3GPP TSG-RAN Working Group 1 Meeting No. 11
San Diego, USA, 28 FEB 2000 - 03 MAR 2000

Agenda Item: Ad Hoc 18, (Ad Hoc1)

Source: Nokia

Title: Out-of-sync handling for UTRA TDD

Document for: Approval

The aim of the CR presented below is to describe the out-of-sync handling with the corresponding procedures for UTRA TDD. The criteria for the uplink transmission is set and it is according to the received burst quality estimation.

In comparison to the FDD proposal an additional criteria is added to address the TDD specific timeslot dependent intercell interference. This criteria allows the UE to continue with the UL transmission for an extended period based on the reception of the downlink common channel (beacon function).

In the case of DTX in the uplink there will be a need to periodically transmit a 'dummy' burst which will help avoid erroneous out-of-sync reporting. This 'dummy' burst will have the same slot format as the normal burst where DTX is used. This burst will not carry any user data.

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***Document* R1-00-0302**
e.g. for 3GPP use the format TP-99xxx
or for SMG, use the format P-99-xxx

CHANGE REQUEST

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25.224 CR 014 Current Version: V3.1.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to:	TSG RAN #7	for approval	X	strategic	(for SMG
list expected approval meeting # here ↑		for information		non-strategic	use only)

Proposed change affects: (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]
(at least one should be marked with an X)

Source: Nokia **Date:** 23.02.2000

Subject: Out-of-sync handling for UTRA TDD

Work item: TS25.224

Category:				**Release:**		
	F	Correction			Phase 2	
	A	Corresponds to a correction in an earlier release			Release 96	
(only one category	B	Addition of feature	X		Release 97	
shall be marked	C	Functional modification of feature			Release 98	
with an X)	D	Editorial modification			Release 99	X
					Release 00	

Reason for change: Completion of the out-of-sync work item for release 99 for UTRA TDD.

Clauses affected: 4.2.2, 4.2.3, 4.4, 4.6

Other specs affected:			
	Other 3G core specifications		→ List of CRs:
	Other GSM core specifications		→ List of CRs:
	MS test specifications		→ List of CRs:
	BSS test specifications		→ List of CRs:
	O&M specifications		→ List of CRs:

Other comments:

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4.2.2 Uplink Control

4.2.2.1 Common Physical Channel

The transmitter power of UE shall be calculated by the following equation:

$$P_{PRACH} = L_{P\text{-}CCPCH} + I_{BTS} + \text{Constant value}$$

where

P_{PRACH} : Transmitter power level in dBm,

$L_{P\text{-}CCPCH}$: Measure representing path loss in dB (reference transmit power is broadcast on BCH),

I_{BTS}: Interference signal power level at cell's receiver in dBm, which is broadcast on BCH,

Constant value: This value shall be set by higher Layer (operator matter).

4.2.2.2 Dedicated Physical Channel

The initial transmission power is decided in a similar manner as PRACH. After the synchronisation between UTRAN and UE is established, the UE transits into open-loop transmitter power control (TPC).

The transmitter power of UE shall be calculated by the following equation:

$$P_{UE} = \alpha L_{P\text{-}CCPCH}+(1-\alpha)L_0 + I_{BTS} + SIR_{TARGET}+ \text{Constant value}$$

where

P_{UE} : Transmitter power level in dBm,

$L_{P\text{-}CCPCH}$: Measure representing path loss in dB (reference transmit power is broadcast on BCH).

L_0: Long term average of path loss in dB

I_{BTS}: Interference signal power level at cell's receiver in dBm, which is broadcast on BCH

α: α is a weighting parameter which represents the quality of path loss measurements. α may be a function of the time delay between the uplink time slot and the most recent down link time slot containing a physical channel that provides the beacon function, see [8]. α is calculated at the UE. An example for calculating α as a function of the time delay is given in Annex 1.

SIR_{TARGET}: Target SNR in dB. A higher layer outer loop adjusts the target SIR.

Constant value: This value shall be set by higher Layer (operator matter).

If the midamble is used in the evaluation of $L_{P\text{-}CCPCH}$ and L_0, and the Tx diversity scheme used for the P-CCPCH involves the transmission of different midambles from the diversity antennas, the received power of the different midambles from the different antennas shall be combined prior to evaluation of these variables.

