation [18] and knowledge of the UE timing advance in TDD, as well as antenna beam direction parameters.

Alternatively, the service area coverage of a cell may be determined by using a reference signal power budget. Based on the reference signal power budget it is possible to obtain, for example, the ~~base station~~Node B transmitted power, isotropic path loss, coverage threshold at coverage area border for a given location probability, and a cell radius for an indoor and outdoor coverage.

The ~~SRNC~~S-RNC may use a reference signal link budget based cell radius estimate, in conjunction with the cell identifier, to make a coverage estimation for the cell(s) related to the target UE.

Additionally, the ~~SRNC~~S-RNC may compare the received power levels with the power budget, whereby more accurate information of the ~~location~~position of the UE may be provided.

Also, the interaction between neighbouring cell coverage areas may be used to determine a more exact UP~~location of the UE~~.

# 9 OTDOA ~~location~~positioning method

The primary standard OTDOA measurement is the "SFN-SFN observed time difference" observed at the UE (see [17] and [18]). These measurements, together with other information concerning the surveyed geographic ~~location~~position of the transmitters and the ~~relative time difference~~ (RTD) of the actual transmissions of the downlink signals may be used to calculate an estimate of the ~~location~~position of the UE. Each OTDOA measurement for a pair of downlink transmissions describes a line of constant difference (a hyperbola (see note 1)) along which the UE may be located. The UE's ~~location~~position is determined by the intersection of these lines for at least two pairs of ~~base station~~Node Bs. The accuracy of the ~~location~~position estimates made with this technique depends on the precision of the timing measurements, the relative ~~location~~position of the ~~base station~~Node Bs involved (see note 2), and is also subject to the effects of multipath radio propagation. This is illustrated in the figure 9.1.

NOTE 1: This is really a figure in three dimensions, a hyperboloid. For convenience here, this will be simplified to the hyperbola representing the intersection of this surface with the surface of the earth. For location service in three dimensions the hyperboloid must be considered.

NOTE 2: The geometry of the ~~base station~~Node B ~~location~~positions may affect the accuracy of the ~~location~~position estimate. The best results are when the ~~base station~~Node Bs equally surround the UE. If they do not, there is a reduction in accuracy, which is sometimes termed the Geometric Dilution of Position (GDP).

The primary OTDOA measurements (made by the UE) are sent to the ~~Position Calculation Function (PCF) in the serving~~ SRNC. These measures are sent via signalling over the Uu, Iub (and Iur) interfaces between the UE and the SRNC ~~(PCF)~~. The calculation function makes use of the measurements, the known ~~location~~positions of the transmitter sites and the RTD~~relative time difference~~ of the transmissions to estimate the UE's ~~location~~position.
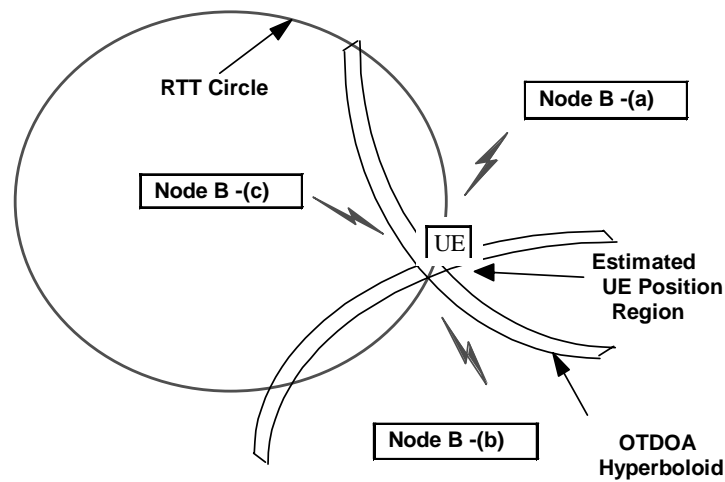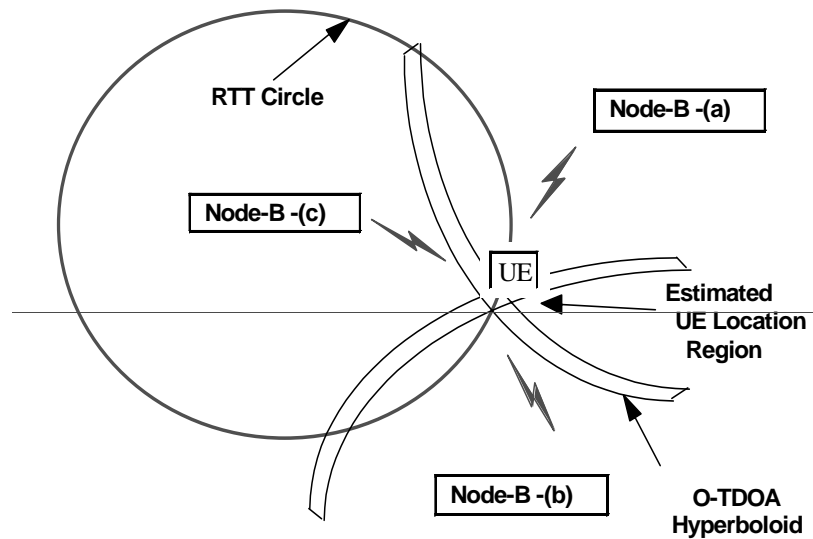
**Figure 9.1: OTDOA ~~Location~~Positioning Method**

The OTDOA method may be operated in two modes: UE-assisted OTDOA and UE-based OTDOA. The two modes differ in where the actual ~~location~~position calculation is carried out.

In the *UE-assisted* mode, the UE measures the difference in time of arrival of several cells and signals the measurement results to the network, where the SRNC~~a network element (the Position Calculation Function (PCF))~~ carries out the ~~location~~position calculation.

In the *UE-based* mode, the UE makes the measurements and also carries out the ~~location~~position calculation, and thus requires additional information (such as the ~~location~~position of the measured ~~base station~~Node Bs) that is required for the ~~location~~position calculation.

The signalling requirements for the two OTDOA modes are described in ~~a later~~ subclause 9.6. As the ~~LCS~~UP involves measurements, there is always uncertainty in the results. Physical conditions, errors and resolution limits in the apparatus all contribute to uncertainty. To minimise the uncertainty in the ~~LCS~~UP result, it is important that as many measurements of OTDOA (and assistance data as RTT in FDD and Rx Timing Deviation in TDD) as are possible for a UE are provided to the UE ~~PCF~~. Thus it is important that the standard UP method ~~for LCS~~ not be restricted to rely on a single measure. The UE thus provides SFN-SFN observed time difference measurements for as many cells as it can receive. The cells to be measured shall include those in the ~~"cell reselection and monitoring set" and those in the "cell selection set".~~active set and the monitored set.

In order to support the OTDOA method, the ~~location~~positions of the UTRAN transmitters needs to be accurately known by the calculation function in SRNC (for UE-assisted method) or UE (for UE-based method) ~~(PCF)~~. This information may be measured by appropriate conventional surveying techniques (see note 3). The surveyed ~~location~~position should be the electrical centre of the transmitting antenna (and not the ~~location~~position of the radio equipment building). The use of antenna diversity, beamforming or beam steering techniques may cause the effective antenna ~~location~~position to change with time and this information is also ~~will~~ needed to perform ~~to be communicated to the PCF to assist with its~~ calculations. The methods of measuring the ~~location~~position of the UTRAN transmitters are outside the scope of the present document.

NOTE 3:  These surveying methods may, for example, make use of a GPS receiver.

In order to support the OTDOA method, the ~~relative time difference (RTD)~~ of the DL~~downlink~~ transmissions must also be known to perform the calculation~~by the calculation function (PCF)~~. If the UTRAN transmitters are unsynchronised, the RTD will change over time as the individual clocks drift. Thus, measurements of RTD may need to be made regularly and the calculation function updated appropriately. The measurement of the RTD is outside the scope of the present document (see note 4).

NOTE 4:  One convenient method is to make use of an LMU at a fixed ~~location~~position. This unit measures the observed time differences of all the local transmitters ~~and reports these to the PCF~~. These measures may then be converted (translated) into the actual (absolute) relative time difference for each of the transmitters by making use of the known ~~location~~position of the LMU and the transmitters.

In some conditions a sufficient number of cells may not be available for measure at the UE. This may occur, for example, if the UE is located quite close to the UTRAN transmitter and its receiver is blocked by the strong local transmissions. This is referred to as the "hearability" problem.

# 9.1 Use of Idle Periods (FDD only)

~~For realising~~ L~~l~~ocation based services needs the support of physical layer as~~is~~ a prerequisite, so that the measurements required for the UE position~~terminal location~~ calculation can be carried out. In UTRAN there are several factors that must be taken into account while considering the physical layer procedures related to location services:

- hearability: a basic consequence of a CDMA radio system is that a terminal near its serving ~~base station~~Node B cannot hear other ~~base station~~Node Bs on the same frequency. In order to calculate its position~~terminal location~~ the UE~~terminal~~ should be able to receive at least three ~~base station~~Node Bs. To facilitate this some special means are required;

- asynchronous network causes significant uncertainty to the time-difference-of-arrival (TDOA) measurements. To compensate for the effects of this, the relative time difference (the synchronicity) between ~~base station~~Node B transmissions must be measured, and used for correcting OTDOA measurement;

- capacity loss: signalling related to ~~location~~position calculation may take capacity from other services. This capacity loss should be minimised.

Based on the results ~~of the work done~~ in ~~ARIB SWG2/ST9 (see reference [21]~~[23]~~)~~ a solution for the above mentioned hearability problem is the IPDL ~~(Idle Period DownLink)~~ method. In this method each ~~base station~~Node B ceases its transmission for short periods of time (idle periods). During an idle period of a ~~base station~~Node B, terminals within the cell can measure other ~~base station~~Node Bs and the hearability problem is reduced. Also, during idle periods the real time difference measurements can be carried out. Because the IPDL method is based on ~~forward link~~ (downlink) the location service can be provided efficiently to a large number of terminals simultaneously.

The specification and operation of the IPDL technique are provided in the following subclause.

## 9.1.1 Operation and specification of idle periods

The operation and specification of idle periods can be found in ~~TS~~ 25.214 ~~(reference~~ [16]~~)~~.

# 9.2 Relative Time Difference (RTD)

In order to calculate the estimate of the ~~location~~position of the UE, the calculation function needs to know:

- the OTDOA measurements;

- the surveyed geographic ~~location~~positions of the ~~base station~~Node Bs that have had their signals measured; and

- the actual relative time difference between the transmissions of the ~~base station~~Node Bs at the time the OTDOA measurements were made.

The accuracy of each of these measurements contributes to the overall accuracy of the ~~location~~position estimate. The measurement of the RTD is described in the following.

There are several approaches to determining the RTD. One is to synchronise the transmissions of Node B~~the base stations~~. In this technique the RTD are known constant values (see NOTE) that may be entered in the database and used by the calculation function when making a ~~location~~position estimate. The synchronisation must be done to a level of accuracy of the order of tens of nanoseconds (as 10 nanoseconds uncertainty contributes 3 metres error in the ~~location~~position estimate). Drift and jitter in the synchronisation timing must also be well controlled as these also contribute uncertainty in the ~~location~~position estimate. Synchronisation to this level of accuracy is currently only readily available through satellite based time-transfer techniques. Generally in the TDD operating mode, the ~~base station~~Node Bs are synchronised.

> NOTE: The transmission times may all be aligned to a common reference (such as UTC) in which case all RTD have a common value. However, in a more general case the transmissions may have a fixed offset with reference to UTC, and thus the RTD values are non-zero and may be stored in the database for use by the calculation function.

Alternatively (typically in FDD mode), Node Bs~~the base stations~~ may be left to free run within some constraint of maximum frequency error. In this scenario, the RTD will change (slowly) with time. The rate of change will depend on the frequency difference and jitter between ~~base station~~Node Bs. If, for example, the maximum frequency difference between two ~~base station~~Node Bs is $\pm10^{-9}$, then the start of transmission of a 10 millisecond code sequence will drift through a cycle in about 1 390 hours (or 57 days). With this relatively slow rate of drift the RTD can be measured by fixed LMUs ~~units~~ at known ~~location~~positions ~~(these are LMUs, Location Measurement Units)~~ and stored in the database for use by the calculation function. The jitter and drift of the individual oscillators in each ~~base station~~Node B may cause the change of timing to slow, remain constant or reverse direction over time. Ongoing measurements of the RTD may be made to assure the most current values are available for the calculation function. The RTD measurement units may be co-located with the ~~base station~~Node Bs or installed at other convenient ~~location~~positions in the UTRAN coverage area, and report their results through the UTRAN signalling ~~channels~~.

## 9.3 Time of Day (ToD)

If there are frequency drifts between the (unsynchronised) Node Bs, as noted in ~~the previous~~ subclause 9.2, the OTDOA measurements must be reported together with the time-of-day they were made (timestamp). This is necessary so that the appropriate value of the RTD may be used by the calculation function.

In order to assure less than a 20 nanosecond uncertainty in the RTD value, the time of day must be known to better than 10 seconds (if the maximum frequency difference between the ~~base station~~Node Bs is $\pm10^{-9}$). The method by which the ToD is measured is the system the frame number, which provides a 10 millisecond resolution and can be unambiguous up to 40.95 seconds.~~.~~

## 9.4 Node B~~Base Station~~ Synchronisation

It is preferable that the ~~location~~positioning methods do not require the ~~base station~~Node B ~~network~~ to be synchronised. The needed level of synchronisation accuracy for ~~LCS~~UP is not by any means straightforward to achieve. The necessary information of ~~Relative Time Differences (~~RTD~~)~~ between ~~base station~~Node Bs can be measured by ~~dedicated units (~~LMU~~, Location Measurement Unit)~~ and distributed in the network (e.g. as broadcast information). Also, the measurements of RTD may benefit from the ~~Idle Period DownLink (~~IPDL~~)~~ option.

In the TDD operating mode the ~~base station~~Node Bs will typically be synchronised and this may be of assistance to the ~~LCS~~UP technique.

## 9.5 OTDOA-IPDL and OTDOA Modes

There are two modes of operation for the OTDOA-IPDL and OTDOA methods.

In the *UE- assisted* mode, the UE measures the difference in time of arrival of several cells and signals the measurement results to the network, where the~~a network element (the Position Calculation Function (PCF))~~ SRNC carries out the ~~location~~position calculation.

In the *UE- based* mode, the UE makes the measurements and also carries out the location calculation, and thus requires additional information (such as the ~~location~~position of the measured ~~base station~~Node Bs) that is required for the ~~location~~position calculation. This information is provided by the System Information Broadcast ~~Location System Information Function (LSIF)~~.

Table 9.1 lists the required information for both UE- assisted and UE- based modes. The required information can be signalled to the UE either in a broadcast channel or partly also as dedicated signalling.

