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Title: **Draft TR on " NodeB Synchronisation for TDD"**

NodeB Synchronisation for TDD is an agreed work item for Release 2000. The attached document is a draft for the TR to be issued on this topic.

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Technical Report

3rd Generation Partnership Project;
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3GPP

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

Contents

Foreword

This Technical Specification 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

This TR describes the solution recommended to enable the synchronisation of NodeBs in UTRA TDD beyond that included in Rel. 99.

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.

[<seq>] <doctype> <#>[([up to and including]{yyyy[-mm]|V<a[.b[.c]]>}[onwards])]: "<Title>".

[1] 3G TS 25.123: "Example 1, using sequence field".

[2] 3G TR 29.456 (V3.1.0): "Example 2, using fixed text".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

***<defined term>**: <definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:
Symbol format

<symbol> <Explanation>

3.3 Abbreviations

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

<ACRONYM> <Explanation>

4 Background and Introduction

NodeB synchronisation for TDD is a release 2000 work item that was agreed in RAN#7 plenary meeting. This work item involves the introduction of functionality to enable nodeBs to be synchronised.
This report identifies the required modifications within the UTRA layers 1/2/3. Emphasis must be put on the fact that it is tried to reuse existing functionality as much as possible for enabling the nodeB synchronisation for

TDD. The methods described are in addition to the Rel. 99 feature of the synchronisation port described in TS 25.402.

5 Motivation

Cell synchronisation is planned for UTRA TDD in order to fully exploit the system capacity. There are several factors, that have an impact on the system capacity. The most important ones are:

- Inter-slot interference: without frame synchronisation there could be leakage from an UL timeslot into a DL timeslot, especially crucial for the UE due to the potentially close distance between UEs and the near-far effect.
- neighbouring cell monitoring: In TDD mode, certain measurements have to be performed in certain parts of certain timeslots of neighbouring cells. Without cell synchronisation, the UE would have to synchronise itself before being able to perform the measurements.
- Handover: The TDD mode may use timing advance in order to align receptions from all UEs at the cell's receiver. After a handover, the UE has to start transmission in the new cell with a timing advance value as good as possible. With the assumption, that the TDD cells are synchronised to each other, the handover performance can be optimised.

6 Accuracy Requirements

Several issues have been identified as of key importance in determining the accuracy requirements that the solution for synchronisation between cells should fulfill:

1) Impact of Time Error on Inter Slot Interference
2) Impact of Time Error on Timing Advance Adjustment for handover
3) Impact of Cell Timing Adjustments on UE receive and tracking performance

The detailed value for cell synchronisation accuracy in order to minimise the above impacts on the system performance is not defined yet, but could be in the area of ±1...3 µs.

In addition to the above requirement the chosen solution should provide the option, that the accuracy can be enhanced, e. g. via more frequent measurements.

7 General Concept of Node B Synchronisation

7.1 General

The different solutions to achieve synchronisation in TDD can be grouped into two main classes:

- Synchronisation of nodes Bs to an external reference via the synchronisation port standardised for Rel. 99
- Synchronisation of cells or Node Bs via the air interface

Each of these two methods has some advantages and some drawbacks, and also a solution might be adopted that combines both techniques and also proprietary means.
It is however probable that whichever solution belonging to the second class is adopted, some new functionality will be needed on Iub.
In every solution the RNC shall be the master of the synchronisation process, since the measurements either performed by one cell on another one, or by the UE, shall be received by the RNC.
This means that at least a procedure from the RNC to the node B is needed to adjust the node B timing.

7.2 Layer 1 concepts

There are currently two concepts for performing synchronisation over-the-air. The first is based on measurements of neighbouring cells' SCH, the second is based on the transmission and measurements of a special burst on the RACH timeslot:

- **SCH method:** The principal feature is based on each Node B occasionally monitoring neighbouring cell's Synchronisation Channel (SCH), measuring the Time of Arrival (TOA), confirming the identity, and sending this information to the controlling RNC.
- **RACH method:** This method is based on using infrequent transmissions of synchronisation bursts in the PRACH time slots. Such soundings between neighbour cells facilitate timing offset measurements. The timing offset measurements are reported back to the RNC for processing to generate cell timing updates.

WG1 Note: Details on these two methods can be found in R1-00-074 (RACH method) and R1-00-471 (SCH method), respectively.

7.3 Higher Layer concepts

In general, the RNC has overall control of the cell synchronisation procedure. The RNC sets up a scheduling plan. In the case of the RACH method it instructs each cell when to transmit a sync burst in its PRACH slot and when to perform measurements.
In the case of the SCH method the RNC instructs each cell when to perform measurements.
All measurement results are processed within the RNC and timing update commands are then sent to the individual cells or Node Bs.
It is currently assumed, that there is no communication between neighbouring RNC areas and that each RNC area has its own timing reference (UTC).

8 Impact on Interfaces

8.1 Uu Interface

8.1.1 SCH method

The impact of the SCH method on the Uu Interface is the measurement of neighbouring cells' SCH code in downlink timeslots or in addition to other uplink data. It is highly desirable that the UE performance be unaffected by these losses, and that they not be required to be signalled. However analysis must be done to determine this fact, and it may be necessary to provide such signalling. The need, or non-need of this signalling is under study.

8.1.2 RACH method

The RACH method has an impact in the transmitting as well as in the receiving cell.
In the transmitting cell, a RACH timeslot is blocked during synchronisation burst transmission. In the receiving cell the Synchronisation Burst is interfered by PRACH bursts as well as it generates interference for these. It is highly desirable that the UE performance be unaffected by these losses, and that they not be required to be signalled. However analysis must be done to determine this fact, and it may be necessary to provide such signalling. The need, or non-need of this signalling is under study.

In addition to the blocking of timeslots, the Synchronisation Burst itself has to be defined.

8.2 Iub Interface

The messages between a NodeB and the RNC have to be standardised.
In the uplink these are:

- Neighbouring cell measurements

In downlink these are:

- Timing adjustment commands
- Transmit (RACH method only) and receive schedule

8.3 Iur Interface

Each RNC area is synchronised individually to at least one reference UTC clock. This automatically ensures synchronisation between RNC areas. Therefore, no communication over Iur is necessary for cell synchronisation between RNC areas.

9 Impact on network elements

9.1 UE

The UE may be required to have the capability to take into account the blocking of timeslots in up- and/or downlink

9.2 Node B

The cells have to support the reception of the Synchronisation Burst and/or the SCH sequence as well as measure the reception time. In addition, for the RACH method the cells have to support the transmission of the Synchronisation Burst.
Furthermore, the cells have to provide means for adjusting their timing and optionally the clock rate on command. The changes in the NBAP protocol have to be supported.

9.3 RNC

The RNC has the control of the whole algorithm. It has to initialise, establish and maintain a connectivity plan. It has to collect measurements and compute adjustment commands as well as support the necessary NBAP signalling. The algorithms involved will be proprietary.

10 Performance Analysis

10.1 Simulations for the SCH method

To be supplied

10.2 Simulations for the RACH method

To be supplied

11 Backward Compatibility

To be supplied

History

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Tel. : +49 89 722 21480 Fax : +49 89 722 24450 Email : stefan.oestreich@icn.siemens.de		
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