4.2.2.2.1 Out of synchronisation handling

UE shall shut off the uplink transmission if the following criteria is fulfilled:

- The UE estimates the received dedicated channel burst quality over the last [160] ms period to be worse than a threshold Q_{out}. This criterion is never fulfilled during the first [160] ms of the dedicated channel's existence. Q_{out} is defined implicitly by the relevant tests in TS 25.102

- If the UE detect the beacon channel reception level [10 dBm] above the handover triggering level, then the UE uses [320] ms estimation period for the burst quality evaluation.

UE shall resume the uplink transmission if the follwowing criteria is fulfilled:

- The UE estimates the burst reception quality over the last [160] ms period to be better than a threshold Q_{in}. This criterion is always fulfilled during the first [160] ms of the dedicated channel's existence. Q_{in} is defined implicitly by the relevant tests in TS 25.102.

4.2.3 Downlink Control

4.2.3.1 Common Physical Channel

The Primary CCPCH transmit power can be changed based on network determination on a slow basis. The reference transmit power of P-CCPCH is signaled on the BCH on a periodic basis.

4.2.3.2 Dedicated Physical Channel

- The initial transmission power of the downlink Dedicated Physical Channel is set by the network. After the initial transmission, the UTRAN transits into SIR-based inner loop TPC as similar to the FDD mode

The measurement of received SIR shall be carried out periodically at the UE. When the measured value is higher than the target SIR value, TPC bit = „0„. When this is lower than the target SIR value, TPC bit = „1„. At the UTRAN, soft decision on the TPC bits is performed, and when it is judged as „0„, the transmission power may be reduced by one step, whereas if judged as „1„, the transmission power may be raised by one step.

When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value. When SIR measurement cannot be performed due to out-of-synchronisation, the TPC bit shall always be = „1„ during the period of being out-of-synchronisation.

A higher layer outer loop adjusts the target SIR.

4.2.3.2.1 Out of synchronisation handling

When the dedicated physical channel out of sync criteria based on the received burst quality is as given in the section 4.4.2 then the UE shall set the uplink TPC bit = „1„ . The CRC based criteria shall not be taken into account in TPC bit value setting.

4.4 Synchronisation and Cell Search Procedures

4.4.1 Cell Search

During the initial cell search, the UE searches for a cell. It then determines the midamble, the downlink scrambling code and frame synchronisation of that cell. The initial cell search uses the Physical Synchronisation Channel (PSCH) described in [8]. The generation of synchronisation codes is described in [10].

This initial cell search is carried out in three steps:

Step 1: Slot synchronisation

During the first step of the initial cell search procedure the UE uses the primary synchronisation code c_p to acquire slot synchronisation to the strongest cell. Furthermore, frame synchronisation with the uncertainty of 1 out of 2 is obtained in this step. A single matched filter (or any similar device) is used for this purpose, that is matched to the primary synchronisation code which is common to all cells.

Step 2: Frame synchronisation and code-group identification

During the second step of the initial cell search procedure, the UE uses the modulated Secondary Synchronisation Codes to find frame synchronisation and identify one out of 32 code groups. Each code group is linked to a specific t_{Offset}, thus to a specific frame timing, and is containing 4 specific scrambling codes. Each scrambling code is associated with a specific short and long basic midamble code.

In Cases 2 and 3 it is required to detect the position of the next synchronization slots. To detect the position of the next synchronization slots, the primary synchronization code is correlated with the received signal at offsets of 7 and 8 time slots from the position of the primary code that was detected in Step 1.

Then, the received signal at the positions of the synchronization codes is correlated with the primary synchronization Code C_p and the secondary synchronization codes $\{C_0,\ldots,C_{15}\}$. Note that the correlations can be performed coherently over M time slots, where at each slot a phase correction is provided by the correlation with the primary code. The minimal number of time slots is M=1, and the performance improves with increasing M.

Step 3: Scrambling code identification

During the third and last step of the initial cell-search procedure, the UE determines the exact basic midamble code and the accompanying scrambling code used by the found cell. They are identified through correlation over the P-CCPCH with all four midambles of the code group identified in the second step . Thus the third step is a one out of four decision. This step is taking into account that the P-CCPCH containing the BCH is transmitted using the first channelization code ($a_{Q=16}^{(h=1)}$ in [10]) and using the first midamble $\mathbf{m}^{(1)}$ (derived from basic midamble code $\mathbf{m}_P$ in [8]). Thus P-CCPCH code and midamble can be immediately derived when knowing scrambling code and basic midamble code.

