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Agenda Item: AH21

Source: Siemens AG

To: TSG RAN WG1

Title: Uplink Synchronisation Procedure

Document for: Decision

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1. Summary

In 1.28Mcps TDD option, the uplink synchronisation procedure is a physical layer procedure. A physical layer command sent in FPACH is to reach initial and coarse synchronization with Node B. And the physical layer procedure with SS commands in each sub-frame give UE to be UL synchronised with high accuracy to the Node B.

2. Introduction

In 3.84 Mcps TDD option, the timing advance is a complete high layer procedure. However, in 1.28Mcps TDD option, the uplink synchronisation is a physical layer procedure. A physical layer command sent in FPACH is to reach initial and coarse synchronization with Node B. Then SS commands in each sub-frame provide UE to be UL synchronised with high accuracy to the Node B.

The initial value for uplink synchronisation will be determined in the UTRAN by measurement of the timing of the UpPCH. The received SYNC_UL timing deviation $UpPCH_{POS}$ is sent in the FPACH will be represented as an 11 bit number (0-2047) being the multiple of 1/8 chips which is nearest to received position of the UpPCH. The UE shall adjust the timing of its transmission accordingly in steps of ±1/8chips with the UpPCH value in the FPACH.

During a 1.28 Mcps TDD to 1.28 Mcps TDD hand-over takes place the UE shall transmit in the new cell with timing advance TA adjusted by the relative timing difference ? t between the new and the old cell:

$$TA_{new} = TA_{old} + 2? t$$

After the initial and coarse uplink synchronisation procedure, the UL Synchronisation with high accuracy is applied in order to enable synchronous CDMA in the UL. This procedure is continuously taking place during connected mode.

The UTRAN will continuously measure the timing of the UE and send the necessary UL synchronization commands each sub-frame. On receipt of this UL Synchronization command the UE will adjust the timing of its transmissions accordingly in steps of ±k/8 chips or do nothing each M sub-frames.

The default value of M (1-8) and k (1-8) is broadcast in the BCH. The value of M and k can also be adjusted during call setup or readjusted during the call.

Support of UL synchronization is mandatory for the UE.

3. Proposal

We propose to add following paragraphs in the working CR for TS25.224 as the description of timing advance procedure in the 1.28Mcps TDD.

---------- Beginning of text proposal for working CR for 25.224 ----------

5.2 Uplink Synchronisation

~~5.2.1.1~~5.2.1 General limits

The initial value for uplink synchronisation will be determined in the UTRAN by measurement of the timing of the UpPCH. The received SYNC_UL timing deviation $UpPCH_{POS}$ is sent in the FPACH will be represented as an 11 bit number (0-2047) being the multiple of 1/8 chips which is nearest to received position of the UpPCH.

~~5.2.1.2~~5.2.2 ~~UpPTS~~UpPCH

UE may estimate the propagation delay $2\tau_p$ upon the path loss by received P-CCPCH and/or DwPCH power.

The UpPCH is sent to the Node B advanced in time according to the timing of the received DwPCH. Time of the beginning of the UpPCH $T_{TX\text{-}UpPCH}$ is given by:

$T_{TX\text{-}UpPCH} = T_{RX\text{-}DwPCH} - 2\tau_p + 12*16\ T_C$

in multiple of 1/8 chips, where

$T_{TX\text{-}UpPCH}$ is the beginning time of UpPCH transmission with the UE's timing,

$T_{RX\text{-}DwPCH}$ is the received beginning time of DwPCH with the UE's timing,

$2\tau_p$ is the timing advance of the UpPCH ($UpPCH_{ADV}$).

5.2.1.1 PRACH

The UTRAN will measure the received SYNC_UL timing deviation $UpPCH_{POS}$ is sent in the FPACH will be represented as an 11 bit number (0-2047) being the multiple of 1/8 chips which is nearest to received position of the UpPCH.

Time of the beginning of the PRACH $T_{TX\text{-}PRACH}$ is given by:

$T_{TX\text{-}PRACH} = T_{RX\text{-}PRACH} - (UpPCH_{ADV} + UpPCH_{POS} - 8*16\ T_C)$

in multiple of 1/8 chips, where

$T_{TX\text{-}PRACH}$ is the beginning time of PRACH transmission with the UE's timing,

$T_{RX\text{-}PRACH}$ is the beginning time of PRACH reception with the UE's timing if the PRACH would be a DL channel.

During a 1.28 Mcps TDD to 1.28 Mcps TDD hand-over takes place the UE shall transmit in the new cell with timing advance TA adjusted by the relative timing difference ?t between the new and the old cell:

$TA_{new} = TA_{old} + 2?t$

5.2.1.2 DPCH and PUSCH

After the initial and coarse uplink synchronisation procedure, the uplink synchronisation with high accuracy is applied in order to enable synchronous CDMA in the UL. This procedure is continuously taking place during connected mode.

The UTRAN will continuously measure the timing of the UE and send the necessary UL synchronisation commands each sub-frame. On receipt of this UL Synchronisation command the UE shall adjust the timing of its transmissions accordingly in steps of ±k/8 chips or do nothing each M sub-frames.

The default value of M (1-8) and k (1-8) is broadcast in the BCH. The value of M and k can also be adjusted during call setup or readjusted during the call.

Support of UL synchronization is mandatory for the UE.

5.2.1.2.1 Out of synchronization 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 following 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.

5.2.1.5 The establishment of uplink synchronization

5.2.1.5.1 Preparation of uplink synchronization (downlink synchronization)

When a UE is powered on, it first needs to establish the downlink synchronisation with the cell. Only after the UE can establish and maintain the downlink synchronisation, it can start the uplink synchronisation procedure.

5.2.1.5.2 Establishment of uplink synchronization

Although the UE can receive the downlink synchronization signal from the Node B, the distance to Node B is still uncertain which would lead unsynchronised uplink transmission. Therefore, the first transmission in uplink direction is performed in a special time-slot UpPTS to reduce interference in traffic time-slots.

The timing used for the UpPCH are set e.g. according to the received power level of DwPCH and/or P-CCPCH.

At the detection of the UpPCH sequence in the searching window, the Node B will evaluate the received power levels and timing, and reply by sending the adjustment information to UE to modify its timing and power level for next transmission and for establishment of the uplink synchronisation procedure. Within the next 4 sub-frames, the Node B will send the adjustment information to the UE in FPACH. The uplink synchronisation procedure can also be used for the re-establishment of the uplink synchronisation when uplink is out of synchronisation.

5.2.1.6 Maintenance of uplink synchronisation

Uplink synchronization is kept in 1.28Mcps TDD option by sending the uplink to the Node B advanced in time according to the timing of the received downlink.

For the maintenance of the uplink synchronization, the midamble field of each uplink burst can be used.

In each uplink time slot the midamble in each UE is different. The Node B can estimate the power level and timing shift by measuring the midamble field of each UE in the same time slot. Then, in the next available downlink time slot, the Node B will signal the Synchronisation Shift (SS) commands to enable the UE to properly adjust its Tx timing.

---------- End of text proposal for working CR for 25.224 ----------