TSG-RAN Meeting #12 ***RP-010411***
Stockholm, Sweden, 12 - 15 June 2001

Subject: **Status of UE positioning**

Source: **TSG-RAN WG2**

Document for: **Information**

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1 General

During RAN meeting #11 RAN2 was requested to provide a status of UE positioning for RAN meeting #12. This document shall provide an overview on the status of UE positioning in UTRAN.

At the moment three different positioning methods are specified for both TDD and FDD:

- cell ID based method
- OTDOA with/without configurable IPDLs
- Assisted GPS

In general position calculation may be performed in the UE or in the network, which is referred to as UE based and UE assisted positioning, respectively.

Regarding UE Positioning in UTRAN, the import requirement is the required accuracy. According to the stage 1 description (TS 22.071) the following requirements regarding accuracy should be fulfilled:

Horizontal Accuracy:

”The required location accuracy varies from 10m up to 1km, depending on applications. The location determining process may be able to combine several techniques to accommodate local conditions and evolving technology. The accuracy provided as a result of a given positioning attempt may vary depending on dynamically changing radio conditions and other factors.”

Vertical Accuracy:

“The vertical accuracy may range from a about ten metres (e.g. to resolve within 1 floor of a building) to hundreds of metres.”

In the following the status of each of these methods is analysed regarding

- achievable accuracy
- measurements and specified accuracys
- signalling support on Uu, Iub and Iur
- Optional and mandatory features
- testing aspects

2 Cell ID based method

2.1 Accuracy

The achievable accuracy depends on the cell size and whether additional measurements like Round Trip Time are used for position calculation. The accuracy may vary from 100 metres up to several kilometres.

2.2 Measurements

For FDD the RTT and Rx-Tx time difference type 1 measurement may be used in order to improve the accuracy of the position.

In TDD, the applied Timing Advance and Rx timing deviation measurement may improve the accuracy of the position estimate.

For RTT/Rx-Tx time difference type 1measurements a minimum accuracy of 1.5 chips is specified. For the Rx timing deviation measurement, a minimum accuracy of 0.5 chips is specified by RAN WG4.

2.3 Signalling

2.3.1 Uu interface

In case of cell ID based positioning, the position is always calculated in the network. Signalling support for the UE measurements Rx-Tx time difference in case of FDD and applied TA in case of TDD exits. UE Rx-Tx time difference type 1 measurement may be reported from UE to network with a resolution of $1/16^{th}$ of a chip. However, up to now it is not possible to indicate the actual measurement accuracy to RNC.

2.3.2 Iub interface

On Iub, RNC has to be able to request RTT or Rx timing deviation measurements, which are then reported back to RNC. At the moment the measurements may be reported with a resolution of $1/16^{th}$ of a chip. However, up to now it is not possible to indicate the actual measurement accuracy to RNC.

2.3.3 Iur Interface

In case the SRNC is not the CRNC of the serving cell of a particular UE, the SRNC should be able to request RTT or Rx timing deviation measurements from CRNC. The reporting resolution is the same as on the Iub interface and again there is no way to indicate the actual measurement accuracy up to now.

2.4 Optional and Mandatory features

Cell ID based method is basically a network based method. However, the method is not mandatory for the network. As already stated the accuracy of this method may be improved by using additional measurements which are already mandatory for both UE and network

2.5 Testing aspects

Test cases are currently being specified within RAN WG2 and T WG1.

3 OTDOA with/without configurable IPDLs

3.1 Accuracy

The achievable accuracy depends on the environment. The accuracy may vary from 20 metres up to several hundred metres.

3.2 Measurements

For both FDD and TDD, the SFN-SFN observed time difference type 2 measurement is the basis of this method. Additionally the time difference of downlink transmission (RTD) of different cells needs to be known for position calculation. Besides, RTT and Rx-Tx time difference type 2 measurements in case of FDD or applied timing advance and Rx timing deviation in case of TDD could be used to improve accuracy of the position estimate.

In order to determine the relative time difference of downlink transmissions (RTD), either the UTRAN SFN-SFN observed time difference measurement type 2 measurement or the GPS timing of cell frames measurement may be used. GPS timing of cell frames measurement may basically be performed by either UE or Node B. However at the moment the UE is not able to report the measurement results with sufficient accuracy (see signalling on Uu interface).

RTT and Rx timing deviation were already discussed for the cell ID based method. For OTDOA the UE may perform Rx-Tx time difference type 2 measurement with a minimum specified accuracy of ½ of a chip for intra-frequency and 1 chip for inter-frequency measurements.

For both UTRAN and UE SFN-SFN observed time difference type 2 measurement, a minimum requirement is specified by RAN WG4 of ½ of a chip for intra-frequency and 1 chip for inter-frequency measurements.