**Table 9.1: Information required for UE- assisted and UE- based OTDOA- IPDL and OTDOA in the UTRAN (LSIF) to UE direction ('Yes' = information required, 'No' = Information not required)**

| Information | UE- assisted | UE- based |
|---|---|---|
| Intra frequency Cell Info (neighbour list)~~.~~ | Yes | Yes |
| Ciphering information for ~~LCS~~UP (see note) | No | Yes |
| Measurement control information (idle period locations) | Yes | Yes |
| Sectorisation of the neighbouring cells | No | Yes |
| Measured RTD values for Cells mentioned at Intra frequency Cell Info | No | Yes |
| RTD accuracy | No | Yes |
| Measured roundtrip delay for primary serving cell | No | Yes |
| Geographical ~~location~~position of the primary serving cell~~.~~ | No | Yes |
| Relative neighbour cell geographical ~~location~~position | No | Yes |
| Accuracy range of the geographic ~~location~~position values | No | Yes |
| NOTE: The idea behind ~~LCS~~UP specific ciphering information is e.g. that the operator can sell information that the UE needs for calculating its ~~location~~position. For reference in the GSM world see [3]. | | |

The information required from UE to UTRAN ~~(PSMF/PCF)~~ is listed in table 9.2.

**Table 9.2: Information required for UE- assisted and UE- based OTDOA- IPDL and OTDOA in the UE to UTRAN (PSMF/PCF) direction**

| Information | UE- assisted | UE- based |
|---|---|---|
| OTDOA measurement results | Yes | No |
| OTDOA measurement accuracy | Yes | No |
| UE geographical ~~location~~position | No | Yes |
| ~~Location~~Position accuracy indicator (based on the signalled and measurement accuracies) | No | Yes |

# 9.6 OTDOA network ~~location~~positioning procedures

The following diagram illustrates the operations for the OTDOA method for ~~LCS~~UP when the request for ~~location~~positioning information is initiated by an LCS application ~~signalled~~ from the ~~Core Network~~CN. ~~As these operations are internal to the RNC, this diagram is to illustrate information flow and implementations may use alternate arrangements.~~

This illustration only includes the information flow related to ~~UP~~LCS operations and does not indicate other operations that may be required, for example, to establish a signalling connection between the UE and the SRNC. Also not illustrated is the signalling used to initiate the location service request ~~(from the Location Client Function)~~ from the ~~Core Network~~CN or a UE- based application.
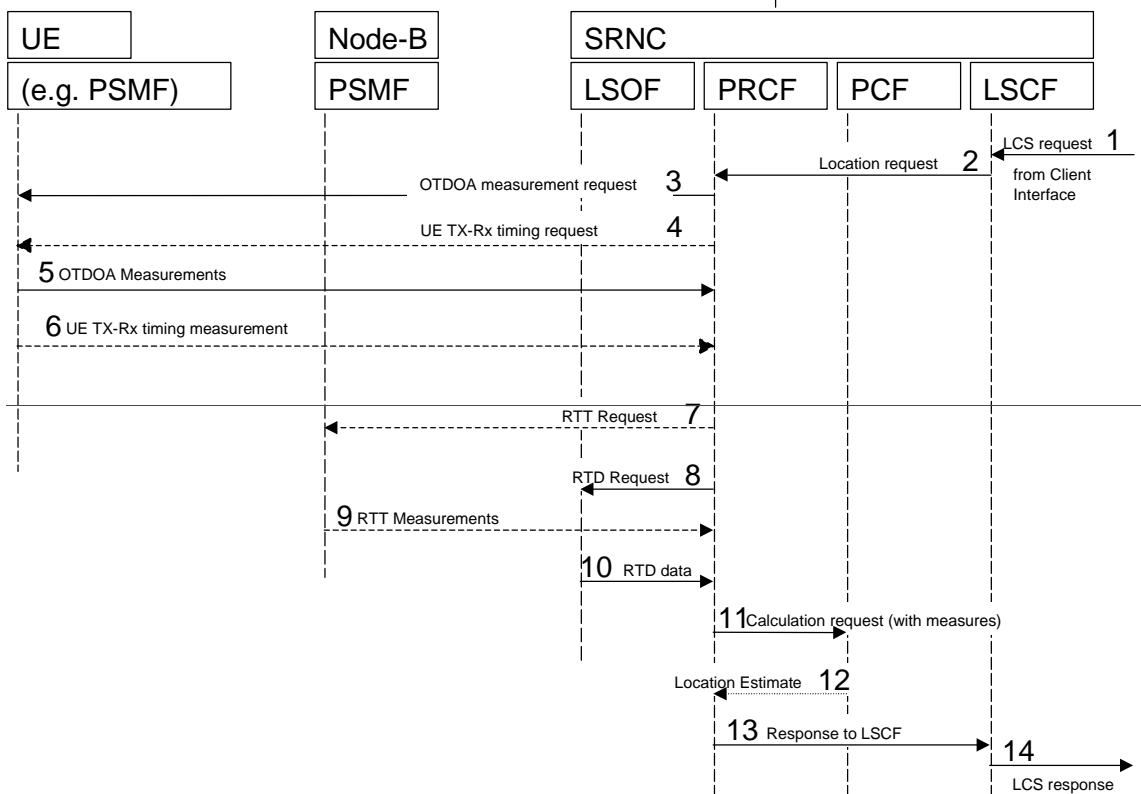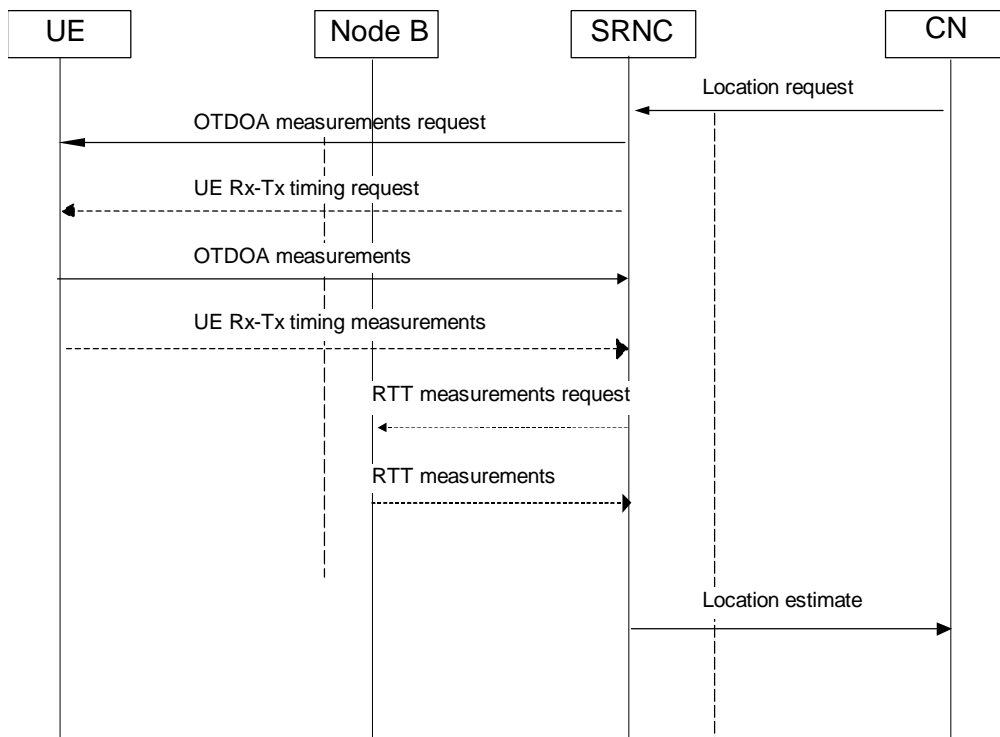
**Figure 9.2: OTDOA Signalling Operations**

1. The operation begins with an authenticated request for positioning information about a UE from an application in the CN being received at the SRNC. The SRNC considers the request and the UTRAN and UE capabilities.

2. The SRNC requests from the UE the measurement of the OTDOA for the signals in the active and neighbourhood sets. These measurements may be made while the UE is in the idle state or while it is connected.

3. If it is considered advantageous to do so, the SRNC requests the UE Rx-Tx timing difference information from the UE.

4. The UE returns the OTDOA measures to the SRNC. The SRNC receives the OTDOA information and co-ordinates obtaining other information to support the calculation request.

5. The UE returns the UE Rx-Tx timing difference information to the SRNC, together with a time stamp of when the value was obtained.

6. If there are insufficient OTDOA measures, or it is otherwise considered advantageous to do so, the SRNC requests the RTT measure for the UE from the serving Node B.

7. The SRNC requests the RTD measures for the associated transmitters from the associated database. These may be stored locally if they are constant over time, otherwise they must be updated to represent the RTD timing at the time-of-day the OTDOA measurements were made.

8. The Node B returns the RTT measures to the SRNC if they were requested.

9. The SRNC using the OTDOA, RTD and, if necessary, RTT information performs a position calculation. The calculation may include a co-ordinate transformation to the geographic system requested by the application. The position estimate includes the position, the estimated accuracy of the results and the time of day of the estimate.

10. The SRNC passes the position estimate to the CN.

1. The operation begins with an authenticated request for location information about a UE from an application in the core network being received at the LSCF. The LSCF acts as interface between the Core Network and the LCS entities in the UTRAN.

2. The LSCF considers the request and the capabilities of the UE and the network and forwards the request to the appropriate PRCF in the Serving RNC.

3. The PRCF requests from the UE the measurement of the OTDOA for the signals in the active and neighbourhood sets. These measurements may be made while the UE is in the idle state or while it is connected.

4. If it is considered advantageous to do so, the PRCF requests the UE TX-Rx timing difference information from the UE.

5. The UE returns the OTDOA measures to the PRCF. The PRCF receives the OTDOA information and co-ordinates obtaining other information to support the calculation request (not illustrated).

6. The UE returns the UE TX-Rx timing difference information to the PRCF, together with a time stamp of when the value was obtained.

7. If there are insufficient OTDOA measures, or it is otherwise considered advantageous to do so, the PRCF requests the RTT measure for the UE from the PSMF in the serving Node-B.

8. The PRCF requests the RTD measures for the associated transmitters from the LSOF (database). These may be stored locally if they are constant over time, otherwise they must be updated to represent the RTD timing at the time-of-day the OTDOA measurements were made.

9. The PSMF in the Node-B returns the RTT measures to the PRCF if they were requested.

10. The LSOF returns the RTD information to the PRCF.

11. The PRCF passes the OTDOA, RTD and, if necessary, RTT information to the PCF and requests a location calculation. The calculation may include a co-ordinate transformation to the geographic system requested by the application.

12. The PCF returns the location estimate to the PRCF. This estimate includes the location, the estimated accuracy of the results and the time of day of the estimate.

13. The PRCF passes the location estimate to the LSCF.

14. The LSCF passes the location estimate to the Core Network.

# 10 Network--assigned GPS locationpositioning method

When GPS is designed to inter-work with the UTRAN, the network assists the UE GPS receiver to improve the performance in several respects. These performance improvements will:

- reduce the UE GPS start-up and acquisition times; the search window can be limited and the measurements sped up significantly;

- increase the UE GPS sensitivity; locationpositioning assistance messages are obtained via UTRAN so the UE GPS can operate also in low SNR situations when it is unable to demodulate UE GPS signals;

- allow the UE to consume less handset power than with stand-alone GPS ; this is due to rapid start-up times as the GPS can be in idle mode when it is not needed.

The Network--assigned GPS methods rely on signalling between possibly reduced complexity UE GPS receivers (possibly with reduced complexity) and a continuously operating GPS reference receiver network which has clear sky visibility of the same GPS constellation as the assisted UEs. GPS reference receivers may be connected to the UTRAN to enable derivation of UE assistance signals.

**Figure 10.1: Network-assisted GPS methods**
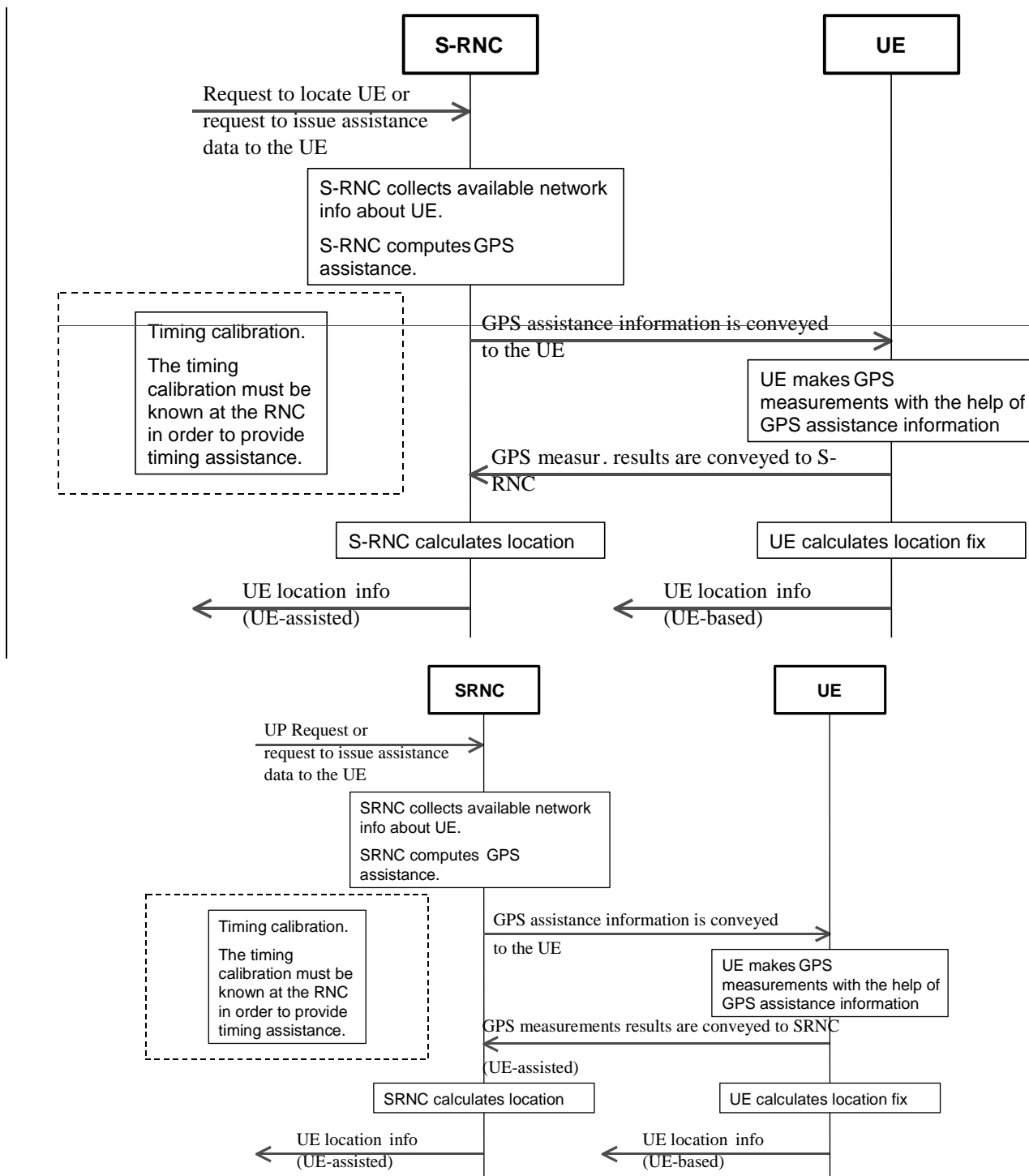
## 10.1 Timing calibration

Timing calibration is achieved by using UE or UTRAN GPS timing measurements as specified in [17].

