Presentation of Specification to TSG or WG

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Abstract of document:

The present document identifies and describes UE positioning methods for use with the 1.28 Mcps TDD option and methods for their enhancements. It should provide the basis for the evaluation and comparison of these methods. The report covers the impact of the positioning methods and their potential enhancements on the layer 1 and UTRAN interfaces.

Changes since last presentation to TSG-RAN Meeting:

This is the first presentation of the TR to RAN.

Outstanding Issues:

Impact on specifications to be determined. CRs to affected specifications to be created based on this TR.

Contentious Issues:

None.

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Technical Report

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Contents

Foreword

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

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

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 identifies and describes UE positioning methods for use with the 1.28 Mcps TDD option and methods for their enhancements. It should provide the basis for the evaluation and comparison of these methods. The report covers the impact of the positioning methods and their potential enhancements on the layer 1 and UTRAN interfaces.

Change Requests to affected specifications should be created based on this TR.

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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 25.305: "Stage 2 Functional Specification of UE positioning".

[2] 3GPP TR 25.847: "UE positioning enhancements (Release 4)".

[3] 3GPP TR 25.331: " RRC Protocol Specification (Release 4)".

[4] 3GPP TR 25.990: "Vocabulary for the UTRAN".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [4] apply.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

DwPCH	Downlink Pilot Channel
DwPTS	Downlink Pilot Timeslot
IPDL	Idle Period Downlink
NBAP	Node B Application Part
OTDOA	Observed Time Difference of Arrival
RNSAP	Radio Network Subsystem Application Part

4 Background and Introduction

'UE Positioning Enhancements for 1.28 Mcps TDD' is a release 5 work item that was agreed at the RAN#11 plenary meeting. Its purpose is to define UE positioning methods that are appropriate to the 1.28 Mcps TDD option. It is envisaged that these will be based on the methods that have already been defined for the 3.84 Mcps TDD option and FDD [1] in earlier releases, modified, if necessary, to take account of the characteristics of the 1.28 Mcps TDD physical layer. In addition, enhancements to these methods or new methods may be identified that exploit particular characteristics of the 1.28 Mcps TDD physical layer, for example angle of arrival estimation from adaptive antennae.

This document will provide a description of the positioning methods that are proposed and accepted for this work item. It will also identify the changes that are required to WG2 documents to enable the adoption of the accepted methods into the 3GPP standards. Emphasis will be placed on the reuse of existing functionality. It also identifies the impact of the methods and their enhancements on the physical layer and UTRAN interfaces.

5 Applicability of UE positioning methods from Release 4

5.1 Cell Id based UE positioning

The Cell Id based method of UE positioning described in [1] can be implemented with the 1.28 Mcps TDD.

The characteristics of the Cell Id method can be summarized in [1] as:

The identification of UE location is determined by SRNC. Where the only information related to the UE position is the cell identity of the serving cell, the cell identity must be converted, dependent upon what has been requested by the CN, into either a geographical position or a Service Area Identifier, or both. This conversion can be completed by the SRNC, in a Network Management System or through the co-operation of a number of access network elements.

If the UE is operating in a state where the cell identity is known to the SRNC, then this can form the basis of the UE position identification. If the UE is not in a state where a SRNC knows the cell identity, the UE can be forced to make a transition to a suitable state. The transition is initiated by paging the UE. The paging may be initiated by the CN (UE in idle mode) or by the SRNC (UE in URA_PCH state).

In the case of 1.28 Mcps TDD, the accuracy of the cell identity based UE position calculation can be improved by combining it with timing advance and/ or its transmissions estimated angle of arrival. The path loss based options identified in [1] can also be applied.

Adaptive (smart) antenna systems are a proposed feature of the 1.28 Mcps TDD. Where a Node B deployment includes adaptive antennae systems, it would be possible for the SRNC to request that angle of arrival measurements are made on the UE transmissions. This information can then be used to improve the cell Id based position estimate.

5.2 OTDOA based UE positioning

The 1.28 Mcps TDD is able to support OTDOA based UE positioning using a similar method and the same scheme for the specification of IPDL idle periods to that has been defined for 3.84 Mcps TDD[1]. Differences are limited to the neighbour cell attributes that are measured and the parameters of the IPDL scheme.

