TSG-RAN Working Group 3 meeting #6
Sophia Antipolis, France, Aug 23-27, 1999

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Agenda Item: ***Sync Ad-Hoc 4.5***

Source: **Ericsson**

Title: **Node offset measurements using Synchronisation Control frames.**

Document for: **Decision**

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1. Introduction

In order to assure good frame transport characteristics (considering e.g. delay and frame loss ratio) and to make it possible to efficiently reuse measured Iub Transport delay offset values (e.g. after a start/restart of a UTRAN node), it is necessary to have means to measure the Node timing difference between a RNC and each Node B in a RNS.

This contribution proposes a procedure and related means in order to perform this node timing difference measurement (below denoted Node offset measurement).
The contribution can be considered as an extension to reference [1] and reference [2] presented at the Helsinki meeting in July-99.
See also reference [3].

2. Discussion

In contributions [1] and [2] a node synchronisation method using node timing measurements is described. Timing entities are in these papers denoted t1, t2, t3 and t4 respectively.
Furthermore, in specification [5] and [6] a procedure and related means to align frame transport timing is presented (without considering node offset measurements). Separate Synchronisation Control frames are defined in these specifications.

Presented in this contribution is a proposal to combine the two approaches mentioned above, through a common Iub signalling. Parameters needed to measure node offsets are added to the earlier defined Synchronisation Control frames.
The proposal is illustrated in Figure 1 below.

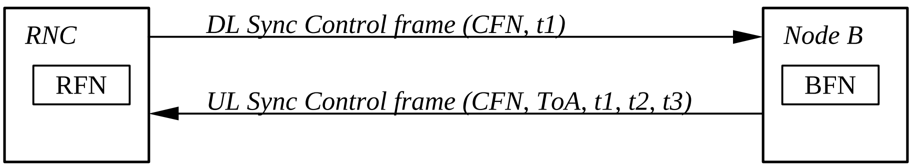

Figure 1: Node offset measurement parameters are added in the *Synchronisation Control frames*. Parameters t1 in DL and t1, t2 and t3 in UL are added.

In the DL Synchronisation Control frame, sent to the Node B, the RNC node timing is added, representing the time of transmission (t1 is represented by a RNC Frame Number counter value, RFN value).
As a response from Node B an UL Synchronisation Control frame is sent to the RNC where additional Node B timing values are added, representing the time of arrival and the time of transmission (t2 and t3 are represented by a Node B Frame Number counter values, BFN value).
RNC timing information t4 is captured when the UL Synchronisation Control frame arrives to the RNC (not present in any Synchronisation Control frame).
By using the t1-t4 values the Node offset (RNC – Node B) can be calculated and stored in the RNC. Repeating the procedure for all Node Bs in a RNS will make it possible to have all RNC to Node B offsets available in the RNC.
(Note; the phrase "Node B Frame Number" is sometimes denoted "Node B Reference FN" in reference [3]).

The Node offsets can be used together with pre-defined or refined transport delay values (for applicable transport bearer with different QoS) to schedule the RNC frame transmission timing and RNC DHO combination timing.
(Note: Naturally, also other parameters such as Tcell and Td are used to perform the RNC transport/combination scheduling).

Below, a number of advantages and characteristics related to the Node offset knowledge (comparable to "node synchronisation") are listed, including some items which are stated in reference [1] and [2].

- Transport delay offset values (pre-defined or refined) can be used directly after a start/restart of a RNC or Node B (following an initial node offset measurement procedure). These Transport delay offsets can be identical as used before the start/restart of the node (only the new node offset value needs to be applied). This makes it possible to set-up connections with low user transport delay combined with low frame loss rate immediately after node start/restart.[1]
- Using the knowledge of the Node offsets it is possible to decide if the first leg at connection setup has a short or a long transport delay. Therefore, it is possible to prepare for a situation where a longer diversity leg is inserted, without causing frame losses and adjustment disturbances.
- The t1 - t3 parameters makes it possible (together with the t4 parameter) to measure round-trip-delay values as well as to estimate respective one-way-delay values. These values can be a base for Transport delay offset value evaluation (related to Transport bearers with different QoS characteristics), possible to use by an operator to configure related parameters.
- When the transport network allow for short delays (or can be considered as being symmetrical in both direction), it will be possible to determine accurate inter Node B timing offsets (and corresponding Cell phase differences). These values can be used in System information / Neighbour cell lists to inform the phase differences to neighbour cell. This can be a base for faster cell search procedures in UEs and also provide the possibility to reduce the BCH Tx power in a cell.