## 10.2 Timing assistance

The UTRAN may derive the estimated UE locationposition using UTRAN (eg. Cell-ID or IPDL) parameters (eg. Cell-ID or IPDL) and may use this information, in conjunction with satellite specific ephemeris data received from the GPS

reference receiver network, to derive the estimated times of arrival (code phases) for equivalent GPS satellite signals received by the UE-based GPS receiver functionality. The estimated code phase data may be conveyed, together with $T_{UTRAN-GPS}$ (as specified in [17] and [18]), from the UTRAN to the UE using higher layer signalling. The estimated code phase data value is uncertain to a degree depending on the accuracy of the UTRAN timing calibration and initial ~~location~~position determination methods used.

## 10.3 Data assistance

The UE may receive GPS information through the UTRAN ~~air~~radio interface, using higher layer signalling.

When the UE is unable to detect a sufficient number of satellites, the assisted GPS method can be combined with other ~~location~~positioning methods. Altitude assistance can compensate for one satellite measurement.

The assistance data signalled to the UE may include all information listed below or a selected subset:

- data assisting the measurements; e.g. reference time, visible satellite list, satellite signal Doppler, code phase, Doppler and code phase search windows. This data can be valid for a few minutes (e.g., less than 5 minutes) or longer depending on the code phase and Doppler search window size that can be accommodated by the UE;

- data providing means for ~~location~~position calculation; e.g. reference time, reference ~~location~~position, satellite ephemeris, clock corrections. Satellite ephemeris and clock corrections data can be used for up to six hours.

   NOTE: Certain types of GPS Assistance data may be derived, wholly or partially, from other types of GPS Assistance data.

If DGPS is utilised, then differential corrections may also be transmitted. If Selective Availability is turned off, these corrections can be valid for a few minutes or more. The DGPS data is valid for a large geographical area, so one centrally located reference receiver can be used to service this large region.

## 10.4 UE search

Provided that timing and/or data assistance is available in the UE they should be applied in the GPS signal search procedure. UE search procedure involves a three-dimensional search for a satellite ~~PRN (pseudorandom)~~ code, time of arrival of a signal and the associated carrier Doppler.

"Modulation wipe-off" is defined here to mean a removal of the GPS navigation data bit modulation to GPS signals received at the UE, through the application of UTRAN timing and data assistance provided from the UTRAN to the UE. This process allows the UE to coherently integrate received GPS signals beyond 1 data bit period (i.e., 20 milliseconds).

## 10.5 ~~Location~~Position determination

There are two types of network-assisted GPS methods, namely UE-based and UE-assisted, which differ according to where the actual position calculation is carried out.

Computation of the ~~location~~position fix can either be performed in UTRAN (i.e. SRNC) for ~~the network infrastructure~~ (UE-assisted) or in the UE for (UE-based).

~~There are two types of network assisted GPS methods, namely UE-based and UE-assisted, which differ according to where the actual location calculation is carried out.~~

### 10.5.1 UE-based method

The UE-based method maintains a full GPS receiver functionality in the UE, and the ~~location~~position calculation is carried out by the UE, thus allowing stand-alone ~~location~~position fixes.

If the ~~location~~position was requested by an application in the network, then the calculated ~~location~~position is signalled to the proper network element.

The following information may be signalled from the UTRAN ~~(LSIF)~~ to the UE:

- number of satellites for which assistance is provided;

- reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]);

- 3-d reference ~~location~~position (specified in [17]);

- ionospheric corrections;

- satellite ID for identifying the satellites for which the assistance is provided;

- ephemeris and clock corrections to accurately model the orbit of the particular satellite and information when this becomes valid;

- UTC offset;

- DGPS corrections;

- almanac data;

- real-time integrity (e.g., a list of unusable satellites).

The following information may be signalled from the UE to the UTRAN (~~LSIF~~):

- reference time for GPS (specified in [17] and [18]);

- serving cell information;

- Latitude/Longitude/Altitude/Error ellipse;

- velocity estimate of the UE;

- satellite ID for which the measurement data is valid;

- Whole/Fractional chips for information about the code-phase measurements;

- $C/N_0$ of the received signal from the particular satellite used in the measurements;

- ~~D~~doppler frequency measured by the UE for the particular satellite signal;

- pseudorange RMS error;

- multipath indicator.

## 10.5.2    UE-assisted method

In the UE-assisted method, the UE employs a reduced complexity GPS receiver functionality. This carries out the pseudorange (code phase) measurements. The~~se~~ measurements results are signalled, using RRC~~higher layer~~ signalling, to UTRAN (i.e. SRNC)~~the specific network element~~ that estimates the ~~location~~position of the UE and carries out the remaining GPS operations. In this method, accurately timed code phase signalling (as specified in [17] and [18]) is required on the downlink. If DGPS is performed in the UE, then differential corrections must be signalled to it. On the other hand, DGPS corrections can be applied to the final result in the network to improve the ~~location~~position accuracy without extra signalling to the UE.

The following information may be signalled from the UTRAN (~~LSIF~~) to the UE:

- number of satellites for which assistance is provided;

- reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]);

- satellite ID for identifying the satellites for which the assistance is provided;

- doppler (0th order term);

- Doppler Search Window width;

- ~~D~~doppler (1st order term);

- code phase;

- code phase centre and Search Window width;

- ephemeris;

- azimuth;

- elevation.

The following information may be signalled from the UE to the UTRAN (LSIF):

- reference time for GPS ($T_{UE-GPS}$) (specified in [17] and [18]);

- number of Pseudoranges;

- SVID;

- satellite C/No;

- doppler;

- satellite Code Phase;

- multipath indicator;

- pseudorange RMS Error.

Additional parameters, such as round trip time (RTT) in FDD or Rx Timing Deviation in TDD, UE receiving transmitting time (UE Rx-Tx), SFN-SFN observed time difference and CPICH Ec/No, may be used to improve the performance of UE-assisted GPS. All the additional parameters are defined in [17] and [18] and can be made available through RRC signalling. Furthermore, to those UE technologies requiring externally provided sensitivity and time aiding data, some navigation bits may be sent from UTRAN to UE for sensitivity assistance and time recovery.

# 11 ~~Position calculation functionality~~

NOTE: ~~The functionality of the PCF is described in more detail in an informative annex FFS.~~

# 11~~12~~ Information storage

NOTE This clause just outlines the information that may need to be stored in the UTRAN ~~LCS~~UP ~~elements (U-LCF, U-PSCF,U-LSCF, UE, etc)~~ that may need to be standardised (if any).

# Annex A (informative): Definitions and Terms

This annex provides definitions and terms for the general LCS. Not all of these are applicable to the UTRAN environment.

**CAMEL:** CAMEL is a network functionality, which provides the mechanisms of Intelligent Network to an ~~an~~ UE ~~mobile user~~.

**Current Location:** after a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp is referred to as the 'current location' at that point in time.

**Deferred location request:** a location request where the location response (responses) is (are) not required immediately.

**Global Positioning System:** the Global Positioning System (GPS) consists of three functional elements: Space Segment (satellites), User Segment (receivers), and Control Segment (maintenance etc.). The GPS receiver estimates its own location based on the observed times of arrival of the satellite signals.

**Immediate location request:** a location request where a single location response only is required immediately.

**Initial Location:** in the context of an originating emergency call the location estimate and the associated time stamp at the commencement of the call set-up is referred to as 'initial location'.

**Last Known Location:** the current location estimate and its associated time stamp for Target ~~MS~~UE stored in the LCS Server is referred to as the 'last known location' and until replaced by a later location estimate and a new time stamp is referred to as the 'last known location'.

**LCS (LoCation Services):** LCS is a service concept in system (e.g. GSM or UMTS) standardisation. LCS specifies all the necessary network elements and entities, their functionalities, interfaces, as well as communication messages, due to implement the location service functionality in a cellular network.

    NOTE:     LCS does not specify any location based (value added) services except locating of emergency calls.

**LCS Client:** a software and/or hardware entity that interacts with a LCS Server for the purpose of obtaining location information for one or more UEs~~Mobile Stations~~. LCS Clients subscribe to LCS in order to obtain location information. LCS Clients may or may not interact with human users. The LCS Client is responsible for formatting and presenting data and managing the user interface (dialogue). The LCS Client may reside in the UE~~Mobile Station (MS)~~.

**LCS Client Access barring list:** an optional list of MSISDNs per LCS Client where the LCS Client is not allowed to locate any MSISDN therein.

**LCS Client Subscription Profile:** a collection of subscription attributes of LCS related parameters that have been agreed for a contractual period of time between the LCS client and the service provider.

**LCS Feature:** the capability of a PLMN to support LCS Client/server interactions for locating Target UEs~~MSs~~.

**LCS Server:** a software and/or hardware entity offering LCS capabilities. The LCS Server accepts requests, services requests, and sends back responses to the received requests. The LCS server consists of LCS components, which are distributed to one or more PLMN and/or service provider.

**Local Service:** a service, which can be exclusively provided in the current serving network by a Value added Service Provider.

**Local Information:** information related to a given location, or general information, which is made available in a given location.

**Location (/location detecting):** location is a functionality, which estimates a geographical location (of e.g. a UE ~~mobile terminal~~).

**Location (Based) Application:** a location application is an application software processing location information or utilising it in some way. The location information can be input by a user or detected by UTRAN~~network~~ or UE~~MS~~. Navigation is one location application example.

**Location Based Service (LBS):** a service provided either by teleoperator or a 3<sup>rd</sup> party service provider that utilises the available location information of the terminal. Location Application offers the User Interface for the service. LBS is either a pull or a push type of service (see Location Dependent Services and Location Independent Services). In ETSI/GSM documentation of SoLSA, LBS is called "Location Related Service". ETSI and/or 3GPP –wide terminology harmonisation is expected here.

**Location Dependent Service:** a service provided either by teleoperator or a 3<sup>rd</sup> party service provider that is available (pull type) or is activated (push type) when the user arrives to a certain area. It doesn't require any subscription in advance, but the push type activation shall be confirmed by the user. The offered service itself can be any kind of service (e.g. a public Xerox machine or the discount list in a store).

**Location Estimate:** the geographic location of an ~~UE~~MS and/or a valid Mobile Equipment (ME), expressed in latitude and longitude data, and optionally altitude data. The Location Estimate shall be represented in a well-defined universal format. Translation from this universal format to another geographic location system may be supported, although the details are considered outside the scope of the primitive services.

**Location Independent Service:** a service provided either by teleoperator or a 3<sup>rd</sup> party service provider that is available and therefore can be activated anywhere in the network coverage. It is activated by the user's request or by other user's activated service, and therefore it requires a subscription in advance (pull type). The offered service itself can be any kind of service (e.g. MMS, SWDL, or LBS!).

**Location method (/locating method):** a principle and/or algorithm which the estimation of geographical location is based on, e.g. AOA, TOA, TDOA. For example, GPS is based on TOA, and E-OTD (on GSM) is based on TDOA.

**Location technology (/locating technology):** a technology or system concept including the specifications of RF interfaces, data types, etc. to process the estimation of a geographical location, e.g. GPS, E-OTD (GSM), and IPDL-TDOA (WCDMA).

**PLMN Access barring list:** an optional list of MSISDN per PLMN where any LCS Client is not allowed to locate any MSISDN therein except for certain exceptional cases.

**Predefined area:** a geographical area which is not related to cell or radio coverage. The ~~UE~~mobile may take special action when it recognises it has entered or left a predefined area.

**Privacy Class:** list of LCS Clients defined within a privacy exception class to which permission may be granted to locate the target ~~UE~~MS. The permission shall be granted either on activation by the target ~~MS~~UE or permanently for a contractual period of time agreed between the target ~~MS~~UE and the service provider.

**Privacy Exception List:** a list consisting of various types of privacy classes (i.e. operator related, personal etc.). Certain types of classes may require agreement between the service provider and the target ~~MS~~UE.

**Prohibited area:** an area where the ~~mobile~~ UE must not activate its transmitter. The Prohibited area may be a Predefined area described above or related to radio cell(s).

**Subscription Profile:** the profile detailing the subscription to various types of privacy classes.

**Target ~~MS~~UE:** the ~~MS~~UE being located.

# Annex B (informative):
# Reference Model of Functional Entities for UTRAN UP

The UTRAN functional entities for UP are shown in figure B.1. In this reference model, the LCS clients in the core network communicate with the UTRAN UP entities across the Iu interface. The RNC LCS Handling Entities and the Positioning Handing Entities work together with the UE to measure and calculate the position information for the requested target UE. These entities within the UTRAN are described in more detail in the following subclauses.

The figure shows the general arrangement of the UP function in UTRAN. Communication among these entities makes use of the messaging and signalling capabilities of the UTRAN across the Iu, Iur, Iub and Uu interfaces. A LMU is also added to the UTRAN to make measurements as needed by the selected positioning method.

This figure does not include elements of 3G Core Network, but focuses on those that participate with the UP functions in the UTRAN. The association of the LCS entities within the Core Network (CN) (e.g. with 3G-MSC or 3G-SGSN) is outside the scope of the present document and is not illustrated in the diagram.

Within the UTRAN, the UP Entities may be associated with, or part of the RNC, the Node B and the UE. Internal LCS Applications may also be part of the RNC and the UE.

The UE Position Calculation Function (PCF) is logically associated with the SRNC in UTRAN.

The UP in UTRAN also makes use of the standardised Iur interface between RNCs, when Node B information, measurements and results are collected.

The functional model presented in the figure includes functional entities for UE utilising either or both circuit switched (CS) and packet switched (PS) services. This model also supports of all the entities needed for different positioning methods (e.g. network-based, UE-based, UE-assisted, and network assisted (see note 1) methods) exploiting either uplink or downlink measurements.

   NOTE 1:  In this approach UE may use the GPS technique but still make use of auxiliary information from the serving network.

Implementations may often associate the UTRAN LCS Entities with an RNC (as illustrated in the figure). However, for networks with a small volume of LCS requests, the LCS Entities in the UTRAN may also be implemented as a separate element (server) which interfaces with the RNCs, and the Node B / LMUs.
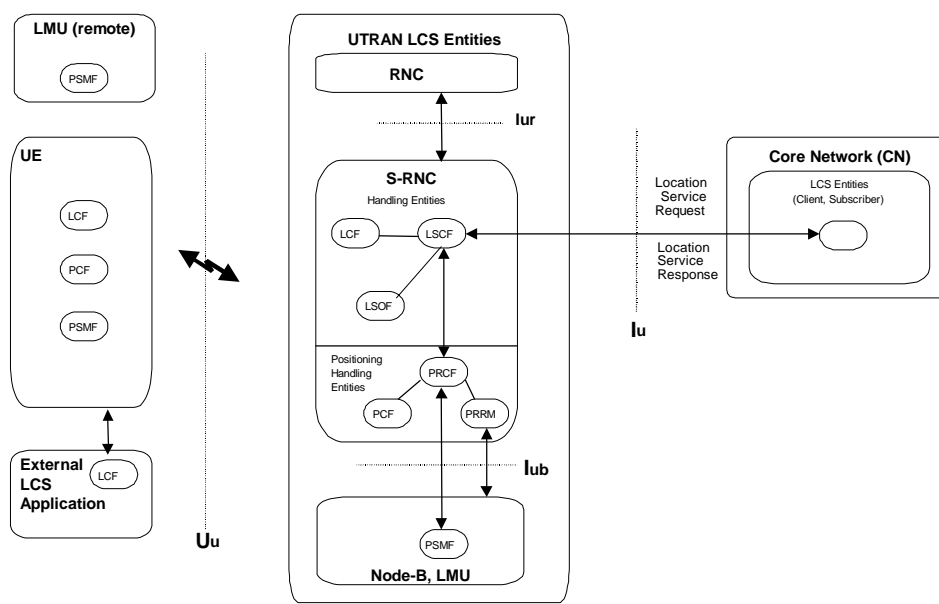


**Figure B.1: UTRAN UP Functional Entities**

Several functional groupings may be defined to describe the UP functions. These groupings occur in both the CN and the UTRAN. The overall LCS functional grouping is described in reference [1]. Each grouping encompasses a number of functional components and functions.

