TSG-RAN Working Group 3 meeting #6 ***TSGR3#6(99)A43***
23rd - 27th August 1999
Sophia Antipolis, France

Agenda Item:

Title: **LS about TDD Synchronisation Methods**

To: **TSG RAN WG1**
TSG RAN WG4

Source: **TSG RAN WG3**

Document for: **Information and Request for Comment**

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1 Introduction

This Liaison Statement informs the recipients about the results obtained TSG RAN WG3 meeting #6 in Sophia Antipolis about Uu Synchronisation methods in TDD.
In the attached Tdoc. TSGR3#6(99)905 [Att] a method has been proposed to get synchronisation via measurements performed over the air interface.
Since the procedure relies on aspects relevant to RAN1 and RAN4, an opinion is asked about the feasibility of the method summarised in the following chapter.

2 Basic Principle

According to [Att], one possible method to acquire Base Stations synchronisation in TDD is to let Nodes B measure over the air interface the time offset in respect to neighbour Nodes B.
To perform this measure, Nodes B using this synchronisation procedure must be able to receive neighbouring cells' signal.
The proposed method has architectural impacts as well, since the measures required must be included in messages to be exchanged between RNCs and Nodes B.

3 Request for Comments

RAN3 would like RAN1 and RAN4 to consider the method described in [Att] and would like to have their opinion about its feasibility and effectiveness.

Attachment

TSG-RAN Working Group 3 Meeting #6 ***TSGR3#6(99)905***
Sophia Antipolis, France
August 23-27, 1999

Agenda Item: Sync Adhoc 4.5, 4.7

Source: InterDigital Comm. Corp.

Title: Synchronization of TDD Cells

Document for: Approval

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1 Introduction

TDD operation requires that base stations frames be in time synchronization with accuracy on the order of 1 microsecond. Reference, TSGR1#3(99) 165 identified an approach based on a new synchronization waveform, beacon transmission. This contribution suggests an approach that does not require a special air interface waveform, but does use new messages between the RNC and Node B.

This document identifies two candidate approaches to perform this synchronization. We may select either one, or a combination of the two.

2 Description of the candidates

2.1 Base stations synchronizes to absolute time

In this solution, there is no action required for the protocol standards. However, the BS performance document must specify that the base station start frame transmission on absolute time intervals, correct to within a specified limit; e.g. 1 microsecond (exact value to be determined).

2.2 Synchronization of Base Stations by the RNC

2.2.1 Basic Principle

In this solution, the RNC will occasionally tell the Node b cells to perform a simple cell search for a defined neighbor cell. It derives the time offset of the received signal with respect to its own reference. It sends a response to the RNC containing the measured Time offset (units: chips; signed number; could be negative).

In this concept, the RNC has all relevant information stored, including sync channel toffset of the primary sync code, downlink scrambling code for the synchronization channel, etc., and passes the information to the node B for this procedure.

For pairs of cells; e.g. Base Station A and Base Station B, the RNC compares two corresponding time delays. Assuming that the measurements have been obtained at nominally the same time,

TAB = Time delay from A as seen by B
TBA= Time delay from B as seen by A

Then, defining

deltaT = the time error to be estimated,
R = the distance between the Base Stations
c = speed of light

We obtain

TAB = deltaT +R/c
TBA =-deltaT +R/c

and

deltaT = (TAB-TBA)/2

Note that R is not needed for the actual calculation. However, noting that TAB+TBA=2*R/c, this could be used to optimize processing.

2.2.2 Effect of non-simultaneous measurements

Consider the effect induced because measurements are not necessarily taken at the same time. If the two base stations under consideration have no drift rate relative to one another, then there is no error introduced by non-simultaneous measurements.

If there is a significant drift, then the RNC must use some form of tracking algorithms, for instance a simple one could be periodic re-synchronization using the basic principle outlined above.

2.2.3 Connectivity issues

It is possible that there is not complete connectivity; i.e. islands of cells, not connected via the air to one another. It is proposed that each group of cells within an island (could be entire network if full connectivity exists), would have at least one cell with an external accurate timing reference. In reference TSGR1#3(99) 165, Siemens identified GPS and GNSS as possible absolute timing references, these or any others can be used as long as the cell can be synchronized to an absolute time reference to within 1 microsecond.