The primary standard measurement for OTDOA position estimation is the 'SFN – SFN' observed time difference between cell transmissions. For the 1.28 Mcps TDD, the transmitting Node B would send its normal SYNC-DL sequence in the DwPCH. The neighbouring Node Bs measure this sequence in their DwPTS, therefore the DwPTS has to be blanked in the neighbouring cells for certain sub-frames to allow the measurement of the transmitting Node B. The scheduling of the blanking is controlled by the RNC. Thus, the UE can also make use of this blanked period to measure 'SFN – SFN' observed time difference from the serving Node B and neighbouring Node Bs' DwPCH with the same scheduling of the blanking used as IPDLs (for the DwPCH only). The IPDL scheme for the 1.28 Mcps takes account of the fixed slot that is used for DwPTS transmissions and the fact that each 10 ms frame contains two 5 ms sub-frames.

The principles of OTDOA based position estimation, for the 1.28 Mcps TDD are the same as those that have been defined for FDD and 3.84 Mcps TDD, they can be summarized as follows:

The UE position may be calculated in the UE (UE-based mode) or in the SRNC (UE-assisted mode). In the former case the UE must be provided with additional information such as the position of the measured Node B's. In the latter case, the UE signals the measurement results to the network where the SRNC calculates its position.

The position calculation procedure is initiated when SRNC receives a location request from the core network. The UE is then requested to make OTDOA measurements by the SRNC by a Measurement Control message. If the calculation is UE assisted then the UE will report the results in one or more Measurement Report messages. The measurements and measurement report can only be made with the UE in connected CELL_DCH state.

The accuracy of the OTDOA based position calculation can be enhanced by taking account of timing advance that is applied by the UE to its uplink transmissions and/or angle of arrival measured on the UE's transmissions.

Because, in the 1.28 Mcps TDD, the aggregate timing advance applied by the UE is not known in the UTRAN, it must be requested from the UE by the SRNC.

Adaptive (smart) antenna is a proposed feature of the 1.28 Mcps TDD. This offers the potential of improving the accuracy of OTDOA based position calculations through the inclusion of angle of arrival estimates in the position calculation.

5.2.1 OTDOA IPDL for 1.28 Mcps TDD

The hear-ability problem, whereby it is difficult for a UE to measure neighbour cells because of interference from its serving cell can, in principle, occur in the 1.28 Mcps TDD. To compensate for this the optional use of IPDL idle periods for DwPTS within 1.28 Mcps TDD cells can be adopted. The procedure for calculating DwPTS idle periods is described in section 8.1.

5.3 Network-assisted GPS

Network-assisted GPS is among the standard positioning methods supported within UTRAN.

Ref [1] describes the operation of network-assisted GPS methods for 3.84 Mcps TDD and FDD in earlier releases.

As the network–assisted GPS methods are independent of the radio technology, they can be adopted unchanged for 1.28 Mcps TDD.

The following descriptions are used only as a reference, the details are depicted in [1].

5.3.1 Network-assisted GPS methods for 3.84 Mcps TDD

In brief:

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; positioning 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.

There are 2 methods of network-assisted GPS, UE-based and UE-assisted.

In the UE-based method, calculation of the UE position is done in the UE, using UE GPS measurements enhanced by data from the UTRAN. The data may include reference time for GPS, satellite IDs, satellite position information. The UE-based method maintains a full GPS receiver functionality in the UE, and the position calculation is carried out by the UE, thus allowing stand-alone position fixes. A full description of the data sent to the UE is given in ref [1]

In the UE-assisted method, calculation of the UE GPS position is done in the RNC, with the UE providing information on GPS satellite pseudo-ranges, and other information as specified in [1]. The calculation can take place in the RNC, or may be carried out in a separate entity, the stand-alone A-GPS SMLC (SAS), which communicates with the RNC.

The GPS information is transmitted to the UE either in the BCCH as System Information, or by dedicated signalling in a RRC Measurement Control Message. The details of System Information and IEs are depicted in [3].