4.4.2 Dedicated channel synchronisation

4.4.2.1 Synchronisation primitives

4.4.2.1.1 General

For the dedicated channels, synchronisation primitives are used to indicate the synchronisation status of radio links, both in uplink and downlink. The definition of the primitives is given in the following sub-clauses.

4.4.2.1.2 Downlink synchronisation primitives

Layer 1 in the UE shall every radio frame indicate synchronisation status of the downlink dedicated channels to higher layers, using either the CPHY-Sync-IND or CPHY-Out-of-Sync-IND primitive.

A radio frame is reported as out-of-sync with the CPHY-Out-of-Sync-IND primitive if any of the following criteria is fulfilled:

- The UE estimates the received dedicated channel burst quality over the last [160] ms period to be worse than a threshold Q_{out}. This criterion is never fulfilled during the first [160] ms of the dedicated channel's existence. Q_{out} is defined implicitly by the relevant tests in TS 25.102
- If the UE detect the beacon channel reception level [10 dBm] above the handover triggering level, the UE uses [320] ms estimation period for the burst quality evaluation.
- No CRC is received correctly on any of the dedicated TrCHs within a [160] ms period and [16] consecutive CRCs as observed on all TrCH are received incorrectly. Only TrCHs configured with CRC shall be included in the decision. In case the beacon channel reception criteria is fulfilled the values are [320] ms and [32] frames respectively.

A radio frame is reported as in-sync with the CPHY-Sync-IND primitive if both of the following criteria are fulfilled:

- The UE estimates the burst reception quality over the last [160] ms period to be better than a threshold Q_{in}. This criterion is always fulfilled during the first [160] ms of the dedicated channel's existence. Q_{in} is defined implicitly by the relevant tests in TS 25.104.
- At least one CRC on any of the dedicated TrCH is received correctly. Only TrCHs configured with CRC shall be included in the decision.

How the primitives are used by higher layers is described in TS 25.331.

4.4.2.1.3 Uplink synchronisation primitives

Layer 1 in the Node B shall every radio frame indicate synchronisation status of the radio link, using either the CPHY-Sync-IND or CPHY-Out-of-Sync-IND primitive.

Reporting of CPHY-Sync-IND corresponds to a radio frame determined to be in-sync, while reporting of CPHY-Out-of-Sync-IND corresponds to a radio frame determined to be out-of-sync. The exact criteria for determining the radio frame to be in-sync/out-of-sync is not subject to specification, but could e.g. be based on received burst quality or CRC checks. One example would be to have the same criteria as for the downlink synchronisation status primitives.

4.4.2.2 Radio link monitoring

4.4.2.2.1 Downlink radio link failure

The downlink radio links are monitored by the UE, to trigger radio link failure procedures. The downlink radio link failure criteria is specified in TS 25.331, and is based on the synchronisation status primitives CPHY-Sync-IND and CPHY-Out-of-Sync-IND, indicating in-sync and out-of-sync respectively.

4.4.2.2.2 Uplink radio link failure/restore

The uplink radio links are monitored by the Node B, to trigger radio link failure/restore procedures. Once the radio links have been established, they will be in the in-sync or out-of-sync states as shown in figure 1 in sub-clause 4.3.2.1. Transitions between those two states are described below.

The uplink radio link failure/restore criteria is based on the synchronisation status primitives CPHY-Sync-IND and CPHY-Out-of-Sync-IND, indicating in-sync and out-of-sync respectively.

When the radio links are in the in-sync state, Node B shall start timer T_RLFAILURE after receiving N_OUTSYNC_IND consecutive out-of-sync indications from layer 1. Node B shall stop and reset timer T_RLFAILURE upon receiving successive N_INSYNC_IND in-sync indications from layer 1. If T_RLFAILURE expires, Node B shall trigger the RL Failure procedure and indicate which radio links are out-of-sync. When the RL Failure procedure is triggered, the radio links' state changes to the out-of-sync state.

When the radio links are in the out-of-sync state, after receiving N_INSYNC_IND successive in-sync indications from layer 1 Node B shall trigger the RL Restore procedure and indicate which radio links have re-established synchronisation. When the RL Restore procedure is triggered, the radio links' state changes to the in-sync state.