[1] In reference [2] it is stated that without node synchronisation (node offset measurements) there can be an obvios consequence/risk that the Transport delay offsets will needed double margins (double frame delay variation margins) in order to secure the frame transport with respect to frame-slip.

3. Proposal

The proposal according to this contribution is to:

- Enable a combined approach with the TOA measurements (as described in reference [5] and [6]) and measurement of absolute node offsets as described in this contribution.
- Carry the new parameters t1-t3 included in the DL Synchronisation Control frames and the UL Synchronisation Control frames, in the Iub CCH data stream as well as in the Iub dedicated data stream.

The following text is proposed to replace current text in TS 25.401 (reference [3])

9.3 Node Synchronisation

Node Synchronisation describes how a common timing reference can be achieved between the UTRAN nodes. An efficient base for the frame transport between nodes in UTRAN is the knowledge of timing relationship between the RNC and each Node B in an RNS. This knowledge of node offsets is related to the concept Node Synchronisation. Through this knowledge it is possible to calculate and schedule the traffic frames between RNC and Node Bs. This applies for the transport in the downlink direction as well as the reception and diversity combination of uplink frames in the RNC, towards the Core Network.
Node synchronisation information will provide means to minimise frame transport delays through UTRAN as well as secure the frame transport with respect to loss of frames. The knowledge of timing relationship between nodes (node offsets) will be based on measurement information carried through specific control frames sent over Iub. Measurement of node offsets can be made at initial start/restart of a node as well as during normal operation to supervise the stability of node synchronisation.
Positioning / Localisation functions may also set requirements on the Node Synchronisation.

The following text is proposed to be included in TS 25.427 (reference [5])

7.2 Control frame structure

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DL synchronisation: DL synchronisation control frames are used to achieve and maintain the synchronisation of the DCH user plane and perform a node offset measurement, according to the synchronisation procedure.

Table below shows the structure of the payload when control frame is used for the user plane synchronisation and node offset measurements. This control information is sent in DL only

NAME	DL Synchronisation
Parameters	CFN
	t1 (RNC FN value, at transmission from RNC) *

*) t1 have a range of TBD and a resolution of 125 sec.

UL synchronisation: UL synchronisation control frames are used to achieve and maintain the synchronisation of the user plane accordingly to the synchronisation procedure and to supply node timing data.

Table below shows the structure of the payload when the control frame is used for the user plane synchronisation (UL). This control information is sent in UL only

NAME	DL Synchronisation
Parameters	CFN
	Time of Arrival (ToA)
	t1 (RNC FN value, at transmission from RNC) *
	t2 (Node B FN value, at reception in Node B) *
	t3 (Node B FN value, at transmission from Node B) *

*) t1-t3 have a range of TBD and a resolution of 125 sec.

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8.2 Synchronisation

In synchronisation procedure SRNC sends a DL SYNCHRONISATION Control Frame towards node B. This message indicates the target CFN and the SRNC transmission time (t1).

Upon reception of the DL SYNCHRONISATION Control Frame Node B shall ~~immediately~~ respond with UL SYNCHRONISATION Control Frame indicating the ToA for the DL Synchronisation frame and the CFN indicated in the received DL SYNCHRONISATION message. Received t1 value, the time when Node B received the DL SYNCHRONISATION Control Frame (t2) and the time when the responding UL SYNCHRONISATION Control Frame is sent from Node B (t3) are included in the UL SYNCHRONISATION Control Frame.

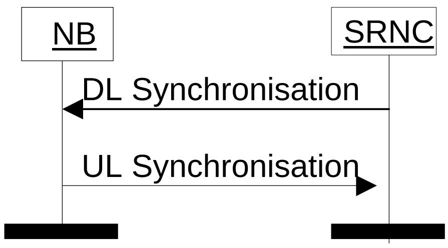

Figure 2. DCH Synchronisation procedure.

