TSG-RAN Working Group 2 (Radio layer 2 and Radio layer 3)
Yokohama 13h to 16th April 1999

TSGR2#3(99) 226

Agenda Item: 7.8

Source: Nortel Networks

Title: Measurement Requirements for LCS

Document for: Discussion and Liaison

1. Discussion

As part of the development of the report on the Location service (99-225) a number of requirements for measurements by the mobile station (UE) and the base station (node-B) have been identified. These are summarised in section 7 of the report. Although the numerical requirements and some items are still FFS, these items provide a guide for the development of the layer 1 and layer 2 for the UTRAN radio system.

At this time, it is most urgent that these requirements be included in the layer 1 and layer 2 to support the measurements for terminal location calculation. This is necessary to assure that all UE deployed from the beginning support the LCS feature.

The Terminals group is preparing an overview of all Terminal Capabilities, and there will be a review of allelements of the system at the TSG-T WG2 meeting 19-21 April 1999. The Terminals group has therefore formally requested all 3GPP Working Groups to provide an input to the Chairman and Vice-Chairmen of TSG-T by the 15th of April.

2. Proposal

(1) It is proposed that a liaison statement outlining the measurement requirements for the LCS feature be prepared and provided to TSG-T and TSG RAN WG1.

(2) The annex to this contribution provides a draft text by making use of material extracted from the draft LCS feature report. It is proposed that this annex be used as the basis for drafting a liaison document.

Annex

Draft Liaison on measurement requirements for LCS in UTRAN

TSG RAN WG2 has prepared a draft preliminary review of the techniques and operation for a Location Service feature in UTRAN. This work has been undertaken to focus attention on the radio and signalling aspects needed to support this feature. This review has developed some draft preliminary requirements for measurements of the radio signals. A number of items and the numerical requirements are still FFS. This material, however, provides a guide for development of new radio systems. These requirements are outlined later in this document.

The Terminals group has formally requested all 3GPP Working Groups to provide an input on terminal capabilities to the Chairman and Vice-Chairmen of TSG-T by the 15th of April to include in a review of capabilities defined across all elements of the system at the T2 meeting 19-21 April 1999.

TSG RAN WG2 requests that the requirements outlined below for the LCS be considered essential in the development of radio systems and terminal capabilities. Comments are solicited on the proposed LCS techniques and methods of operation. Further details of the proposed LCS methods may be found in the draft report TSG RAN R2-99225.

Measurement Requirements for LCS

Outline of Location technique

The basic technique is based on measurements at the mobile station (user equipment or UE) of the observed time difference of arrival (OTDOA) between the downlink signals received from a number of base stations (the more the better, but at least three are required). These measurements are then sent to the calculation function together with the identity of the base stations. For operation in an asynchronous network, the measurements need to be accompanied by information concerning the time-of-day that they were made. The calculation function will then obtain from the database the surveyed geographic position of the base stations that have been measured. The calculation process also needs to know the relative time difference (termed RTD) of the actual downlink transmissions of each of the base stations. With these three basic inputs, the calculation function may estimate the geographic location of the UE. The estimate, together with the estimate of errors may be returned to the application requesting the location information (LCS Client). This is illustrated in the following figure.

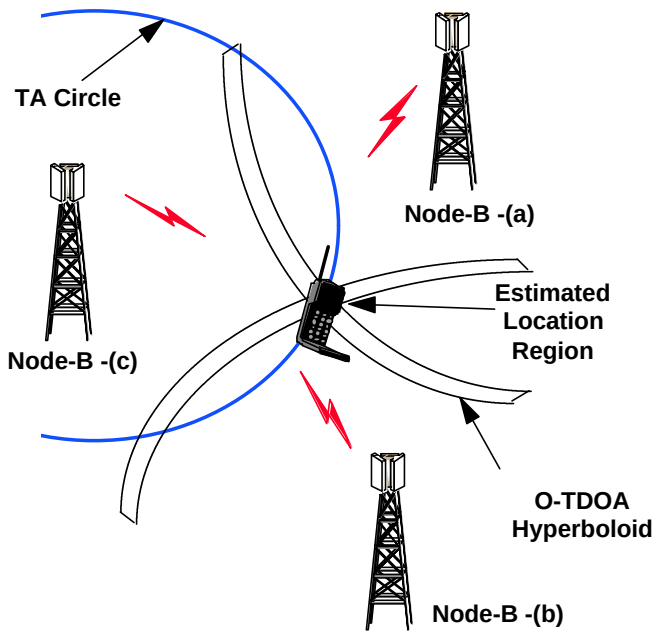

FIGURE Base Stations and the Location Estimate

While the exact downlink signal to be measured by the UE are FFS, it is expected that the synchronisation channel will be one of the signals. This signal is a suitable choice because it is available from all base stations and has been designed for rapid acquisition to facilitate handover operations by the UE. These signals can also be measured by both idle and active UE and may be measured for many base stations, including transmissions from base stations other than the UE's chosen operator. The measurement of the timing difference between the synchronisation signals is also used as part of the handover process to obtain the necessary timing correction required to facilitate soft-handover, or simultaneous transmission of downlink signals, from two or more base stations. This timing measurement, perhaps to a higher degree of accuracy, is suitable for the LCS process. It is expected that some additional elements of hardware and software may be required in the UE to measure and report the LCS OTDOA data. The Timing Advance measurement, made at the serving base station, may also be used to define a range distance from the base station. This information may be used to assist the location calculation in some cases.