Within UTRAN the functional entities may be grouped as follows:

   - the *Internal Client* group that includes:

      - *Internal UTRAN Location Client Function* (U-LCF);

   - the *UTRAN System Handling* group that includes:

      - *UTRAN Location System Control Function* (U-LSCF),

      - *UTRAN Location System Operations Function* (U-LSOF);

  - the *UTRAN Positioning* group that includes:

      - *UTRAN Position Radio Co-ordination Function* (U-PRCF),

      - *UTRAN Position Calculation Function* (U-PCF),

      - *UTRAN Position Signal Measurement Function* (U-PSMF),

      - *UTRAN Position Radio Resource Management* (U-PRRM).

The functions within the UTRAN are described in more detail in the following subclauses.

# B.1        Internal Client Group

## B.1.1          Internal UTRAN Location Client Function (U-LCF)

The UTRAN Location Client Function (U-LCF) represents a logical interface between the internal UTRAN LCS applications and the LCS RNC Handling entities (e.g. the Location System Control Function (U-LSCF) in the RNC).

    NOTE:     There is not necessarily a requirement for a LCCF (Location Client Control Function) for the UTRAN Internal Client as is described for external clients in reference [1] (the system stage specification).

The UTRAN may make use of positioning information for internal operations such as location assisted handover. In such a case, a U-LCF representing the internal UTRAN LCS application may communicate with the U-LSCF to request and receive the positioning information.

# B.2        UTRAN System Handling group

## B.2.1          UTRAN Location System Control Function (U-LSCF)

The UTRAN Location System Control Function (U-LSCF) in RNC is responsible for co-ordinating UP requests within the RNC handling entity. This function manages call-related and non-call-related UP requests and allocates network resources for handling them. This function "insulates" the Location clients in the Core Network from the detailed operation of the positioning method in order that the UTRAN may be used by several types of core network and with several positioning methods.

The U-LSCF provides flow control between simultaneous UP requests. Simultaneous UP requests must be queued in a controlled manner to account for priority requests (e.g. for Emergency Clients). The details of the flow control, priority selection and queuing are beyond the scope of the present document.

The U-LSCF will select the appropriate positioning method based on the availability of resources and parameters of the UP request. The U-LSCF co-ordinates resources and activities needed to obtain data (e.g. Node B geographic co-ordinates) needed for the positioning method. It also records LCS RNC usage data for the location service request that may be passed to a Location System Recording Function (U-LSRF) or OA&M function in the Core Network.

If the positioning method requires the broadcast of system information, the LSCF initiates and maintains this activity through the Position Radio Co-ordination Function (U-PRCF). Broadcast information (such as the geographic co-ordinates of the Node Bs) may be required, for example, to support a Position Calculation Function (U-PCF) located in the UE. These broadcasts may also include other information (such as currently observable satellites) that may assist a UE in the use of external location services.

The information to be broadcast is selected based on the positioning methods offered for use by the LCS and the needs of the UE. This broadcast information may be specially coded (i.e. encrypted) to ensure its availability only to subscribers of the service. The use of broadcasts or other methods for signalling to the UE or the LMU may be selected based on the chosen positioning method.

The information to be broadcast could include, for example:

  - identification and spreading codes of the neighbouring Node Bs (the channels that are used for measurements);

- Relative Time Difference (RTD), i.e. the timing offsets, asynchrony between Node Bs, could be based on measurement results obtained by LMUs;

- roundtrip delay estimates in connected mode;

- the geographic position, co-ordinates, of the neighbouring Node Bs;

- the idle period places within the frame structure for multiple Node Bs;

- the local time-of-day.

Some of this information may be broadcast to support other UTRAN operations (e.g. handover). The function of the LSCF is to ensure information is broadcast when needed for the LCS operations and the LSCF may make use of other UTRAN processes to do so.

## B.2.2 UTRAN Location System Operations Function (U-LSOF)

The UTRAN Location System Operations Function (U-LSOF) is responsible for provisioning of data, positioning capabilities, data related to clients and subscription (LCS client data and UE data), fault management and performance management of LCS within the RNC.

An LSOF may be associated with each entity. The LSOF interacts with Internal (OAM) Clients for administration and maintenance of the data.

The Iur interface may pass messages relating to changes or reporting of the data associated with the LSOF in the RNC.

The Iub interface may pass messages relating to changes or reporting of the data associated with the LSOF in the Node-B or the LMU.

The Uu interface may pass messages relating to changes or reporting of the data associated with the LSOF in the UE or the remote LMU.

## B.3 Positioning group

## B.3.1 UTRAN Position Radio Co-ordination Function (U-PRCF)

The UTRAN Position Radio Co-ordination Function (U-PRCF) manages a UP for a UE through overall co-ordination and scheduling of resources to perform positioning measurements. This function interfaces with the U-PSMF, the U-PRRM and the U-PCF. The U-PRCF determines the positioning method to be used based on the UP request, the QoS, the capabilities of the UTRAN, and the UE's capabilities. The U-PRCF also manages the needed radio resources through the U-PRRM. It determines which U-PSMFs are to be involved, what to measure, and obtains processed signal measurements from the U-PSMF.

Some positioning methods may involve measurements made at the UE. In this case the U-PRCF interfaces with the UE to obtain the measurements (or the positioning results if they have been determined by the UE). Some positioning methods may involve measurements or information from several sources, including radio units at several Node B (or other LMU) and involve a series of transmissions and receptions. The U-PRCF entity also provide ancillary measurements in case of network-assisted positioning method. Ancillary information may be extracted from navigating systems like GPS.

The U-PRCF forwards the signal measurement data to the U-PCF.

It is the function of the U-PRCF to co-ordinate the sequence of activities and compensate for failures (if they occur) to provide the position estimate.

## B.3.2 UTRAN Position Calculation Function (U-PCF)

The UTRAN Position Calculation Function (U-PCF) is responsible for calculating the position of the UE. This function applies an algorithmic computation on the collected signal measurements to compute the final position estimate and accuracy.

The U-PCF may also support conversion of the position estimate between different geographic reference systems. It may obtain related data (e.g.: Node B geographic co-ordinates) needed for the calculation. There may be more than one calculating function available within, or associated with, the calculation function of the UTRAN.

In the cell ID based positioning method, the U-PCF shall determine the geographical co-ordinates corresponding to the cell(s) associated with the the target UE.

The PCF is also responsible for estimating the accuracy of the position estimate. This accuracy estimate should include, for example, the effect of geometric dilution of precision (GDOP), the capabilities of the signal measuring hardware, the effects of multipath propagation and the effects of timing and synchronisation unknowns. The accuracy should be returned as a measure of distance in the same units as the position estimate. The accuracy zone may be reported as the axis and orientation of an ellipse surrounding the position estimate.

## B.3.3　　　　UTRAN Position Signal Measurement Function (U-PSMF)

The UTRAN Position Signal Measurement Function (U-PSMF) is responsible for performing and gathering uplink or downlink radio signal measurements for use in the calculation of a UE position. These measurements can be positioning related or ancillary.

There may be one or more PSMF within a UTRAN and they may be located at the UE, the Node B, or a separate LMU. The PSMF, generally, may provide measurement of signals (i.e. satellite signals) in addition to measurements of the UTRA radio transmissions. The measurements to be made will depend on the selected positioning method.

## B.3.4　　　　UTRAN Position Radio Resource Management (U-PRRM)

The UTRAN Position Radio Resource Management (U-PRRM) entity is responsible for managing the effect of LCS operations on the overall performance of the radio network. This may ensure, for example, that the operation of the U-PSMF does not degrade the QoS of other calls. The U-PRRM handles following functions:

- controlling the variation of the UL and DL signal power level due to the LCS application;

- calculating the DL and UL power/interference due to UE positioning operations;

- to admit/reject the new LCS requests;

- co-operating with Admission Control, and entities of the RRM (such as power control) to provide the system stability in terms of radio resources;

- controlling the RTD measurement mechanism. It may also forward the results of the RTD; ATD (or any similar timing parameter) measurements to the PRCF (or PCF);

- controlling the IPDL mechanism for positioning measurements. This may include the overall control of the periodical measurement fulfilment. Co-ordination among RNC (e.g. to assure non-overlapping idle periods) will be communicated through the Iur interface.

# B4　　　Assignment of LCS Functional Entities to UTRAN Elements

The figure B.1 and the table B.1 show the generic configuration for different positioning methods, including network-based, UE-based, UE-assisted and network-assisted methods. With this approach both UTRAN and the UE are able to measure the timing of signals and compute the UE position estimate. Depending on the applied positioning method it is possible to utilise the corresponding configuration containing all needed entities. For instance, if a network-based positioning method is applied, the entities that are involved in measuring the UE's signal and calculating its position estimate are allocated to the network elements of the access stratum. On the other hand, in case UE-based or network-assisted methods are used these entities should be allocated to the UE.

**Table B.1: Example Allocation of LCS Functional Entities to Network Elements**

| UTRAN | UE | Node-B | LMU | RNC |
|-------|----|--------|-----|-----|
| **LCF** | X | | | X |
| **LSCF** | | | | X |
| **PRCF** | | | | X |
| **PCF** | X | | | X |
| **PRRM** | | | | X |
| **PSMF** | X | X | X | |
| **LSOF** | X | X | X | X |

# Annex C (informative):
# Location Services Categories

Generally there are four categories of usage of the location service:

- the **Commercial LCS** (or **Value Added Services**);

- the **Internal LCS**;

- the **Emergency LCS**;

- the **Lawful Intercept LCS**.

These location services categories are further defined in [1] and [4].

# Annex DB (informative):
# Change history

| Change history | | | | | |
|---|---|---|---|---|---|
| TSG-RAN# | Version | CR | Tdoc RAN | New Version | Subject/Comment |
| RAN_06 | - | - | RP-99635 | 3.0.0 | (12/99)<br>Approved at TSG-RAN #6 and placed under Change Control |
| RAN_07 | 3.0.0 | 001 | RP-000038 | 3.1.0 | (03/00)<br>Network assisted GPS LCS |
| RAN_07 | 3.0.0 | 002 | RP-000038 | 3.1.0 | Enhancements for cell coverage based positioning |
| RAN_07 | 3.0.0 | 003 | RP-000038 | 3.1.0 | Replacement for Figure 4.1 |
| RAN_07 | 3.0.0 | 004 | RP-000038 | 3.1.0 | Restructuring |
| RAN_07 | 3.0.0 | 006 | RP-000038 | 3.1.0 | Target UE-RNC signalling model |
| RAN_07 | 3.0.0 | 007 | RP-000038 | 3.1.0 | LMU description |
| RAN_07 | 3.0.0 | 008 | RP-000038 | 3.1.0 | LMU signalling description |
| RAN_07 | 3.0.0 | 009 | RP-000038 | 3.1.0 | Incorporation of R1 Liaisons R2-000022 and R2-000023 |
| RAN_07 | 3.0.0 | 010 | RP-000038 | 3.1.0 | OTDOA - GPS Location Procedures |
| RAN_07 | 3.0.0 | 011 | RP-000038 | 3.1.0 | Clarification of the different LMU types |
| RAN_08 | 3.1.0 | 013 | RP-000218 | 3.2.0 | (06/00)<br>Modifications to LCS text on cell-ID method |
| RAN_08 | 3.1.0 | 015 | RP-000218 | 3.2.0 | Editorial modifications of OTDOA descriptions for alignment with TDD |
| RAN_08 | 3.1.0 | 016 | RP-000218 | 3.2.0 | Update on clause 5 |
| RAN_08 | 3.1.0 | 017 | RP-000218 | 3.2.0 | Editorial additions |
| RAN_08 | 3.1.0 | 018 | RP-000218 | 3.2.0 | Clarification of OTDOA signalling operation |
| RAN_08 | 3.1.0 | 019 | RP-000218 | 3.2.0 | Assisted GPS procedures |
| RAN_09 | 3.2.0 | 020 | RP-000356 | 3.3.0 | (09/00)<br>Alignment of FDD and TDD positioning methods and editorial changes |
| RAN_09 | 3.2.0 | 021 | RP-000356 | 3.3.0 | Assisted GPS Procedures |
| RAN_09 | 3.2.0 | 022 | RP-000356 | 3.3.0 | TDD/FDD alignment of OTDOA and GPS assisted positioning methods |
| RAN_09 | 3.2.0 | 023 | RP-000356 | 3.3.0 | Clean-up |
| RAN_09 | 3.2.0 | 024 | RP-000356 | 3.3.0 | Corrections from LCS Ad Hoc |

# CHANGE REQUEST

*Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.*

| | | | |
|---|---|---|---|
| **25.305** | **CR** | **038r2** | Current Version: 3.3.0 |

*GSM (AA.BB) or 3G (AA.BBB) specification number* ↑ — ↑ *CR number as allocated by MCC support team*

| For submission to: | TSG-RAN #10 | for approval | **X** | | strategic | | *(for SMG* |
|---|---|---|---|---|---|---|---|
| *list expected approval meeting # here* ↑ | | for information | | | non-strategic | | *use only)* |

*Form: CR cover sheet, version 2 for 3GPP and SMG      The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

**Proposed change affects:**      (U)SIM ☐      ME ☐      UTRAN / Radio **X**      Core Network ☐
*(at least one should be marked with an X)*

| **Source:** | TSG-RAN WG2 | | **Date:** | 2 November, 2000 |
|---|---|---|---|---|

| **Subject:** | Clarification on information to be transferred between UTRAN nodes |
|---|---|

| **Work item:** | |
|---|---|

| **Category:** | F | Correction | **X** | **Release:** | Phase 2 | |
|---|---|---|---|---|---|---|
| | A | Corresponds to a correction in an earlier release | | | Release 96 | |
| *(only one category* | B | Addition of feature | | | Release 97 | |
| *shall be marked* | C | Functional modification of feature | | | Release 98 | |
| *with an X)* | D | Editorial modification | | | Release 99 | **X** |
| | | | | | Release 00 | |

| **Reason for change:** | The CR proposes some editorial changes in order to improve readability of the document and to clarify what kind of information has to be transferred between UTRAN nodes for each method. |
|---|---|

| **Clauses affected:** | 7.6.3, 9.2, 9.5, 10.5 |
|---|---|

| **Other specs affected:** | Other 3G core specifications | | → List of CRs: | |
|---|---|---|---|---|
| | Other GSM core specifications | | → List of CRs: | |
| | MS test specifications | | → List of CRs: | |
| | BSS test specifications | | → List of CRs: | |
| | O&M specifications | | → List of CRs: | |

| **Other comments:** | |
|---|---|

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<---------- double-click here for help and instructions on how to create a CR.