3 Proposals

The proposal is to allow the use of a combination of both the absolute timing reference and the air synchronization method to achieve the desired synchronization while giving a maximum flexibility to a vendor for the Node B hardware implementation. Any RNC to RNC coordination is outside the scope of this document.

3.1 Replace section 9.7 of UTRAN Overall description 25.401 with the following text.

9.7 TDD Frame Synchronization

In the UTRA TDD mode, the cells within the UTRAN are synchronized with respect to Radio Frame. This synchronization is achieved via a combination of absolute timing references such as GPS and/or GNSS, and simple adjustments commanded by the RNC's which are made by cells reading the synchronization channel of neighboring cells.

For time alignment of the uplink radio signals from the UE to the UTRAN, timing advance can be applied whenever necessary. Timing advance is based on uplink burst timing measurements performed by the Node B L1, and on Timing Advance commands sent downlink to the UE. The details are FFS.

3.2 Add the following two procedures to the list of procedures in NBAP 25.433 (chapter 7)

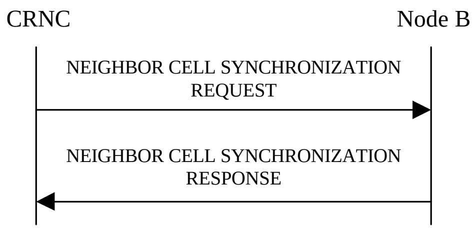
- Neighbor Cell Synchronization (TDD only)
- Cell Synchronization adjustment (TDD only)

3.3 Add the following two sections to chapter 8 of NBAP 25.433 (sections 8.1.10, and 8.1.11)

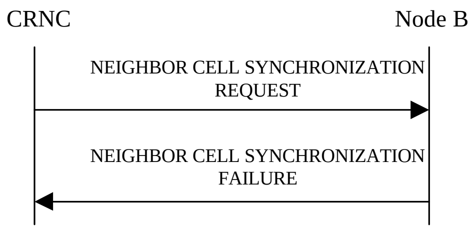
8.1.10 Neighbor Cell Synchronization

The purpose of Neighbor Cell Synchronization is to have the selected cell read the synchronization channel of another cell allowing the timing alignment necessary for TDD.

The Neighbor Cell Synchronization Procedure requires three message types, a Neighbor Cell Synchronization request, a Neighbor Cell Synchronization response in the successful case when a neighbor cell is received and a chip offset is determined, and a Neighbor Cell Synchronization failure in the unsuccessful case. The CRNC initiates this based on its knowledge of the cell configuration and the cells necessary to align timing. The request contains the cell id that is making the request along with the pertinent neighbor cell information to allow it to read the synchronization channel. The Node B responses back with the offset from its internal timing and the timing read from the neighbor's synch channel.



a) Successful case



b) Unsuccessful case

NEIGHBOR CELL SYNCHRONIZATION REQUEST message contains:

- Transaction ID
- Cell Id
- Neighbor Cell information

NEIGHBOR CELL SYNCHRONIZATION RESPONSE message contains:

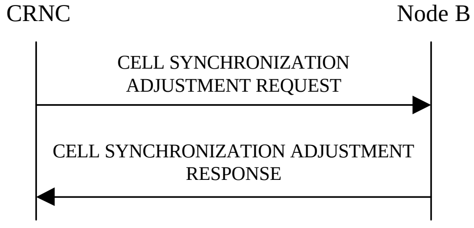
- Transaction ID
- Cell Id
- Frame discrepancy

NEIGHBOR CELL SYNCHRONIZATION FAILURE message contains:

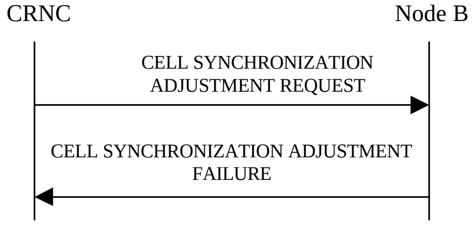
- Transaction ID
- Cell Id
- Failure reason

