

Agenda Item: Ad-Hoc-17

Source: Nortel networks

Title: Measurements for Location services to be supported in release 99 specifications

Document for: Discussion & Action

1 Summary

This contribution proposes standard measurements to be used for the location service to be supported in release 99 specifications for UTRAN. The primary measure is of the observed time difference of arrival (OTDOA) of UTRA signals received at the UE. As sufficient downlink signals may not always be available, a secondary measure is also provided. The secondary measure is of the round-trip-time (RTT) for the transmissions between the serving transmitter and the UE. These measurements are sent to a position calculation function in the serving RNC where the calculation of the UE's location is performed. These measurements are considered equally applicable to FDD and TDD modes.

This is proposed to be the basis for the LCS for release 99, and text is proposed in this contribution for addition to document 25.231.

2 Proposal

It is proposed that the following text be added to document 25.231. The proposed section numbers follow those of the 25.231 V0.3.1.

In Section 4 References :

4 References

[mn] 3GPP RAN 25.923 Report on Location Services (LCS)

In section 5 Measurements in idle mode:

5.3 Measurements for Location Services

The general operation for measurements for the Location Service (LCS) is outlined in sub-section 7.7.1.

In the idle mode, the UE shall be able to measure the observed time difference of the (downlink) pilot signals. The measurement process by the UE is triggered by an internal UE operation (e.g. power on or change of cell) while in the idle state. The carriers to be measured shall include those in the "cell reselection and monitoring set" and those in the "cell selection set". The measurements shall be as outline in sub-section 7.7.2.1.

In section 7 Measurements in connected mode:

7.7 Measurements for Location Services (LCS)

7.7.1 Operation

The standard OTDOA-RTT location method involves measurements of the UTRA radio transmissions made by the UE and the Node-B (or LMU). These measures are then sent to a Position Calculation Function (PCF) in the Serving RNC where the location of the UE is calculated (see reference [nn]). As the location estimate is derived from timing measures, these must be made to sufficient resolution to achieve the desired accuracy. A 50 metre uncertainty in distance requires a total timing uncertainty of less than 150 nanoseconds¹. This is about ½ chip time. The measures for LCS are similar to those performed by the UE for handover with, perhaps, a finer resolution of timing measurement.

The primary standard measurements are of the observed time difference of arrival (OTDOA) of downlink signals received at the UE. 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 by the PCF to calculate an estimate of the position of the UE. Each OTDOA measurement for a pair of downlink transmissions describes a line of constant difference (hyperbola) along which the UE may be located. The UE's position is determined by the intersection of these lines for at least two pairs of transmitters. In most cases these measurements will be sufficient.

Under some circumstances, a sufficient number of downlink signals may not always be available. In these cases, a secondary measure is provided. The secondary measure is of the Round-Trip-Time (RTT) for transmissions between the serving transmitter and the UE. This measurement defines a line (arc) of constant distance (radius) from the transmission site in the sector served. This measure may be used to supplement the TDOA measurements with the location of the UE being the intersection of the arc from the serving transmitter and the line of constant difference (hyperbola) between the serving and second transmitter sites.

In the event that sufficient primary measures are available, the secondary measure is not needed. However, with the use of the secondary measure, the location may be estimated even if the UE can only receive transmissions from two transmitters. Studies of the pilot-to-carrier interference ratio for a number of environments have shown a 94% coverage availability for at least one other pilot. The use of the OTDOA-RTT technique thus permits availability of the LCS in the majority of the coverage area. In the remainder of the cases, the UE is typically very close to the serving Node-B transmitter and its receiver is blocked by the strong local signals. In these cases the UE may be so close to the transmitter that no other location information is needed beyond the RTT distance and sector estimate. If this is not sufficient, then measurements may be made on other carriers or by other techniques such as the IS-DL described elsewhere in reference [nn].

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 minimize the uncertainty in the LCS result, it is important that as many measurements of OTDOA and RTT as

¹ As the total uncertainty has contributions from a number of measures, the resolution of individual measurements must be much better than this to achieve the desired accuracy of result.

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.

7.7.2 Measurements

This sub-section summarises the requirements for the measurements to be made by the UE (mobile station) and the base station (Node-B) for the basic LCS operation described in sub-section 7.7.1.

7.7.2.1 UE (mobile station) Support for OTDOA measurement

The UE shall be able to measure the observed time difference of the (downlink) pilot signals for carriers it can receive. 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 measured resolution shall be [1/4 chip duration]. The resolution of the measurements shall be indicated to the LCS process by appropriate signalling² together with the measurements. The UE shall make these measurements when requested by the network, or autonomously prior to making a request for location information. These measurements may be made in the connected or the idle state.

The carriers to be measured shall include those in the “cell reselection and monitoring set” and those in the “cell selection set”. Should these lists be empty, the measurements shall be made for all signals received above the sensitivity limit of the receiver³. As the signals from various base stations will be received at (markedly) different signal levels, the UE shall also measure the signal strength of each measurement to assist the calculation function (e.g. to apply more weight to the measurements of the strongest signals).

The UE shall also report the time-of-day the OTDOA measurements were made. [The system frame number of the serving Node-B may be a convenient means of denoting time for these measurements. The UE may otherwise report time-of-day in another format agreed with the LCS process.]

For each measured signal the UE shall report :

- Timing difference with relation to the pilot signal of the serving transmitter (1/8 chip resolution);
- Signal Strength of measured pilot (dBm)
- The Time-of-day of the measurements (system frame number of serving transmitter);
- Frequency offset of pilot carrier (0.01 Hz);
- Resolution of the timing measurement (1 / fraction of chip duration)

7.7.2.2 UE Support for Round Trip Time (RTT) Measurement

In order to support the use of the RTT 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 uplink transmissions. The frame timing of the uplink transmissions shall be maintained within this resolution with reference to an offset from the received downlink frame timing. The jitter in the

² The signalling between the UE and the UTRAN LCS entities is beyond the scope of this document.

³ 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.

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 appropriate signalling.

7.7.2.3 Node-B Support for Round Trip Time (RTT) Measurement

The Node-B shall be capable of measuring the Round Trip Time (RTT) (or 1/2 that for one way delay (OWD)) for its active UE. This measure is based on the delay between reference frame timing of the transmitted downlink transmissions and the frame arrival time of the UE's transmissions. This measure shall be made to resolution of less than [1/4 chip] duration or better. The resolution of the measurement (e.g. 1/4, 1/8 1/10 chip duration) shall be indicated to the LCS process by the Node-B through appropriate signalling when the measurements are reported.

For each measured signal the Node-B shall report :

- Round-Trip-Time with relation to its transmission for selected UE (1/8 chip resolution);
- Signal Strength of measured signals (average dBm)
- The Time-of-day of the measurements (system frame number of serving transmitter);
- Frequency offset of UE carrier (0.01 Hz) from carrier reference of Node-B;
- Resolution of the timing measurement (1 / fraction of chip duration)