The following text is proposed to be included in TS 25.435 (reference [6])

5.2.2 DL Synchronisation

DL Synchronisation control frames are used to achieve and maintain the initial synchronisation of the CTCH user plane accordingly to the synchronisation procedure and to supply CRNC timing information.

Table below shows the structure of the payload when control frame is used for the user plane synchronisation (DL). This control information is sent in DL only.

NAME	DL Synchronisation
Parameters	FN_{CELL}
	t1 (RNC FN value, at transmission from RNC) *

*) t1 have a range of TBD and a resolution of 125 sec.

5.2.3 UL Synchronisation

UL Synchronisation control frames are used to achieve and maintain the initial synchronisation of the CTCH user plane accordingly to the synchronisation procedure, procedure and to supply node timing data.

Table below shows the structure of the payload when control frame is used for the user plane synchronisation (UL). This control information is sent in UL only.

NAME	UL Synchronisation
Parameters	FN_{CELL}
	TOA, Time of arrival
	t1 (RNC FN value, at transmission from RNC) *
	t2 (Node B FN value, at reception in Node B) *
	t3 (Node B FN value, at transmission from Node B) *

*) t1-t3 have a range of TBD and a resolution of 125 sec.

6.2 Synchronisation

6.2.1 FACH/PCH Channels

CRNC sends a DL SYNCHRONISATION Control Frame to node B. This message indicates the target Cell SFN and the CRNC transmission time (t1).
Upon reception of the DL SYNCHRONISATION Control Frame Node B shall ~~immediately~~ respond with UL SYNCHRONISATION Control Frame indicating the ToA for the DL Synchronisation frame and the Cell SFN indicated in the received message. Received t1 value, the time when Node B received the DL SYNCHRONISATION Control Frame (t2) and the time when the responding UL SYNCHRONISATION Control Frame is sent from Node B (t3) are included in the UL SYNCHRONISATION Control Frame.

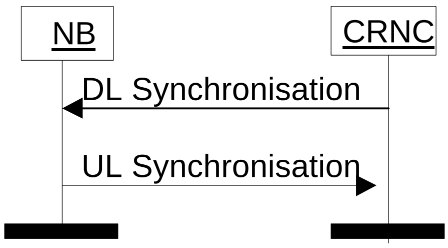

Figure 3. FACH/PCH Synchronisation procedure.

6.2.2 DSCH Channels

SRNC sends a DL SYNCHRONISATION Control Frame to node B. This message indicates the target Cell SFN and the CRNC transmission time (t1).
Upon reception of the DL SYNCHRONISATION Control Frame Node B shall ~~immediately~~ respond with UL SYNCHRONISATION Control Frame indicating the ToA for the DL Synchronisation frame and the Cell SFN indicated in the received message. Received t1 value, the time (t2) when Node B received the DL SYNCHRONISATION Control Frame and the time (t3) when the responding UL SYNCHRONISATION Control Frame is sent from Node B are included in the UL SYNCHRONISATION Control Frame.

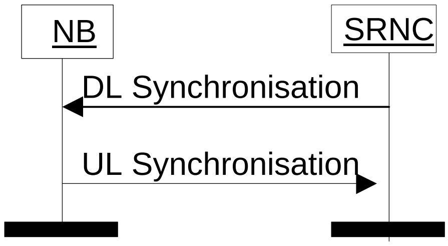

Figure 4. DSCH Synchronisation procedure.

4. References

[1] TSGR3#5 (99)687; Synchronisation between RNC and Node B [NTT DoCoMo].

[2] TSGR3#5 (99)688; Proposed Iub node synchronisation procedure [NTT DoCoMo].

[3] TSGR3#6 (99)872; A potential merged sync solution including two approaches [Ericsson].

[4] TS 25.401 v1.2.1; UTRAN Overall Description.

[5] TS 25.427 v0.3.1; UTRAN Iub/Iur Interface User Plane Protocol for DCH Data Streams.

[6] TS 25.435 v0.3.1; UTRAN Iub Interface User Plane Protocol for Common Transport Channel Data Streams.