5.3.2 Network-assisted GPS methods for 1.28 Mcps TDD

Network–assisted GPS methods can be adopted unchanged for 1.28 Mcps TDD

6 UE positioning methods not from Release 4

6.1 Angle of arrival enhanced positioning

The angle of arrival methods of UE positioning described in [2] can also be used in 1.28 Mcps TDD, taking account of the characteristics of the physical layer of 1.28 Mcps TDD, in addition, enhancements to this method, angle of arrival enhanced positioning, may be identified.

The characteristics of angle of arrival positioning method can be summarized as:

Angle of arrival positioning can make use of a knowledge of the sector, which the base station has used for receiving and transmitting to the UE, to estimate its location region and assist in resolving some ambiguity in other techniques.

Adaptive (smart) antenna systems are a proposed feature of the 1.28 Mcps TDD option. Where adaptive antennae are employed, the angle of arrival of the UE transmissions and hence its location region can be estimated with greater accuracy than can be obtained from a simple sector method. In addition, angle of arrival and UE range, estimated from the uplink timing advance applied by the UE, can be combined to provide a much-improved estimate of the UE's position. The combination of angle of arrival and UE range will also provide a method of position calculation that does not impact on system operation and has minimal impact on the UE capability requirements.

7 UTRAN UE positioning architecture

UTRAN UE Positioning Architecture that has been defined for 3.84Mcps TDD can be adopted for use with 1.28 Mcps TDD with no modification.

8 Impact on layer 1

8.1 OTDOA location method in 1.28 Mcps TDD

8.1.1 Impacts of Idle Periods

8.1.1.1 General

To support time difference measurements for location services, idle periods can be created in the downlink (hence the name IPDL). During these idle periods, the visibility of neighbour cells from the UE is improved. It is reasonable to choose a time slot in a way that impacts on the system is minimum. It is proposed to use the DwPTS for this purpose. The scheduling of the blanking is controlled by the RNC like FDD and 3.84 Mcps TDD.

The UE can listen to the DwPCHs of serving Node B and neighbouring Node B by making use of the IPDLs. With the received time difference (OTDOA) of the DwPCH, UE can carry out the position calculation (UE-based mode), or report the received arrival time difference of several cells and signals of the measurement results to the network, then SRNC will figure out the position of the UE (UE-assisted mode). By means of higher layer signalling (e.g. channel reconfiguration) it may be possible to shift all transmission during an idle period to other slots in order to prevent the loss of data.

In general there are two modes for these idle periods:

- Continuous mode; and
- Burst mode.

In continuous mode the idle periods are active all the time. In burst mode the idle periods are arranged in bursts where each burst contains enough idle periods to allow a UE to make sufficient measurements for its location to be calculated. The bursts are separated by a period where no idle periods occur.

Activities are ongoing in TSG-RAN WG1 on IPDL.

8.1.2 Parameters of IPDL

The following parameters are signalled to the UE via higher layers:

- **IP_Status:**
  This is a logic value that indicates if the idle periods are arranged in continuous or burst mode.
- **IP_Spacing:**
  The number of 10 ms radio frames between the start of a radio frame that contains an idle period and the next radio frame that contains an idle period.

NOTE: There is at most one idle period in a radio subframe.

- **IP_Start:**
  The number of the first frame with idle periods.
- **IP_Sub:**
  Indicates whether the idle period is to occur in the odd, the even or both the odd and even 5 ms sub-frames of the 10 ms idle frame.

Additionally in the case of burst mode operation, the following parameters are also communicated to the UE.

- **Burst_Start:**
  The SFN of the first burst of idle periods.
- **Burst_Length:**
  The number of idle periods in a burst.
- **Burst_Freq:**
  The number of radio frames between the start of a burst and the start of the next burst.

8.1.3 Calculation of idle period position

In burst mode, the first burst starts in the radio frame with SFN = Burst_Start. The *n*th burst starts in the radio frame with SFN = Burst_Start + $n \times$Burst_Freq. The sequence of bursts according to this formula continues up to and including the radio frame with SFN = 4095. At the start of the radio frame with SFN = 0, the burst sequence is terminated (no idle periods are generated) and at SFN = Burst_Start, the burst sequence is restarted with the first burst followed by the second burst etc., as described above.