# 7.6　Radio interface timing procedures

The Radio Interface Timing determination system consists of functions in LMUs and in the SRNC. The system runs continuously offering cell timing information for mobile station location.

## 7.6.1　LMU Functions

The Radio Interface Timing functionality in the LMU should be capable of performing the following functions:

- The LMU performs necessary air interface measurements from signals transmitted by Node Bs

- If the LMU contains a common reference clock, e.g. GPS TOW, it time stamps reception of Node B signals.

- If there is no reference clock available, the LMU may make Relative Time Difference measurements, i.e. measures the time difference between arrival of SFNs

- The LMU may perform some processing of measurements, like averaging and filtering, using parameters delivered to it, or in their absence using default settings

## 7.6.2　SRNC Functions

The SRNC must be capable of performing the following functions related to Radio Interface Timing determination:

- The SRNC sends to LMUs requests for Radio Interface Timing measurement information.

- The SRNC will communicate regularly with LMUs; thus, the SRNC can monitor operation of LMUs. If a LMU fails to send Radio Interface Timing information, the SRNC shall try to restart the LMU, and if this restarting fails, the SRNC shall inform O&M system. SRNC can use also diagnostics messages to query the status of LMUs.

- The SRNC receives Radio Interface Timing measurement results from LMUs.

- The SRNC stores or queries extra information required for Node B synchronization determination, like base station and LMU coordinates, Node B identity information.

- The SRNC determines synchronization differences between different downlink signals using LMU measurements and other information.

- Synchronization information is delivered for UE location purposes.

## 7.6.3　LMU-SRNC Interactions

The request for Radio Interface Timing measurement information from the SRNC to a LMU contains the following parameters:

- Measurement type. This indicates whether the SRNC wants the LMU to perform Absolute Time Difference (ATD) (e.g. GPS time stamp of signal) or Relative Time Difference (RTD) measurements.

- Measurement result reporting frequency. This indicates how often the LMU should send Radio Interface Timing measurement results.

- Measurement duration. This indicates how long the LMU should make measurements and report results.

- Instructions about filtering of raw measurement data.

- Instructions about Primary CPICH signals to be measured. The LMU unit can measure autonomously a certain number of most strongly received signals. Another possibility is that the SRNC tells which Node B signals it should measure.

- In the RTD case, which common Primary CPICH the LMU should use as a reference in the measurements.

- Instruction of how the measurement quality should be reported.

~~The Radio Interface Timing measurement response from a LMU to the SRNC contains:~~

- ~~Identity of the Node B at which the asssociated LMU is residing~~

- ~~Primary CPICH info of the measured signals.~~

- ~~If the LMU can perform ATD measurements, and it is requested to do them, the ATD measurements of the requested CPICH signals is returned.~~

- ~~If the LMU can perform RTD measurements, and it is requested to do them, the RTD measurements of the requested CPICH signals is returned.~~

- ~~The SFN of the last frame measured, for each measurement.~~

- ~~The quality of each measurement, according to the requested quality type~~

In case a RTD measurement was requested by the CRNC, the LMU returns the following information to CRNC:

- Identity of the Node B at which the associated LMU is residing

- Primary CPICH info of the measured signals

- SFN-SFN time difference between neighbour cells and reference cell

- Identity of the neighbour cells

- SFN-SFN drift between neighbour cells and reference cell

- time stamp of the measurement (e.g. SFN)

- accuracy of the measurement

In case a ATD measurement was requested by the CRNC, the LMU returns the following information to the CRNC:

- cell id of the measured cell

- SFN

- time stamp (e.g. GPS Time of Week) of the SFN

- Node B clock drift

- accuracy of the measurement

# 8        Cell ID based location method

In the Cell ID based method, the S-RNC determines the identification of the cell providing coverage for the target UE. This subsection outlines the procedures for this location method. Sub-section 8.1 provides procedures for the determination of the cell ID depending on the operational status of the target UE. Sub-section 8.2 discusses the relation between the LCS location service and the Support of Localised Service Area (SoLSA) feature. Sub-section 8.3 provides a procedure for the mapping of the Cell ID to a corresponding Service Area Identifier (SAI) to be returned to the LCS application in the core network. The general flow to determine the cell ID is shown in figure 8.1.
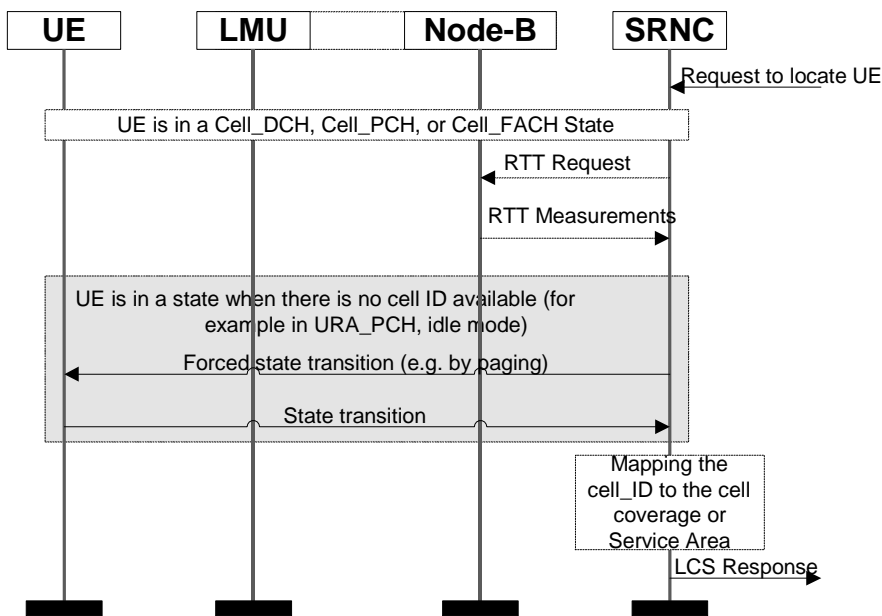
**Figure 8.1: Cell ID Based Method**

# 8.1 Cell ID determination

In order for the S-RNC to determine the cell ID when an LCS request is received, additional operations may be needed depending on the operational status of the UE.

Figure 8.1 illustrates the procedure for the cell ID based location method when the UE is in different RRC states. When the LCS request is received from the core network the S-RNC checks the state of the target UE. If the UE is in a state where the cell ID is available, the target cell ID is chosen as the basis for the UE location. In states where the cell ID is not available, the UE is paged, so that S-RNC can establish the cell with which the target UE is associated. In order to improve the accuracy of the LCS response the S-RNC may also request RTT or RX Timing Deviation measurements from the Node B or LMU associated with the cell ID. The S-RNC may also map the cell ID to a corresponding Service Area Identifier (SAI) to match the service coverage information available in the core network.

The cell ID based method shall determine the location of the UE regardless of the RRC state, including URA_PCH, Cell_PCH, Cell_DCH, Cell_FACH, cell reselection, inter-system modes, as well as an idle mode.

## 8.1.1 UE Cell ID is not known

For UE for which the cell ID is not known at the time the LCS request is received at the S-RNC, the UE may be paged to locate its current cell ID. If the UE is in an idle mode and there is a need for it to be paged, then the paging may be initiated either by the core network or by the S-RNC in the UTRAN access network. For example, the UE can be forced to perform a transition to a Cell_FACH state to define the cell ID of its current cell.

If the UE is in an idle mode, Cell_PCH state or in any other state when there is a need to page for the UE to obtain the cell ID, the Core Network may initiate paging, authentication and ciphering, as specified in TS 23.171.

Alternatively, the cell ID may be determined as the one that was used during the last active connection to the UE. This determination should be accompanied by the time-of-day of the last connection in the cell.

## 8.1.2 UE Cell ID is known

### 8.1.2.1 UE not in Soft handover

The cell ID may be determined as the cell that is providing an active connection for the UE at the time of receiving the LCS request at the S-RNC.

### 8.1.2.2　　UE in Soft handover

In order for the S-RNC to provide the geographical co-ordinates of a target UE in soft handover, the S-RNC combines the information about all cells associated with the UE.

In soft handover, the UE may have several signal branches connected to different cells, reporting different cell IDs. A reference cell ID may be determined by the S-RNC based on the coverage area of each cell. The reference cell ID may be selected based on one or more of the following principles:

- the cell ID may be selected based on the parameters defining the quality of the received signal branches. That is, the cell ID with the best quality signal branch is selected as the reference cell ID;

- the cell ID may be selected that was used during connection set-up between the UE and the serving Node B;

- the cell ID of the cell most recently associated with the UE may be selected;;

- the cell ID of the latest "new" cell that the UE has started to receive, but has not yet been handed over to may be selected;

- the cell ID may be selected as the cell to which UE has the shortest distance (to the Node-B site);

- the cell ID may be selected as the cell that provides an active connection for the UE at the time of receiving theLCS request at the S-RNC.

The selection may also be based on measurements of Round Trip Time, power levels and received signal strengths in UE and related Node B or LMU.

Other relevant mechanisms such as Idle Period Downlink, (IPDL) or Site Selection Diversity Transmit power control (SSDT) should also be taken into account when applying the cell ID selection procedure for UE in a soft handover mode.

## 8.2　　Localised Service Area

The Support of Localised Service Area (SoLSA) feature is quite close to the location service in principle, but SoLSA is based, for example, on radio network cell coverage and cell configuration. SoLSA has been standardised in GSM and is being developed for UTRAN. Some SoLSA service features like Exclusive Access and LSA only Access may be less applicable in UTRAN due to the 1 frequency reuse.

It should be noted that the Service Area concept described in this specification is different from the Localised Service Area concept defined for SoLSA.

## 8.3　　Mapping the Cell ID to Geographic Co-ordinates or a Service Area

A UTRAN cell ID should be mapped to geographical coordinates or a Service Area Identifier (SAI) before being sent from UTRAN to the core network. The Service Area Identifier may include one or several cells. The mapping may be accomplished either in the S-RNC, in a Network Management System (NMS, including Network Management Unit, NEMU) or by co-operation of various access network elements.

The core network may request the geographical co-ordinates or the SAI, or both for the target UE. The SAI may be used for routing of corresponding Emergency calls, or for CAMEL services to correspond to the usage of Cell ID in the core network of GSM. However, the MSC shall not send the Service Area Identity to GMLC.

Although the mapping of the cell(s) associated with the target UE into geographical co-ordinates by the S-RNC is not standardised, the response to the core network location request with geographical co-ordinates shall be as defined in TS 23.032.

It should be noted that the Service Area concept is different from the Localised Service Area concept used for SoLSA services.

In order to determine a cell coverage estimate and to map it to the geographical coordinates or Service Area parameter Identity, the S-RNC may use parameters such as the best reference signal, Round Trip Time (RTT) in FDD [17] or Rx Timing Deviation [18] and knowledge of the UE timing advance in TDD, as well as antenna beam direction parameters.

Alternatively, the service area coverage of a cell may be determined by using a reference signal power budget. Based on the reference signal power budget it is possible to obtain, for example, the base station transmitted power, isotropic path loss, coverage threshold at coverage area border for a given location probability, and a cell radius for an indoor and outdoor coverage.

The S-RNC may use a reference signal link budget based cell radius estimate, in conjunction with the cell identifier, to make a coverage estimation for the cell(s) related to the target UE.

Additionally, the S-RNC may compare the received power levels with the power budget, whereby more accurate information of the location of the UE may be provided.

Also, the interaction between neighbouring cell coverage areas may be used to determine a more exact location of the UE.

# 9 OTDOA location method

The primary standard OTDOA measurement is the "SFN-SFN observed time difference" observed at the UE (see [17 and [18]. These measurements, together with other information concerning the surveyed geographic location of the transmitters and the relative time difference (RTD) of the actual transmissions of the downlink signals may be used to calculate an estimate of the location of the UE. Each OTDOA measurement for a pair of downlink transmissions describes a line of constant difference (a hyperbola (see note 1)) along which the UE may be located. The UE's location is determined by the intersection of these lines for at least two pairs of base stations. The accuracy of the location estimates made with this technique depends on the precision of the timing measurements, the relative location of the base stations involved (see note 2), and is also subject to the effects of multipath radio propagation. This is illustrated in the figure 9.1.

   NOTE 1:   This is really a figure in three dimensions, a hyperboloid. For convenience here, this will be simplified to the hyperbola representing the intersection of this surface with the surface of the earth. For location service in three dimensions the hyperboloid must be considered.

   NOTE 2:   The geometry of the base station locations may affect the accuracy of the location estimate. The best results are when the base stations equally surround the UE. If they do not, there is a reduction in accuracy, which is sometimes termed the Geometric Dilution of Position (GDP).

The primary OTDOA measurements (made by the UE) are sent to the Position Calculation Function (PCF) in the serving RNC. These measures are sent via signalling over the Uu, Iub (and Iur) interfaces between the UE and the SRNC (PCF). The calculation function makes use of the measurements, the known locations of the transmitter sites and the relative time difference of the transmissions to estimate the UE's location.
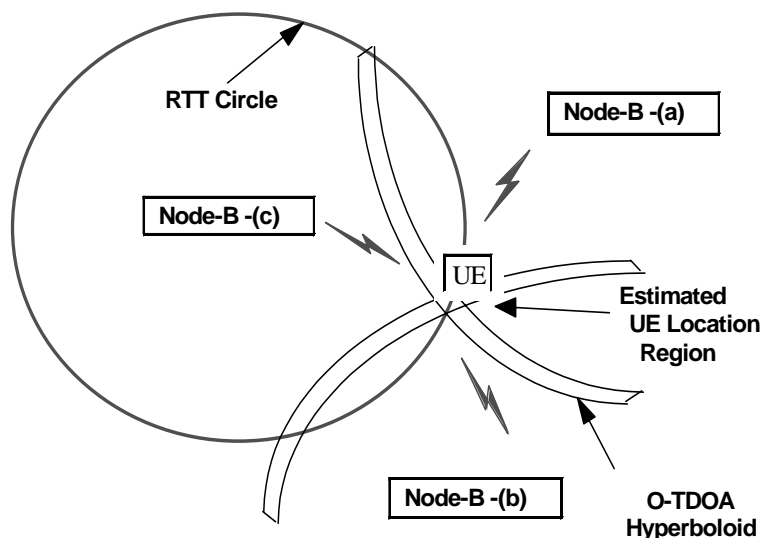
**Figure 9.1: OTDOA Location Method**

The OTDOA method may be operated in two modes: UE assisted OTDOA and UE based OTDOA. The two modes differ in where the actual location calculation is carried out. In the *UE assisted* mode, the UE measures the difference in time of arrival of several cells and signals the measurement results to the network, where a network element (the Position Calculation Function (PCF)) carries out the location calculation. In the *UE based* mode, the UE makes the measurements and also carries out the location calculation, and thus requires additional information (such as the location of the measured base stations) that is required for the location calculation. The signalling requirements for the two OTDOA modes are described in a later subclause. As the LCS involves measurements, there is always uncertainty in the results. Physical conditions, errors and resolution limits in the apparatus all contribute to uncertainty. To minimise the uncertainty in the LCS result, it is important that as many measurements of TDOA (and assistance data as RTT in FDD and Rx Timing Deviation in TDD) as are possible for a UE are provided to the PCF. Thus it is important that the standard method for LCS not be restricted to rely on a single measure. The UE thus provides SFN-SFN observed time difference measurements for as many cells as it can receive. The cellsto be measured shall include those in the "cell reselection and monitoring set" and those in the "cell selection set".