Measurements

This section sumarises the general requirements for the measurements to be made by the UE (mobile station) and the base station (node-B) for LCS operation.

UE (mobile station)

Support for OTDOA measurement

The UE shall be able to measure (and report) the observed time difference of the (downlink) synchronization signals from as many base stations as it can receive in the active or idle state. These measurements shall be reported to the highest resolution possible. A resolution of [1/8 chip duration] is suggested as a design goal. The minimum resolution shall be [1/4 chip duration]. It is likely that various UE will have different capability of measurement resolution. These may range from one or more chip times to small fractions of chip times and shall be indicated to the LCS process by appropriate class marks and signalling.

These measurements shall be made for all signals received down to the sensitivity limit of the receiver[1]. As the signals from various base stations will be received at (markedly) different signal levels, the UE shall also report the signal strength of each measurement so that the calculation function may, if it so chooses, apply more weight to the measurements of the stronger signals.

The UE shall also be able to report the time-of-day the OTDOA measurements were made. [The frame number may be a convenient means of denoting time for these measurements. Note that if the UE is unable to return the time-of-day of its measurements, the positioning signal measurement function may use the average of the time the request was sent and the time measurements are returned (half way in-between) as an indication of the time-of-day the measurements were actually made.]

A number of other detailed parameters of the OTDOA measurement must also be specified. These are FFS. The nature of the measurements and their timing in the three operating environments, (vehicular, outdoor pedestrian and indoor) are FFS.

Support for TA measurement

In order to support the use of the TA measurement to assist the location service, the UE shall provide a resolution of [1/4 chip] time, or less, in the measurement and timing of its transmissions. The jitter in the upstream transmission timing for shall also be less than this value. If the UE is capable of better resolution (e.g. 1/4, 1/8 1/10 chip duration) this capability shall be indicated to the LCS process by means of a class mark and signalling.

A number of other detailed parameters to support the TA measurement must also be specified. These are FFS.

[1] It may not be necessary to measure quite all the received signals. At least the three strongest should be measured, together with as many others as may provide reliable measurements.

Node-B (base station)

TA Measurement

The node-B shall be capable of measuring the round trip delay (or 1/2 that for one way delay (OWD) for its active UE. The accuracy of this measurement depends on the combination of the resolution of the measurement at the Node-B and the resolution in transmission at the UE. The Node-B shall be capable of a resolution of measurement of less than [1/2 chip duration]. Various Node-B may be capable of better resolution (e.g. 1/4, 1/8 1/10 chip duration) and this capability shall be indicated to the LCS process by the node-b through a class mark and signalling.

A number of other detailed parameters to support the TA measurement must also be specified. These are FFS.

Frequency offset

In order to constrain the rate at which the RTD drifts between asynchronous base stations, the maximum frequency difference between base stations involved in the LCS shall be limited to less than [$\pm 10^{-9}$] [Other considerations may constrain the frequency difference to a smaller range than this.] The frequency stability of each Node-B shall be denoted by a class mark and made available to the LCS process through signalling.

A number of other detailed parameters for the frequency offset must also be specified. These are FFS.

Survey location

The geographic location of the Node-B transmit antenna radiating centre shall be surveyed to an accuracy of better than [±3 metres] in horizontal and vertical directions. This represents a timing uncertainty of [±10] nanoseconds.

These coordinates shall be made available to the database and the calculating functions. More accurate coordinates may also be made available. The improved accuracy shall be indicated to the LCS process by means of a class mark and signalling.

If the base station is making use of diversity transmissions, the coordinates of each antenna radiating centre shall be measured and made available to the database and the calculation functions. The location calculation function may use the time of measurement of the downlink signals to determine which antenna location was used.

Relative Time Difference (RTD)

To achieve the desired accuracy in the location estimates, the RTD needs to be known to (at least) the same level of accuracy as the OTDOA measurements. Whether the downlink transmissions are synchronised or their time offset measured, the timing offsets shall be reported to the highest resolution available. A resolution of [1/8 chip duration] is suggested as a design goal. The minimum resolution shall be [1/4 chip duration]. It is likely that

various node-B will have different capability of measurement resolution. These may range from one or more chip times to small fractions of chip times and shall be indicated to the LCS process by appropriate class marks and signalling.

If the timing of transmissions at the base stations is synchronised, so that the RTD is maintained approximately constant, the maximum jitter in the transmission timing shall not exceed [1/8 chip duration].

The RTD measurement shall also be able to report the time-of-day the measurements were made. [The frame number may be a convenient means of denoting time for these measurements.]