For the UTRAN GPS timing of cell, three different accuracy classes were specified by RAN WG4 One with a minimum accuracy of +/- 5ms (or +/- 20000 chips) and another one with an accuracy of +/- 5 us (+/- 20 chips). The third accuracy class with an even lower minimum accuracy will be used for RTD determination, but the minimum requirement is not yet specified. For the UE GPS timing of cell frames measurement, no minimum accuracy is specified yet.

In order to improve performance of this method Idle Periods in Downlink (IPDLs) may be configured. During the Idle Periods, downlink transmission is ceased within the serving cell, making it easier for the UE to measure neighbouring cells.

3.3 Signalling

3.3.1 Uu interface

The Uu interface is already completely specified for this method, including IPDLs. UE and UTRAN SFN-SFN observed time difference type 2 measurement may be reported with a resolution of $1/16^{th}$ of a chip. The achieved accuracy of the SFN-SFN observed time difference type 2 measurement may be signalled as standard deviation in steps of 10, 20 or 30 metres.

The minimum resolution for signalling the GPS timing of cell frames is 1 us. This makes it impossible to use UE GPS timing of cell frames measurement for estimating the RTD. Besides, up to now it not possible to indicate the GPS timing of cell frames measurement accuracy.

3.3.2 Iub interface

On Iub, RNC has to be able to request UTRAN SFN-SFN observed time difference type 2 and GPS timing of cell frames measurements, which are then reported back to RNC. Besides signalling support for configuration of IPDLs is already specified. For the SFN-SFN time difference measurement, the resolution is the same as on the Uu interface. The achieved accuracy of the SFN-SFN observed time difference type 2 measurement may be signalled as standard deviation in steps of 0.0625 chips.

GPS timing of cell frames measurements may be reported with a resolution of $1/16^{th}$ of a chip. Reporting is done by using standard deviation in steps of 0.0625 chips and possibly the accuracy classes specified in RAN WG4.

3.3.3 Iur Interface

In case the SRNC is not the CRNC of the serving cell of a particular UE, the SRNC should be able to request UTRAN SFN-SFN observed time difference type 2 and GPS timing of cell frames measurements from CRNC.

Necessary signalling support is already specified. SRNC is also able to request IPDL configuration from CRNCs in order to indicate them to the UE.

The reporting resolution and accuracy indication of the SFN-SFN observed time difference type 2 measurement is the same as on the Iub interface.

The GPS timing of cell frames measurement may be reported with a resolution of $1/16^{th}$ of a chips and also indication of the accuracy class is supported.

3.4 Optional and Mandatory features

UE assisted OTDOA is mandatory for all UEs, meaning that all UEs need to support the SFN-SFN observed time difference type2 measurement and the corresponding signalling for reporting the measurement results to the network. OTDOA is not mandatory for the network. Idle Periods in Downlink are optional for both UE and network. GPS timing of cell frames measurement is optional for both UE and network.

The Rx-Tx time difference type 2 measurement is an optional measurement but it is not possible so far to signal it as a UE capability. It is currently investigated in RAN WG2 if a change to the UE capabilities is necessary.

4.4 Testing aspects

Test cases are currently being specified within RAN WG2 and T WG1.

4 Assisted GPS

4.1 Accuracy

The achievable accuracy with Assisted GPS is about 10-15 metres, when applying Differential corrections the accuracy can be improved up to just a few metres.

4.2 Measurements

The measurements are performed by GPS receivers within the UEs, NodeBs and LMUs. The only UTRAN related measurements are UE and UTRAN GPS timing of cell frames measurements.

As already stated for OTDOA there are three accuracy classes defined for the UTRAN GPS timing of cell frames measurement.One with a minimum accuracy of +/- 5ms (or +/- 20000 chips) and another one with an accuracy of +/- 5 us (+/- 20chips). The minimum accuracy of the third accuracy class is not specified yet.

For the UE GPS timing of cell frames measurement no minimum accuracy is specified yet.

4.3 Signalling

4.3.1 Uu interface

Regarding signalling of UE GPS timing of cell frames measurement, please refer to 3.3.1. Signalling for A-GPS e.g. for providing assistance data to the UE, report GPS measurements etc. is already specified.

4.3.2 Iub interface

On Iub, RNC is able to request GPS timing of cell frames measurement, which are then reported back to RNC. Additionally the current specifications also enable the RNC to request GPS assistance data from NodeB. Regarding resolution and accuracy indicators, refer to 3.3.2.

4.3.3 Iur Interface

In case the SRNC is not the CRNC of the serving cell of a particular UE, the SRNC should be able to request UTRAN GPS timing of cell frames measurement from CRNC. A RNC may also request GPS assistance data from another RNC. Regarding resolution and accuracy indicators, refer to 3.3.2.

4.4 Optional and Mandatory features

UE assisted and UE based Assisted GPS is optional for both UE and network. In case a UE supports A-GPS it may only support UE assisted or UE based or both. Even if A-GPS is supported by either UE or network, the GPS timing of cell frames measurement is optional.

4.4 Testing aspects

Test cases are currently being specified within RAN WG2 and T WG1.