In order to support the OTDOA method, the locations of the UTRAN transmitters needs to be accurately known by the calculation function (PCF). This information may be measured by appropriate conventional surveying techniques (see note 3). The surveyed location should be the electrical centre of the transmitting antenna (and not the location of the radio equipment building). The use of antenna diversity, beamforming or beam steering techniques may cause the effective antenna location to change with time and this information will need to be communicated to the PCF to assist with its calculations. The methods of measuring the location of the UTRAN transmitters are outside the scope of the present document.

NOTE 3:　These surveying methods may, for example, make use of a GPS receiver.

In order to support the OTDOA method, the relative time difference (RTD) of the downlink transmissions must also be known by the calculation function (PCF). If the UTRAN transmitters are unsynchronised, the RTD will change over time as the individual clocks drift. Thus, measurements of RTD may need to be made regularly and the calculation function updated appropriately. The measurement of the RTD is outside the scope of the present document (see note 4).

NOTE 4:　One convenient method is to make use of an LMU at a fixed location. This unit measures the observed time differences of all the local transmitters and reports these to the PCF. These measures may then be converted (translated) into the actual (absolute) relative time difference for each of the transmitters by making use of the known location of the LMU and the transmitters.

In some conditions a sufficient number of cells may not be available for measure at the UE. This may occur, for example, if the UE is located quite close to the UTRAN transmitter and its receiver is blocked by the strong local transmissions. This is referred to as the "hearability" problem.

# 9.1 Use of Idle Periods (FDD only)

For realising location based services the support of physical layer is a prerequisite, so that the measurements required for the terminal location calculation can be carried out. In UTRAN there are several factors that must be taken into account while considering the physical layer procedures related to location services:

- hearability: a basic consequence of a CDMA radio system is that a terminal near its serving base station cannot hear other base stations on the same frequency. In order to calculate terminal location the terminal should be able to receive at least three base stations. To facilitate this some special means are required;

- asynchronous network causes significant uncertainty to the time-difference-of-arrival (TDOA) measurements. To compensate for the effects of this, the relative time difference (the synchronicity) between base station transmissions must be measured, and used for correcting TDOA measurement;

- capacity loss: signalling related to location calculation may take capacity from other services. This capacity loss should be minimised.

Based on the results of the work done in ARIB SWG2/ST9 (see reference [21]) a solution for the above mentioned hearability problem is the IPDL (Idle Period DownLink) method. In this method each base station ceases its transmission for short periods of time (idle periods). During an idle period of a base station, terminals within the cell can measure other base stations and the hearability problem is reduced. Also, during idle periods the real time difference measurements can be carried out. Because the IPDL method is based on forward link (downlink) the location service can be provided efficiently to a large number of terminals simultaneously.

The specification and operation of the IPDL technique are provided in the following subclause.

## 9.1.1 Operation and specification of idle periods

The operation and specification of idle periods can be found in TS 25.214 (reference [16]).

# 9.2 Relative Time Difference (RTD)

In order to calculate the estimate of the location of the UE, the calculation function needs to know:

- the OTDOA measurements;

- the surveyed geographic locations of the base stations that have had their signals measured; and

- the actual relative time difference between the transmissions of the base stations at the time the OTDOA measurements were made.

The accuracy of each of these measurements contributes to the overall accuracy of the location estimate. The measurement of the RTD is described in the following.

There are several approaches to determining the RTD. One is to synchronise the transmissions of the base stations. In this technique the RTD are known constant values (see NOTE) that may be entered in the database and used by the calculation function when making a location estimate. The synchronisation must be done to a level of accuracy of the order of tens of nanoseconds (as 10 nanoseconds uncertainty contributes 3 metres error in the location estimate). Drift and jitter in the synchronisation timing must also be well controlled as these also contribute uncertainty in the location estimate. Synchronisation to this level of accuracy is currently only readily available through satellite based time-transfer techniques. Generally in the TDD operating mode, the base stations are synchronised.

NOTE: The transmission times may all be aligned to a common reference (such as UTC) in which case all RTD have a common value. However, in a more general case the transmissions may have a fixed offset with reference to UTC, and thus the RTD values are non-zero and may be stored in the database for use by the calculation function.

Alternatively (typically in FDD mode), the base stations may be left to free run within some constraint of maximum frequency error. In this scenario, the RTD will change (slowly) with time. The rate of change will depend on the frequency difference and jitter between base stations. If, for example, the maximum frequency difference between two base stations is $\pm10^{-9}$, then the start of transmission of a 10 millisecond code sequence will drift through a cycle in about 1 390 hours (or 57 days). With this relatively slow rate of drift the RTD can be measured by fixed units at known

locations (these are LMUs, Location Measurement Units) and stored in the database for use by the calculation function. The jitter and drift of the individual oscillators in each base station may cause the change of timing to slow, remain constant or reverse direction over time. Ongoing measurements of the RTD may be made to assure the most current values are available for the calculation function. The RTD measurement units may be co-located with the base stations or installed at other convenient locations in the UTRAN coverage area, and report their results through the UTRAN signalling channels.

The LMUs may directly measure the RTD between neighbouring and reference cells and return the measurements to the CRNC. Alternatively the LMUs may measure the ATD of the neighbouring and reference cells and return the measurements to the CRNC. If the CRNC is not the SRNC the information is also forwarded from CRNC to SRNC. The SRNC then uses the ATD measurements to calculate the RTD values. The information to be transferred in each case are listed in 7.6.3.

# 9.3     Time of Day (ToD)

If there are frequency drifts between the (unsynchronised) Node Bs, as noted in the previous subclause, the OTDOA measurements must be reported together with the time-of-day they were made (timestamp). This is necessary so that the appropriate value of the RTD may be used by the calculation function.

In order to assure less than a 20 nanosecond uncertainty in the RTD value, the time of day must be known to better than 10 seconds (if the maximum frequency difference between the base stations is $\pm 10^{-9}$). The method by which the ToD is measured is the system the frame number, which provides a 10 millisecond resolution and can be unambiguous up to 40.95 seconds..

# 9.4     Base Station Synchronisation

It is preferable that the location methods do not require the base station network to be synchronised. The needed level of synchronisation accuracy for LCS is not by any means straightforward to achieve. The necessary information of Relative Time Differences (RTD) between base stations can be measured by dedicated units (LMU, Location Measurement Unit) and distributed in the network (e.g. as broadcast information). Also, the measurements of RTD may benefit from the Idle Period DownLink (IPDL) option.

In the TDD operating mode the base stations will typically be synchronised and this may be of assistance to the LCS technique.

# 9.5     OTDOA-IPDL and OTDOA Modes

There are two modes of operation for the OTDOA-IPDL and OTDOA methods. In the *UE assisted* mode, the UE measures the difference in time of arrival of several cells and signals the measurement results to the network, where a network element (the Position Calculation Function (PCF)) carries out the location calculation. In the *UE based* mode, the UE makes the measurements and also carries out the location calculation, and thus requires additional information (such as the location of the measured base stations) that is required for the location calculation. This information is provided by the Location System Information Function (LSIF).

## 9.5.1     Information to be transferred between UTRAN elements

Table 9.1 lists the required information for both UE assisted and UE based modes that may be sent from SRNC to UE. The required information can be signalled to the UE either in a broadcast channel or partly also as dedicated signalling.

**Table 9.1: Information** ~~required~~ to be transferred from SRNC to UE ~~for UE assisted and UE based OTDOA- IPDL and OTDOA in the UTRAN (LSIF) to UE direction~~ **('Yes' = information required, 'No' = Information not required)**

| Information | UE assisted | UE based |
|---|---|---|
| Intra frequency Cell Info (neighbour list). | Yes | Yes |
| Ciphering information for LCS (see note) | No | Yes |
| Measurement control information (idle period locations) | Yes | Yes |
| Sectorisation of the neighbouring cells | No | Yes |
| Measured RTD values for Cells mentioned at Intra frequency Cell Info | No | Yes |
| RTD accuracy | No | Yes |
| Measured roundtrip delay for primary serving cell | No | Yes |
| Geographical location of the primary serving cell. | No | Yes |
| Relative neighbour cell geographical location | No | Yes |
| Accuracy range of the geographic location values | No | Yes |
| NOTE:      The idea behind LCS specific ciphering information is e.g. that the operator can sell information that the UE needs for calculating its location. For reference in the GSM world see [3]. | | |

The information that may be signalled~~required~~ from UE to ~~UTRAN (PSMF/PCF)~~SRNC is listed in table 9.2.

**Table 9.2: Information** to be transferred from UE to SRNC~~required for UE assisted and UE based OTDOA- IPDL and OTDOA in the UE to UTRAN (PSMF/PCF) direction~~

| Information | UE assisted | UE based |
|---|---|---|
| OTDOA measurement results | Yes | No |
| OTDOA measurement accuracy | Yes | No |
| UE geographical location | No | Yes |
| Location accuracy indicator (based on the signalled and measurement accuracies) | No | Yes |

Table 9.3 shows the information that may be transferred from Node B to its CRNC. If the CRNC is not the SRNC the information is also forwarded from CRNC to SRNC.

**Table 9.3: Information to be transferred from Node B/LMU to CRNC and between RNCs**

| Information | UE assisted | UE based |
|---|---|---|
| Measured RTD or ATD values for Cells mentioned at Intra frequency Cell Info | Yes | Yes |
| RTD or ATD accuracy | Yes | Yes |

Table 9.4 shows the information that may be transferred between RNCs.

**Table 9.4: Information to be transferred between RNCs**

| Information | UE assisted | UE based |
|---|---|---|
| Geographical location of the primary serving cell | Yes | Yes |
| Relative neighbour cell geographical location | Yes | Yes |
| Accuracy range of the geographic location values | Yes | Yes |

# 9.6      OTDOA network location procedures

The following diagram illustrates the operations for the OTDOA-LCS when the request for location information is initiated by an LCS application signalled from the Core Network. As these operations are internal to the RNC, this diagram is to illustrate information flow and implementations may use alternate arrangements.

This illustration only includes the information flow related to LCS operations and does not indicate other operations that may be required, for example, to establish a signalling connection between the UE and the SRNC. Also not illustrated is the signalling used to initiate the location service request (from the Location Client Function) from the Core Network or a UE based application.
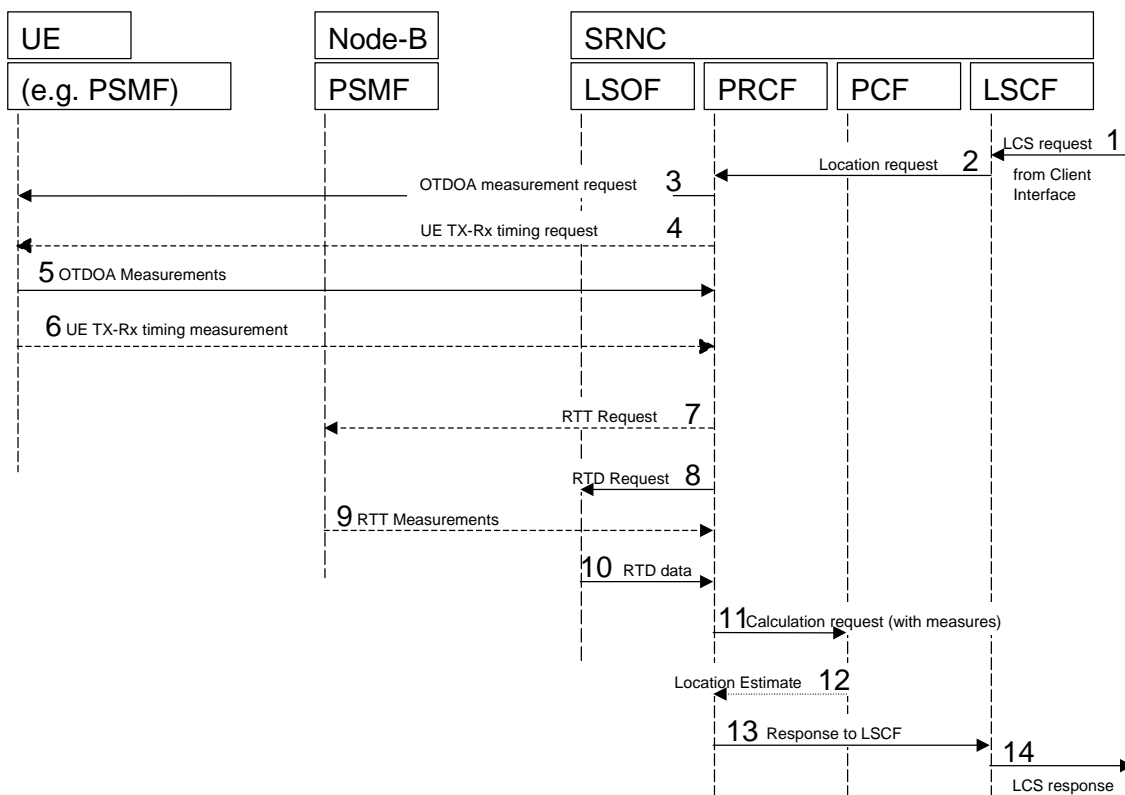
**Figure 9.2: OTDOA Signalling Operations**

1. The operation begins with an authenticated request for location information about a UE from an application in the core network being received at the LSCF. The LSCF acts as interface between the Core Network and the LCS entities in the UTRAN.

2. The LSCF considers the request and the capabilities of the UE and the network and forwards the request to the appropriate PRCF in the Serving RNC.

3. The PRCF requests from the UE the measurement of the OTDOA for the signals in the active and neighbourhood sets. These measurements may be made while the UE is in the idle state or while it is connected.

4. If it is considered advantageous to do so, the PRCF requests the UE TX-Rx timing difference information from the UE.

5. The UE returns the OTDOA measures to the PRCF. The PRCF receives the OTDOA information and co-ordinates obtaining other information to support the calculation request (not illustrated).

6. The UE returns the UE TX-Rx timing difference information to the PRCF, together with a time stamp of when the value was obtained.

7. If there are insufficient OTDOA measures, or it is otherwise considered advantageous to do so, the PRCF requests the RTT measure for the UE from the PSMF in the serving Node-B.

8. The PRCF requests the RTD measures for the associated transmitters from the LSOF (database). These may be stored locally if they are constant over time, otherwise they must be updated to represent the RTD timing at the time-of-day the OTDOA measurements were made.

9. The PSMF in the Node-B returns the RTT measures to the PRCF if they were requested.

10. The LSOF returns the RTD information to the PRCF.

11. The PRCF passes the OTDOA, RTD and, if necessary, RTT information to the PCF and requests a location calculation. The calculation may include a co-ordinate transformation to the geographic system requested by the application.

12. The PCF returns the location estimate to the PRCF. This estimate includes the location, the estimated accuracy of the results and the time of day of the estimate.

