TSG-RAN Working Group 3 meeting
September 20th – 24th 1999
Sophia Antipolis, France

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Title:	**Node B states during TDD Synchronisation procedure on air**
Source:	**Italtel / Siemens**
Agenda Item:	**6.3**
Document for:	**Approval**

1.   Introduction

A basic proposal for TDD synchronisation has been submitted by Interdigital (R3-99905) during meeting #6.

The proposal is based on the synchronisation of a number of node B (masters) to an external reference (Italtel/Siemens have proposed in R3-99959 that this synchronisation to the external reference is achieved via a standardised synchronisation port). The other nodes B are synchronised either to the reference or to already synchronised nodes B via the air interface through cross measurements of cell Physical Synchronisation Channels (PSCHs).

Some extensions to Interdigital concept have been proposed by Italtel/Siemens in R3-99872 and a complete high level description of the extended method has been given R3-99B81

This contribution therefore proposes a description of the Node B states during the synchronisation procedures described in R3-99B81.

2.   Node B states during the on air synchronisation procedure

The Node B on air synchronisation procedure can be represented by the following state-state transitions and associated actions.

Synchronisation. Acquisition State (Sync_Acquisition)

The Node B enters this state when it receives a NEIGHBOR CELL MEASUREMENT REQUEST message from the CRNC. In this state the Node B has only the receiving part active that is used for monitoring the surrounding radio environment.

As soon as the Node B locks the PSCH of the master cell selected by the CRNC, it tries to decode the associated BCCH in order to get knowledge of the extended Cell Identity (Master Cell ID).

The detection of the PSCH allows the receiving Node B to estimate the time difference (Frame Timing Offset) between the received cell frame timing and its own frame timing.

This information (Master Cell ID, Frame Timing Offset) shall be reported to the CRNC by the NEIGHBOR CELL MEASUREMENT RESPONSE message.

From the reported parameters, the CRNC can select a master cell for the slave Node B (i.e. the Node B to be synchronised). The selection criteria could be based, for example, on a tree algorithm which characterises each cell with the following two parameters:

- ♦ Master Cell ID;
- ♦ Cell Hierarchical level of synchronisation, in respect to the Reference cell.

As soon as a suitable master cell has been identified, the CRNC shall forward to slave Node B the timing adjustment (Frame Timing Adjustment) together with the Master Cell ID through the SYNCHRONIZATION ADJUSTMENT REQUEST message.
The Node B acknowledges to the CRNC the execution of the required frame timing adjustment with the SYNCHRONIZATION ADJUSTMENT RESPONSE message and moves into the "*Synchronisation Locked*" State.

Synchronisation Locked State (Sync_Locked)

In this state the Node B, which is frame synchronised to a master cell, has both the receiving and the transmitting parts active.
Periodically (e.g. when the traffic conditions allow to) the locked Nodes B re-phase their frame timings by detecting the PSCH of their master cells and adjusting their own frame timing by the measured time difference.
In this state, an updated SYNCHRONIZATION ADJUSTMENT REQUEST message may still be received from the CRNC; this message allows to compensate for the propagation delay determined by the CRNC after cross checking the measurement reports both from the master and from the slave cell.
In case one of the following conditions apply:

a) the measured frame timing difference to the master cell is higher than a pre-configured threshold value;
b) the master cell cannot be detected anymore, at least within a maximum per-configured refresh time interval),

Then the slave Node B signals the condition to the CRNC through the NODE B OUT OF SYNC INDICATION message. The CRNC may decide to move the slave Node B into the "*Synchronisation Acquisition*" State by sending a SYNCHRONISATION RESTART REQUEST message or into the "*Synchronisation Tracking*" State by means of the NEIGHBOR CELL MEASUREMENT REQUEST message.

Synchronisation Tracking State (Sync_Tracking)

In this state, the Node B continues to be active both in reception and in transmission and, at the same time, monitors the radio environment.
For the detected PSCH, it reports back to the CRNC with the NEIGHBOR CELL MEASUREMENT RESPONSE message the measured frame timing difference and the associated (short) Cell Identities (e.g. BSIC) of the received master cell.
At the reception of the SYNCHRONIZATION ADJUSTMENT REQUEST message, the Node B acknowledges to the CRNC, by the SYNCHRONIZATION ADJUSTMENT RESPONSE message, the execution of the required frame timing adjustment and moves into the "*Synchronisation Locked*" State.
At the reception of the SYNCHRONISATION RESTART REQUEST message, it moves into the "*Synchronisation Acquisition*" State.
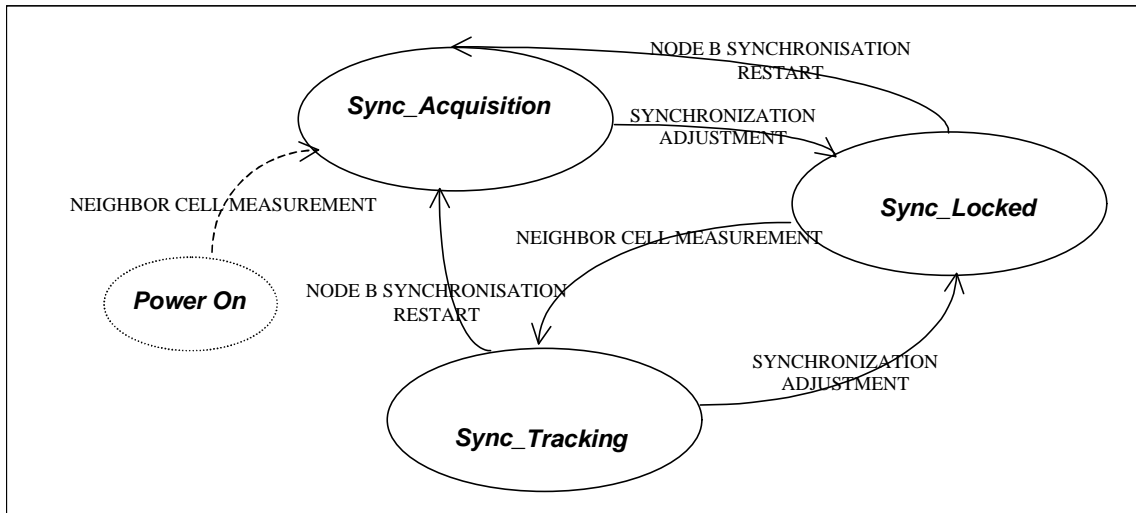
Sync_Acquisition

NODE B SYNCHRONISATION
RESTART

SYNCHRONIZATION
ADJUSTMENT

Sync_Locked

NEIGHBOR CELL MEASUREMENT

NEIGHBOR CELL MEASUREMENT

Power On

NODE B SYNCHRONISATION
RESTART

SYNCHRONIZATION
ADJUSTMENT

Sync_Tracking

Figure 1: Node B state diagram for the on air synchronisation procedure

3.   Proposal

It is proposed to add section 2 of this contribution either to an informative annex of 25.401 or to section 7.12 of I3.05.