The specific parameter settings (values of T_RLFAILURE, N_OUTSYNC_IND, and N_INSYNC_IND) are configurable, see TS 25.433.

4.5 ODMA Relay Probing

This section describes the probe-response procedure used by ODMA nodes to detect neighbours which may be used as relays during a call.

4.5.1 Initial Mode Probing

The initial mode probing procedure is activated by a UE when it is switched on and has no information about its surroundings. In this case the UE will synchronise with the ODMA Random Access Channel (ORACH) which is used by all UEs to receive and broadcast system routing control information and data. The UE begins a probing session by periodically broadcasting a probe packet on the ORACH. The broadcast probe includes the current neighbour list for the UE which will initially be empty. If a neighbouring UE, UE*a*, receives the broadcast packet it will register the UE as a neighbour and send an addressed response probe. The response probe is transmitted at random to avoid contention with other UEs and typically one response is sent for every *n* broadcast probes received from a particular UE.

The next time the UE transmits a broadcast probe the neighbour list will have one new entry, UE*a*, and an associated quality indicator (a weighted factor based on the received signal strength of the response probe). It is through this basic mechanism that each UE builds a neighbour list.

4.5.2 Idle Mode Probing

The Idle Mode Probing procedure is activated when the UE has synchronised with the ORACH but is not transmitting data. This procedure is the same as that described above after ORACH synchronisation.

The ODMA Idle Mode Probing procedure controls the rate of probing on the ORACH to reduce interference levels and regulate power consumption. The procedure is governed by a state machine, which consists of the following states: full probing, duty maintained probing, and relay prohibited. Each state defines the number of probing opportunities within one *N* multiframe, and a probing activity parameter *K* which is the ratio of probe transmission time to probe monitoring time.

Full probing

Full probing is the case where probing is allowed on every ORACH timeslot within an *N* multiframe. The UE_R will probe on the ORACH at a rate defined by the probing activity parameter *K*.

Duty Maintained probing

The duty maintained probing is the case where probing is allowed on *M* slots of an *N* multiframe. The UE_R will probe on the *M* ORACH slots in an *N* multiframe at a rate defined by the probing activity parameter *K*.

Relay Prohibited

In this mode the UE_R would cease all of its ODMA probing activities and will fall into standard TDD or FDD operation.

The probing activity levels for given state machines are illustrated in Figure 1 for a system with an ORACH for M slots per $N \times 16$ multiframe.

Note that the distribution of probing opportunities within a multiframe may not necessarily be consecutive and located at the beginning of a multiframe.