13. The PRCF passes the location estimate to the LSCF.

14. The LSCF passes the location estimate to the Core Network.

# 10 Network assisted GPS location method

When GPS is designed to inter-work with the UTRAN, the network assists the UE GPS receiver to improve the performance in several respects. These performance improvements will:

- reduce the UE GPS start-up and acquisition times; the search window can be limited and the measurements sped up significantly;

- increase the UE GPS sensitivity; location assistance messages are obtained via UTRAN so the UE GPS can operate also in low SNR situations when it is unable to demodulate UE GPS signals;

- allow the UE to consume less handset power than with stand-alone GPS ; this is due to rapid start-up times as the GPS can be in idle mode when it is not needed.

The Network assisted GPS methods rely on signalling between possibly reduced complexity UE GPS receivers and a continuously operating GPS reference receiver network which has clear sky visibility of the same GPS constellation as the assisted UEs. GPS reference receivers may be connected to the UTRAN to enable derivation of UE assistance signals.
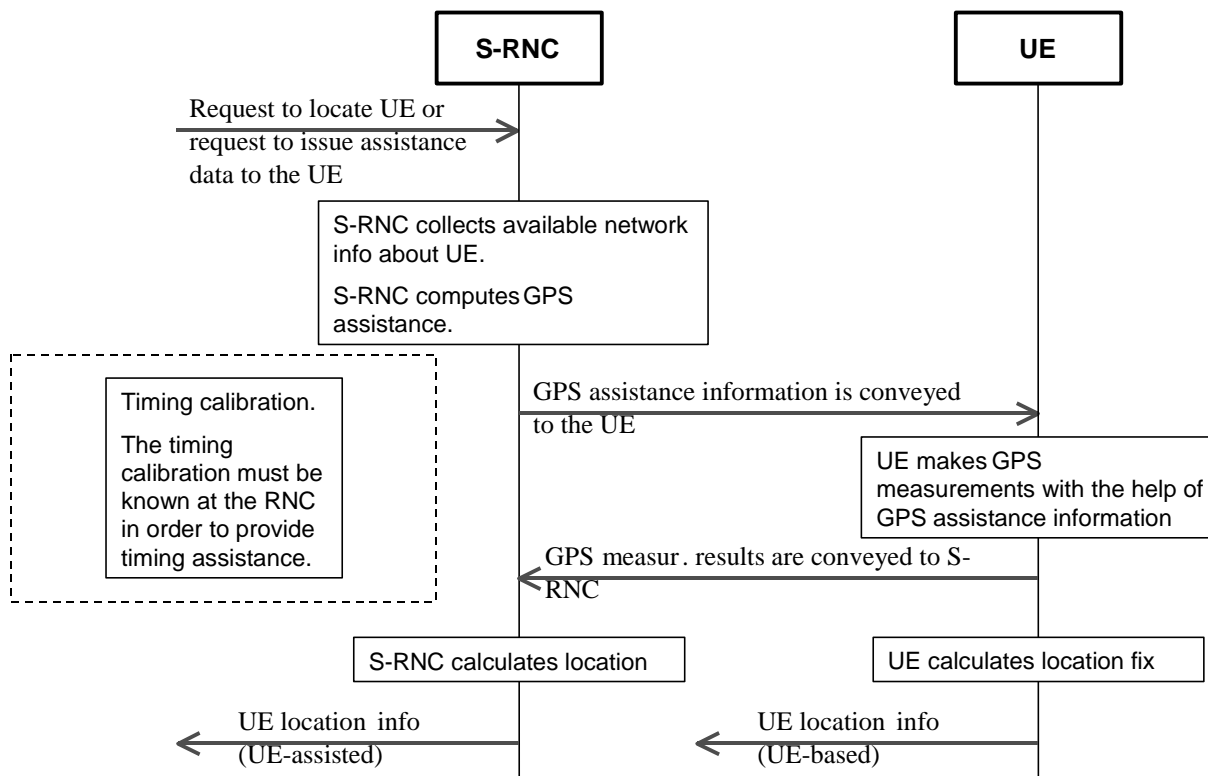


**Figure 10.1: Network assisted GPS methods**

## 10.1    Timing calibration

Timing calibration is achieved by using UE or UTRAN GPS timing measurements as specified in [17].

## 10.2    Timing assistance

The UTRAN may derive the estimated UE location using UTRAN (eg. Cell-ID or IPDL) parameters and may use this information, in conjunction with satellite specific ephemeris data received from the GPS reference receiver network, to derive the estimated times of arrival (code phases) for equivalent GPS satellite signals received by the UE-based GPS receiver functionality. The estimated code phase data may be conveyed, together with $T_{UTRAN-GPS}$ (as specified in [17] and [18]), from the UTRAN to the UE using higher layer signalling. The estimated code phase data value is uncertain to a degree depending on the accuracy of the UTRAN timing calibration and initial location determination methods used.

## 10.3    Data assistance

The UE may receive GPS information through the UTRAN air interface, using higher layer signalling.

When the UE is unable to detect a sufficient number of satellites, the assisted GPS method can be combined with other location methods. Altitude assistance can compensate for one satellite measurement.

The assistance data signalled to the UE may include all information listed below or a selected subset:

- data assisting the measurements; e.g. reference time, visible satellite list, satellite signal Doppler, code phase, Doppler and code phase search windows. This data can be valid for a few minutes (e.g., less than 5 minutes) or longer depending on the code phase and Doppler search window size that can be accommodated by the UE;

- data providing means for location calculation; e.g. reference time, reference location, satellite ephemeris, clock corrections. Satellite ephemeris and clock corrections data can be used for up to six hours.

NOTE:    Certain types of GPS Assistance data may be derived, wholly or partially, from other types of GPS Assistance data.

If DGPS is utilised, then differential corrections may also be transmitted. If Selective Availability is turned off, these corrections can be valid for a few minutes or more. The DGPS data is valid for a large geographical area, so one centrally located reference receiver can be used to service this large region.

## 10.4    UE search

Provided that timing and/or data assistance is available in the UE they should be applied in the GPS signal searchprocedure. UE search procedure involves a three-dimensional search for a satellite PRN (pseudorandom) code, time of arrival of a signal and the associated carrier Doppler.

"Modulation wipe-off" is defined here to mean a removal of the GPS navigation data bit modulation to GPS signals received at the UE, through the application of UTRAN timing and data assistance provided from the UTRAN to the UE. This process allows the UE to coherently integrate received GPS signals beyond 1 data bit period (i.e., 20 milliseconds).

## 10.5    Location determination

Computation of the location fix can either be performed in the network infrastructure (UE-assisted) or in the UE (UE-based).

There are two types of network assisted GPS methods, namely UE-based and UE-assisted, which differ according to where the actual location calculation is carried out.

The UE-based method maintains a full GPS receiver functionality in the UE, and the location calculation is carried out by the UE, thus allowing stand-alone location fixes.

In the UE-assisted method, the UE employs a reduced complexity GPS receiver functionality. This carries out the pseudorange (code phase) measurements. These are signalled, using higher layer signalling, to the specific network element that estimates the location of the UE and carries out the remaining GPS operations. In this method, accurately timed code phase signalling (as specified in [17] and [18]) is required on the downlink. If DGPS is performed in the UE, then differential corrections must be signalled to it. On the other hand, DGPS corrections can be applied to the final result in the network to improve the location accuracy without extra signalling to the UE.

## 10.5.1 ~~UE-based method~~Information to be transferred between UTRAN elements

Table 10.1 lists information for both UE-assisted and UE-based modes that may be sent from SRNC to UE. This information can be signalled to the UE either in a broadcast channel or as dedicated signalling.

**Table 10.1: Information that may be transferred from SRNC to UE('Yes' = information applicable 'No' = information not applicable**

| Information | UE-assisted | UE-based |
|---|---|---|
| Number of satellites for which assistance is provided | Yes | Yes |
| reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]) | Yes | Yes |
| 3-d reference location (specified in [17]) | No | Yes |
| ionospheric corrections | No | Yes |
| satellite ID for identifying the satellites for which assistance data is provided | Yes | Yes |
| Ephemeris & clock corrections | Yes | Yes |
| UTC offset | No | Yes |
| DGPS corrections | No | Yes |
| almanac data | Yes | Yes |
| real-time integrity (e.g. a list of unusable satellites) | No | Yes |
| doppler ($0^{th}$ order term) | Yes | No |
| Doppler Search Window width | Yes | No |
| doppler ($1^{st}$ order term) | Yes | No |
| azimuth | Yes | No |
| elevation | Yes | No |
| code phase | Yes | No |
| code phase centre and search window width | Yes | No |

The information that may be signalled from UE to SRNC is listed in table 10.2.

**Table 10.2: Information that may be transferred from UE to SRNC**

| Information | UE-assisted | UE-based |
|---|---|---|
| reference time for GPS ($T_{UE-GPS}$) (specified in [17] and [18]) | Yes | Yes |
| serving cell information | No | Yes |
| Latitude/Longitude/Altitude/Error ellipse | No | Yes |
| velocity estimate in the UE | No | Yes |
| satellite ID for which measurement data is valid | Yes | No |
| Whole/Fractional chips for information about the code-phase measurement | Yes | No |
| $C/N_0$ of the recieved signal from the particular satellite used in the measurements | Yes | No |
| doppler frequency measured by the UE for the particular satellite | Yes | No |
| pseudorange RMS error | Yes | No |
| multipath indicator | Yes | No |
| number of Pseudoranges | Yes | No |

Table 10.3 shows the information that may be transferred from Node B to its CRNC. If the CRNC is not the SRNC the information is also forwarded from CRNC to SRNC.

**Table 10.3: Information that may be transferred from Node B/LMU to CRNC and between RNCs**

| Information | UE-assisted | UE-based |
|---|---|---|
| reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]) | Yes | Yes |

The UE-based method maintains a full GPS receiver functionality in the UE, and the location calculation is carried out by the UE, thus allowing stand-alone location fixes.

If the location was requested by an application in the network, then the calculated location is signalled to the proper network element.

The following information may be signalled from the UTRAN (LSIF) to the UE:

- number of satellites for which assistance is provided;

- reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]);

- 3-d reference location (specified in [17]);

- ionospheric corrections;

- satellite ID for identifying the satellites for which the assistance is provided;

- ephemeris and clock corrections to accurately model the orbit of the particular satellite and information when this becomes valid;

- UTC offset;

- DGPS corrections;

- almanac data;

- real-time integrity (e.g., a list of unusable satellites).

The following information may be signalled from the UE to the UTRAN (LSIF):

- reference time for GPS (specified in [17] and [18]);

- serving cell information;

- Latitude/Longitude/Altitude/Error ellipse;

- velocity estimate of the UE;

- satellite ID for which the measurement data is valid;

- Whole/Fractional chips for information about the code-phase measurements;

- $C/N_0$ of the received signal from the particular satellite used in the measurements;

- doppler frequency measured by the UE for the particular satellite signal;

- pseudorange RMS error;

- multipath indicator.

## 10.5.2 UE-assisted method

In the UE-assisted method, the UE employs a reduced complexity GPS receiver functionality. This carries out the pseudorange (code phase) measurements. These are signalled, using higher layer signalling, to the specific network element that estimates the location of the UE and carries out the remaining GPS operations. In this method, accurately timed code phase signalling (as specified in [17] and [18]) is required on the downlink. If DGPS is performed in the UE, then differential corrections must be signalled to it. On the other hand, DGPS corrections can be applied to the final result in the network to improve the location accuracy without extra signalling to the UE.

The following information may be signalled from the UTRAN (LSIF) to the UE:

- number of satellites for which assistance is provided;

- reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]);

- satellite ID for identifying the satellites for which the assistance is provided;

- doppler ($0^{th}$ order term);

- Doppler Search Window width;

- doppler ($1^{st}$ order term);

- code phase;

- code phase centre and Search Window width;

- ephemeris;

- azimuth;

- elevation.

The following information may be signalled from the UE to the UTRAN (LSIF):

- reference time for GPS ($T_{UE-GPS}$) (specified in [17] and [18]);

- number of Pseudoranges;

- SVID;

- satellite C/No;

- doppler;

- satellite Code Phase;

- multipath indicator;

- pseudorange RMS Error.

Additional parameters, such as round trip time (RTT) in FDD or Rx Timing Deviation in TDD, UE receiving transmitting time (UE Rx-Tx), SFN-SFN observed time difference and CPICH Ec/No, may be used to improve the performance of UE-assisted GPS. All the additional parameters are defined in [17] and [18] and can be made available through RRC signalling. Furthermore, to those UE technologies requiring externally provided sensitivity and time aiding data, some navigation bits may be sent from UTRAN to UE for sensitivity assistance and time recovery.

# 11 Position calculation functionality

NOTE: The functionality of the PCF is described in more detail in an informative annex FFS.

# 12 Information storage

NOTE This clause just outlines the information that may need to be stored in the UTRAN LCS elements (U-LCF, U-PSCF,U-LSCF, UE, etc) that may need to be standardised (if any).

# Annex A (informative):
# Definitions and Terms

This annex provides definitions and terms for the general LCS. Not all of these are applicable to the UTRAN environment.

**CAMEL:** CAMEL is a network functionality, which provides the mechanisms of Intelligent Network to a mobile user.

**Current Location:** after a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp is referred to as the 'current location' at that point in time.

**Deferred location request:** a location request where the location response (responses) is (are) not required immediately.

**Global Positioning System:** the Global Positioning System (GPS) consists of three functional elements: Space Segment (satellites), User Segment (receivers), and Control Segment (maintenance etc.). The GPS receiver estimates its own location based on the observed times of arrival of the satellite signals.

**Immediate location request:** a location request where a single location response only is required immediately.

**Initial Location:** in the context of an originating emergency call the location estimate and the associated time stamp at the commencement of the call set-up is referred to as 'initial location'.

**Last Known Location:** the current location estimate and its associated time stamp for Target MS stored in the LCS Server is referred to as the 'last known location' and until replaced by a later location estimate and a new time stamp is referred to as the 'last known location'.

**LCS (LoCation Services):** LCS is a service concept in system (e.g. GSM or UMTS) standardisation. LCS specifies all the necessary network elements and entities, their functionalities, interfaces, as well as communication messages, due to implement the location service functionality in a cellular network.

   NOTE:    LCS does not specify any location based (value added) services except locating of emergency calls.

**LCS Client:** a software and/or hardware entity that interacts with a LCS Server for the purpose of obtaining location information for one or more Mobile Stations. LCS Clients subscribe to LCS in order to obtain location information. LCS Clients may or may not interact with human users. The LCS Client is responsible for formatting and presenting data and managing the user interface (dialogue). The LCS Client may reside in the Mobile Station (MS).

**LCS Client Access barring list:** an optional list of MSISDNs per LCS Client where the LCS Client is not allowed to locate any MSISDN therein.

**LCS Client Subscription Profile:** a collection of subscription attributes of LCS related parameters that have been agreed for a contractual period of time between the LCS client and the service provider.

**LCS Feature:** the capability of a PLMN to support LCS Client/server interactions for locating Target MSs.

**LCS Server:** a software and/or hardware entity offering LCS capabilities. The LCS Server accepts requests, services requests, and sends back responses to the received requests. The LCS server consists of LCS components, which are distributed to one or more PLMN and/or service provider.

**Local Service:** a service, which can be exclusively provided in the current serving network by a Value added Service Provider.

**Local Information:** information related to a given location, or general information, which is made available in a given location.

**Location (/location detecting):** location is a functionality, which estimates a geographical location (of e.g. a mobile terminal).

**Location (Based) Application:** a location application is an application software processing location information or utilising it in some way. The location information can be input by a user or detected by network or MS. Navigation is one location application example.