8.1.11 Cell Synchronization Adjustment

The purpose of Cell Synchronization Adjustment is to allow the CRNC to adjust the timing of a cell for time alignment in TDD. The Cell Synchronization Adjustment Procedure requires three message types, a Cell Synchronization adjustment request, a Cell Synchronization response in the successful case, and a Cell Synchronization Failure in the unsuccessful case. The CRNC initiates this based on its knowledge of the cell configuration and the cells necessary to align timing. The request contains the cell id that is being aligned along with the pertinent adjustment. The Node B responses back with a response in the successful case or a failure in the unsuccessful case.



a) Successful case



b) Unsuccessful case

CELL SYNCHRONIZATION ADJUSTMENT REQUEST message contains:

- Transaction ID
- Cell Id
- Chip Offset

CELL SYNCHRONIZATION ADJUSTMENT RESPONSE message contains:
- Transaction ID
- Cell Id

CELL SYNCHRONIZATION ADJUSTMENT FAILURE message contains:
- Transaction ID
- Cell Id
- Cause

3.4 Add the following sections to chapter 9.1 of NBAP 25.433 (sections 9.1.38 – 9.1.43)

9.1.38 NEIGHBOR CELL SYNCHRONIZATION REQUEST

This message is sent from CRNC to Node B in order to check the synchronization of neighbor cells in TDD.

Information Element	*Reference*	*Type*
Message Discriminator		***M***
Message Type		***M***
Transaction ID		***M***
Cell ID		***M***
Neighbor Cell information		*M*
DL Scrambling Code		***M***
Toffset		***M***
Sync Midamble		***M***
PSCH TS id - K		***M***

9.1.39 NEIGHBOR CELL SYNCHRONIZATION RESPONSE

This message is sent from Node B to CRNC as response to the Neighbor Cell Synchronization Request message and returns the chip offset of the neighbors synchronization channel.

Information Element	*Reference*	*Type*
Message Discriminator		***M***
Message Type		***M***
Transaction ID		***M***
Cell Id		***M***
Measured Chip Offset		***M***

9.1.40 NEIGHBOR CELL SYNCHRONIZATION FAILURE

This message is sent from Node B to CRNC as response to the Neighbor Cell Synchronization Request message when the Neighbor cell could not be read.

Information Element	*Reference*	*Type*
Message Discriminator		***M***
Message Type		***M***

Transaction ID		***M***
Cell Id		***M***
Failure Cause		***M***

9.1.41 CELL SYNCHRONIZATION ADJUSTMENT REQUEST

This message is sent from CRNC to Node B in order to set the clocking of a cell in TDD.

Information Element	*Reference*	*Type*
Message Discriminator		***M***
Message Type		***M***
Transaction ID		***M***
Cell ID		***M***
Chip Offset Adjustment		***M***

9.1.42 CELL SYNCHRONIZATION ADJUSTMENT RESPONSE

This message is sent from Node B to CRNC as response to the Cell Synchronization Adjustment Request message and returns the chip offset of the neighbors synchronization channel.

Information Element	*Reference*	*Type*
Message Discriminator		***M***
Message Type		***M***
Transaction ID		***M***
Cell Id		***M***

9.1.43 CELL SYNCHRONIZATION ADJUSTMENT FAILURE

This message is sent from Node B to CRNC as response to the Cell Synchronization Adjustment Request message when the Neighbor cell could not be adjusted.

Information Element	*Reference*	*Type*
Message Discriminator		***M***
Message Type		***M***
Truncation ID		***M***
Cell Id		***M***
Failure Cause		***M***

3.5 Add the following sections to chapter 9.2 of NBAP 25.433 (sections 9.2.39 – 9.2.43)

9.2.39 Toffset

The offset of the primary synchronization code for a neighboring cell

9.2.40 Sync Midamble

Midamble used of the TDD synchronization channel for a neighboring cell

9.2.41 PSCH TS id K

The timeslot in TDD that contains the Synchronization channel.

9.2.42 Measured Chip Offset

Value of the measured offset of neighbor cell during synchronization process.

9.2.43 Chip Offset adjustment

The chip adjustment to be made in a cell to facilitate cell synchronization