Continuous mode is equivalent to burst mode, with only one burst spanning the whole SFN cycle of 4096 radio frames. In case of continuous mode the parameter IP_Start defines the first frame with idle periods. Assume that IP_Frame(x) is the frame with the idle period number x within a burst, where x = 1, 2...,

The time slot that has to be idle is defined by two values: IP_Frame(x) and IP_Sub. IP_Frame(x) defines the x^{th} frame within a burst in which subframe with the number IP_Sub has to be switched off.

The actual frame with idle periods within a burst is calculated as follows:

$$\text{IP\_Frame}(x) = \text{IP\_Start} + (x-1) \times \text{IP\_Spacing with } x = 1, 2, 3, ...$$

NOTE: x is reset to 1 for the first idle period in every burst.

Figure 8.1 below illustrates the idle periods for the burst mode, which shows the case that both subframes within each frame have DwPTS as an idle period.

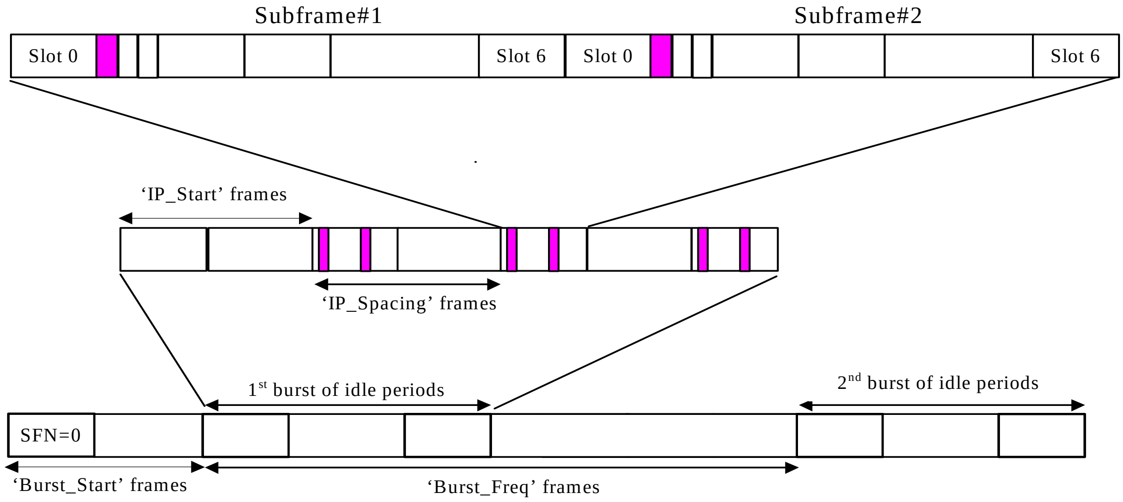

Figure 8.1: Idle periods of burst mode for 1.28Mcps TDD

8.2 Angle of arrival enhanced positioning

To enable methods of UE positioning that make use of the angle of arrival of UE transmissions, Node B should, optionally support angle of arrival measurement. These measurements are made on UE's transmissions using a simple sector or adaptive antennae, where the Node B implements adaptive (smart) antennae systems. The parameters of these measurements are ffs.

9 Impact on UTRAN interfaces

9.1 OTDOA location method

9.1.1 Impacts of Idle Periods

In order to avoid overlapping IPDLs of neighbouring cells that are associated with different RNCs, the RNCs should co-ordinate their IPDL configurations via RNSAP signalling.

Additionally, Node B has to be configured in order to support IPDLs and therefore the IPDL parameters have to be supplied from CRNC to Node B via NBAP signalling.

Only differences concerning the exact parameters are foreseen compared to the existing mechanisms specified for FDD and 3.84 Mcps TDD in Release 4.

9.2 Angle of arrival enhanced positioning

Angle of arrival enhanced positioning makes use of angle of arrival measurements made by Node B. UTRAN interfaces should enable the requesting of these measurements by SRNC and their reporting by Node B. The information elements required and their parameters are ffs.

10 Impact on Specifications

Annex A:
Change history

Document history		
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August, 2001	0.1.0	Sections updated according to RAN2#22
September,2001	1.0.0	Revised version for RAN#13
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NOTE: The table above will be deleted when this TS is presented to the TSG-RAN plenary in version 2.0.0 and be replaced by the table below.

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**