**Location Based Service (LBS):** a service provided either by teleoperator or a 3$^{rd}$ party service provider that utilises the available location information of the terminal. Location Application offers the User Interface for the service. LBS is either a pull or a push type of service (see Location Dependent Services and Location Independent Services). In ETSI/GSM documentation of SoLSA, LBS is called "Location Related Service". ETSI and/or 3GPP –wide terminology harmonisation is expected here.

**Location Dependent Service:** a service provided either by teleoperator or a 3$^{rd}$ party service provider that is available (pull type) or is activated (push type) when the user arrives to a certain area. It doesn't require any subscription in advance, but the push type activation shall be confirmed by the user. The offered service itself can be any kind of service (e.g. a public Xerox machine or the discount list in a store).

**Location Estimate:** the geographic location of an MS and/or a valid Mobile Equipment (ME), expressed in latitude and longitude data, and optionally altitude data. The Location Estimate shall be represented in a well-defined universal format. Translation from this universal format to another geographic location system may be supported, although the details are considered outside the scope of the primitive services.

**Location Independent Service:** a service provided either by teleoperator or a 3$^{rd}$ party service provider that is available and therefore can be activated anywhere in the network coverage. It is activated by the user's request or by other user's activated service, and therefore it requires a subscription in advance (pull type). The offered service itself can be any kind of service (e.g. MMS, SWDL, or LBS!).

**Location method (/locating method):** a principle and/or algorithm which the estimation of geographical location is based on, e.g. AOA, TOA, TDOA. For example, GPS is based on TOA, and E-OTD (on GSM) is based on TDOA.

**Location technology (/locating technology):** a technology or system concept including the specifications of RF interfaces, data types, etc. to process the estimation of a geographical location, e.g. GPS, E-OTD (GSM), and IPDL-TDOA (WCDMA).

**PLMN Access barring list:** an optional list of MSISDN per PLMN where any LCS Client is not allowed to locate any MSISDN therein except for certain exceptional cases.

**Predefined area:** a geographical area which is not related to cell or radio coverage. The mobile may take special action when it recognises it has entered or left a predefined area.

**Privacy Class:** list of LCS Clients defined within a privacy exception class to which permission may be granted to locate the target MS. The permission shall be granted either on activation by the target MS or permanently for a contractual period of time agreed between the target MS and the service provider.

**Privacy Exception List:** a list consisting of various types of privacy classes (i.e. operator related, personal etc.). Certain types of classes may require agreement between the service provider and the target MS.

**Prohibited area:** an area where the mobile must not activate its transmitter. The Prohibited area may be a Predefined area described above or related to radio cell(s).

**Subscription Profile:** the profile detailing the subscription to various types of privacy classes.

**Target MS:** the MS being located.

# Annex B (informative):
# Change history

| TSG-RAN# | Version | CR | Tdoc RAN | New Version | Subject/Comment |
|---|---|---|---|---|---|
| **Change history** |
| RAN_06 | - | - | RP-99635 | 3.0.0 | (12/99)<br>Approved at TSG-RAN #6 and placed under Change Control |
| RAN_07 | 3.0.0 | 001 | RP-000038 | 3.1.0 | (03/00)<br>Network assisted GPS LCS |
| RAN_07 | 3.0.0 | 002 | RP-000038 | 3.1.0 | Enhancements for cell coverage based positioning |
| RAN_07 | 3.0.0 | 003 | RP-000038 | 3.1.0 | Replacement for Figure 4.1 |
| RAN_07 | 3.0.0 | 004 | RP-000038 | 3.1.0 | Restructuring |
| RAN_07 | 3.0.0 | 006 | RP-000038 | 3.1.0 | Target UE-RNC signalling model |
| RAN_07 | 3.0.0 | 007 | RP-000038 | 3.1.0 | LMU description |
| RAN_07 | 3.0.0 | 008 | RP-000038 | 3.1.0 | LMU signalling description |
| RAN_07 | 3.0.0 | 009 | RP-000038 | 3.1.0 | Incorporation of R1 Liaisons R2-000022 and R2-000023 |
| RAN_07 | 3.0.0 | 010 | RP-000038 | 3.1.0 | OTDOA - GPS Location Procedures |
| RAN_07 | 3.0.0 | 011 | RP-000038 | 3.1.0 | Clarification of the different LMU types |
| RAN_08 | 3.1.0 | 013 | RP-000218 | 3.2.0 | (06/00)<br>Modifications to LCS text on cell-ID method |
| RAN_08 | 3.1.0 | 015 | RP-000218 | 3.2.0 | Editorial modifications of OTDOA descriptions for alignment with TDD |
| RAN_08 | 3.1.0 | 016 | RP-000218 | 3.2.0 | Update on clause 5 |
| RAN_08 | 3.1.0 | 017 | RP-000218 | 3.2.0 | Editorial additions |
| RAN_08 | 3.1.0 | 018 | RP-000218 | 3.2.0 | Clarification of OTDOA signalling operation |
| RAN_08 | 3.1.0 | 019 | RP-000218 | 3.2.0 | Assisted GPS procedures |
| RAN_09 | 3.2.0 | 020 | RP-000356 | 3.3.0 | (09/00)<br>Alignment of FDD and TDD positioning methods and editorial changes |
| RAN_09 | 3.2.0 | 021 | RP-000356 | 3.3.0 | Assisted GPS Procedures |
| RAN_09 | 3.2.0 | 022 | RP-000356 | 3.3.0 | TDD/FDD alignment of OTDOA and GPS assisted positioning methods |
| RAN_09 | 3.2.0 | 023 | RP-000356 | 3.3.0 | Clean-up |
| RAN_09 | 3.2.0 | 024 | RP-000356 | 3.3.0 | Corrections from LCS Ad Hoc |

**3GPP TSG-RAN WG2 Meeting #17**

**Sophia Antipolis, France, 13-17 Nov 2000**

*Document* **R2-002420**

# CHANGE REQUEST

*Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.*

| **25.305** | **CR** | **039r1** | Current Version: | 3.3.0 |
|---|---|---|---|---|

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑*          *↑ CR number as allocated by MCC support team*

| For submission to: | TSG-RAN #10 | for approval | **X** | strategic | | *(for SMG* |
|---|---|---|---|---|---|---|
| *list expected approval meeting # here* ↑ | | for information | | non-strategic | | *use only)* |

*Form: CR cover sheet, version 2 for 3GPP and SMG*          *The latest version of this form is available from:* ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

**Proposed change affects:**          (U)SIM ☐          ME **X**          UTRAN / Radio **X**          Core Network ☐
*(at least one should be marked with an X)*

| **Source:** | TSG-RAN WG2 | | **Date:** | 15 Nov 2000 |
|---|---|---|---|---|

| **Subject:** | Moving of Semantic Descriptions from RRC (25.331) to 25.305 |
|---|---|

| **Work item:** | |
|---|---|

**Category:**          F    Correction          **X**          **Release:**    Phase 2          ☐

|  | A | Corresponds to a correction in an earlier release | | | Release 96 | ☐ |
|---|---|---|---|---|---|---|
| *(only one category* | B | Addition of feature | | | Release 97 | ☐ |
| *shall be marked* | C | Functional modification of feature | | | Release 98 | ☐ |
| *with an X)* | D | Editorial modification | | | Release 99 | **X** |
| | | | | | Release 00 | ☐ |

| **Reason for change:** | It was agreed that the text describing Integrity Monitor should be moved to 25.305. |
|---|---|

| **Clauses affected:** | 10 |
|---|---|

| **Other specs affected:** | Other 3G core specifications | ☐ | → List of CRs: | |
|---|---|---|---|---|
| | Other GSM core specifications | ☐ | → List of CRs: | |
| | MS test specifications | ☐ | → List of CRs: | |
| | | ☐ | → List of CRs: | |
| | O&M specifications | ☐ | → List of CRs: | |

| **Other comments:** | |
|---|---|

help.doc

<--------- double-click here for help and instructions on how to create a CR.

**\*\*\* Next Modified Section \*\*\***

# 10 Network assisted GPS location method

When GPS is designed to inter-work with the UTRAN, the network assists the UE GPS receiver to improve the performance in several respects. These performance improvements will:

- reduce the UE GPS start-up and acquisition times; the search window can be limited and the measurements sped up significantly;

- increase the UE GPS sensitivity; location assistance messages are obtained via UTRAN so the UE GPS can operate also in low SNR situations when it is unable to demodulate UE GPS signals;

- allow the UE to consume less handset power than with stand-alone GPS ; this is due to rapid start-up times as the GPS can be in idle mode when it is not needed.

The Network assisted GPS methods rely on signalling between possibly reduced complexity UE GPS receivers and a continuously operating GPS reference receiver network which has clear sky visibility of the same GPS constellation as the assisted UEs. GPS reference receivers may be connected to the UTRAN to enable derivation of UE assistance signals.
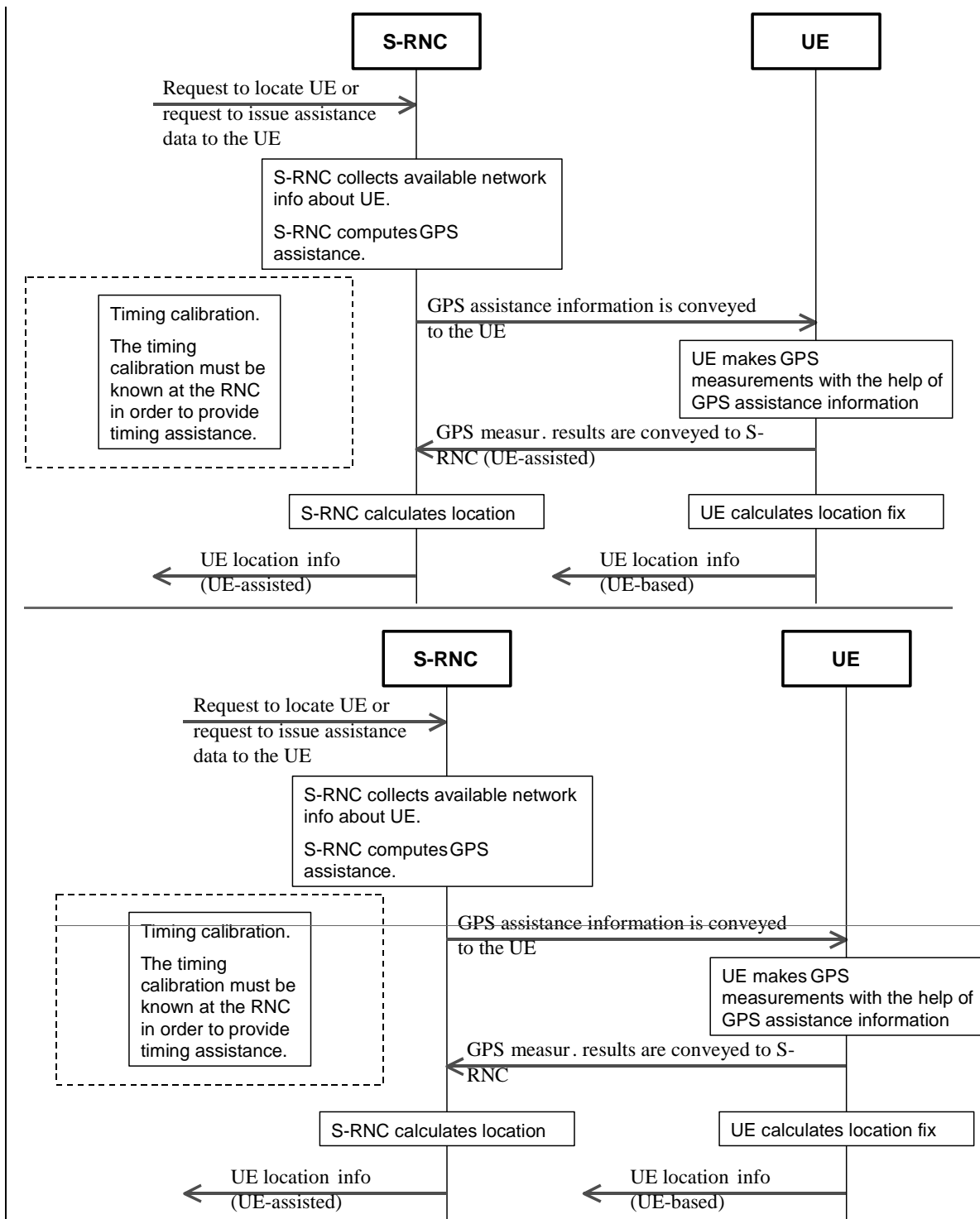
**Figure 10.1: Network assisted GPS methods**

# *** Next Modified Section ***

## 10.5.1   UE-based method

The UE-based method maintains a full GPS receiver functionality in the UE, and the location calculation is carried out by the UE, thus allowing stand-alone location fixes.
If the location was requested by an application in the network, then the calculated location is signalled to the proper network element.
The following information may be signalled from the UTRAN (LSIF) to the UE:

- number of satellites for which assistance is provided;

- reference time for GPS ($T_{UTRAN-GPS}$) (specified in [17] and [18]);

- 3-d reference location (specified in [17]);

- ionospheric corrections;

- satellite ID for identifying the satellites for which the assistance is provided;

- ephemeris and clock corrections to accurately model the orbit of the particular satellite and information when this becomes valid;

- UTC offset;

- DGPS corrections ~~(see Section 10.6 for using one of the IEs for Integrity Monitor)~~;

- almanac data;

- real-time integrity (e.g., a list of unusable satellites).

The following information may be signalled from the UE to the UTRAN (LSIF):
- reference time for GPS (specified in [17] and [18]);

- serving cell information;

- Latitude/Longitude/Altitude/Error ellipse;

- velocity estimate of the UE.~~;~~

- ~~satellite ID for which the measurement data is valid;~~

- ~~Whole/Fractional chips for information about the code-phase measurements;~~

- ~~C/N₀ of the received signal from the particular satellite used in the measurements;~~

- ~~doppler frequency measured by the UE for the particular satellite signal;~~

- ~~pseudorange RMS error;~~

- ~~multipath indicator.~~

**\*\*\* Next Modified Section \*\*\***

## 10.7  Real time integrity~~Integrity Monitor~~

An Integrity Monitor (IM) function ~~at the SRNC~~ should detect unhealthy (i.e., failed/failing) satellites. Excessively large pseudo range errors, as evidenced by the magnitude of the corresponding DGPS correction determined by the IM, ~~should~~may be used to detect unhealthy satellites. Unhealthy satellites should be detected very close to the ~~within 10 seconds of the~~ occurrence of the satellite failure (e.g. 10 seconds) and marked in an unhealthy satellite list as unusable/bad. When unhealthy satellites are detected, the assistance and/or DGPS correction data should not be supplied for these satellites. Upon receiving the list of unhealthy satellites from the SRNC, the UE should discard data associated with these satellites in its positioning calculation.

The IM function should also inform the UE of measurement quality in DGPS modes when satellites are healthy.  When the error in the IM computed position is excessive for solutions based upon healthy satellites only, DGPS users should be informed of measurement quality through the supplied User Differential Range Error (UDRE) adjusted values based on the operation of the IM. Note that UDRE is one of the IEs contained in the DGPS information (~~see 23.331 for details~~[19]).