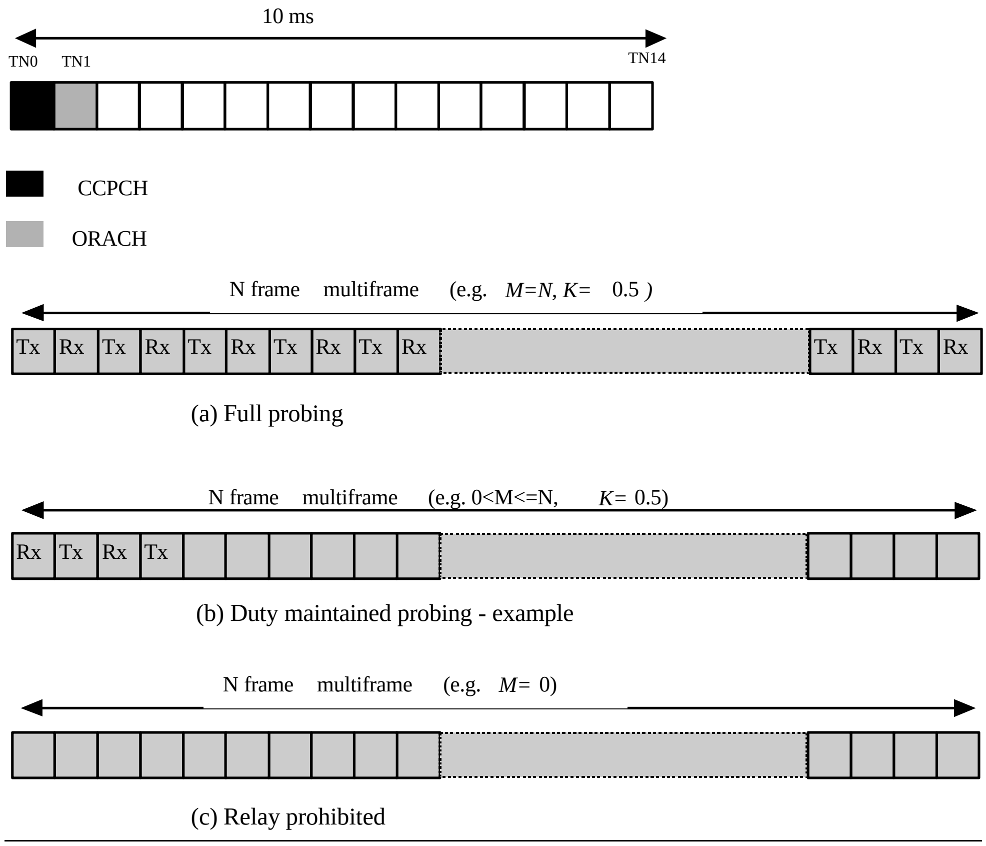


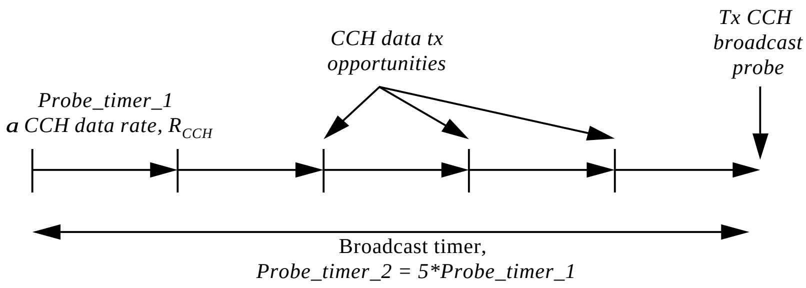
Figure 1: Probing state machines and mechanism

4.5.3 Active Mode Probing

The Active Mode Probing procedure is activated when the UE has synchronised with the ORACH and is transmitting data.

With ODMA, data may be relayed on either the ODMA Random Access Channel (ORACH) or the ODMA dedicated transport channel (ODCH), depending on the volume of data to be sent. When a UE has small amounts of data to send it may transmit an addressed probe response packet on the ORACH at an interval proportional to air interface modem rate, R_{CCH}, and is defined by *Probe_timer_1*. This interval also defines the broadcast probe interval, *Probe_timer_2*, which is typically five times longer than *Probe_timer_1*. Every time an UE transmits a response probe containing data on the ORACH, it may be received, but not acknowledged, by third party neighbour UEs, and provides an implicit indication of activity. In this instance broadcast probes are not necessary and *Probe_timer_2* is reset after every addressed probe transmission. Only when an UE has no data to send is it necessary to transmit a broadcast probe every *Probe_timer_2* seconds to register its active status with its neighbours.

In order to avoid overlapping packet transmissions the length of the packet may not exceed the probe timer interval, *Probe_timer_1*. The relationship between the different probe timers is illustrated in Figure 2.



Maximum packet length = *Probe_timer_1***R*$_{CCH}$

Figure 2: Probe timer relationships

4.6 Discontinuous transmission (DTX) of Radio Frames

Discontinuous transmission (DTX) is applied in up- and downlink when the total bit rate after transport channel multiplexing differs from the total channel bit rate of the allocated dedicated physical channels.

Rate matching is used in order to fill resource units completely, that are only partially filled with data. In the case that after rate matching and multiplexing no data at all is to be transmitted in a resource unit the complete resource unit is discarded from transmission. This applies also to the case where only one resource unit is allocated and no data has to be transmitted.

When a UE applies DTX it is forced to transmit at least once after [16] / 2-1 silent frames. If after [16] / 2-1 silent frames no data has to be transmitted, then a dummy burst shall be generated and transmitted in the next possible frame.

This dummy burst has the same slot format as the normal burst where DTX is used. The dummy burst is filled with an arbitrary bit pattern, contains a TFCI and TPC bits if inner loop PC is applied. The TFCI of the dummy burst indicates that there were no data to be transmitted.