3GPP TSG-RAN WG1 Meeting #19 **R1-01-0228**
Las Vegas, USA, 27th February – 02nd March 2001

Agenda Item: Ad Hoc 29
Source: Siemens
Title: Clarifications about power control and cell search related to idle periods for UTRA TDD.
Document for: Discussion and decision

1 Introduction

It has been shown that idle periods are necessary for UE positioning (UP) in UTRA-TDD using OTDOA measurements to achieve a sufficient accuracy and coverage [1][3].
The proposed UP scheme with IPDLs provides the flexibility to use any appropriate channel for the time difference measurements. This paper addresses the concerns which have been raised at the last WG1-meeting in Boston and which are mentioned in the LS to WG2 [6]. The identified open issues are about power control, backward compatibility of R99 terminals and cell search.

2 Uplink power control

In TDD an open loop power control is used in the uplink direction. It is based on a path loss estimation which is performed on the beacon channel. The uplink transmission power is set by the following formula [4]:

$$P_{UL} = ?\ L_{P\text{-}CCPCH} + (1-?)\ L_0 + I_{BTS} + SIR_{TARGET} + \text{Constant value}, \qquad (1)$$

where $L_{P\text{-}CCPCH}$ represents the measured path loss and L_0 the long term average path loss. ? is a weighting parameter representing the quality of the path loss estimation. The ? parameter can be a function of the delay between the uplink time slot and the most recent downlink time slot containing a beacon channel, e.g. the P-CCPCH.
If the transmission of the beacon channel is switched off due to idle periods, power control can be affected. Because no actual path estimation is available for uplink power control, it is proposed to use only the long term average path loss estimation for all uplink transmission until the next beacon slot is available. It has to be pointed out, that a maximum of 6% of all frames will contain idle periods [1]. Therefore the impact on the uplink transmission is rather small.
Figure 1 shows one TDD frame with two beacon channels. This corresponds to the case 2 of the SCH allocation. In the slots number 1 to 7 uplink power control is based on only long term average path loss L_0.

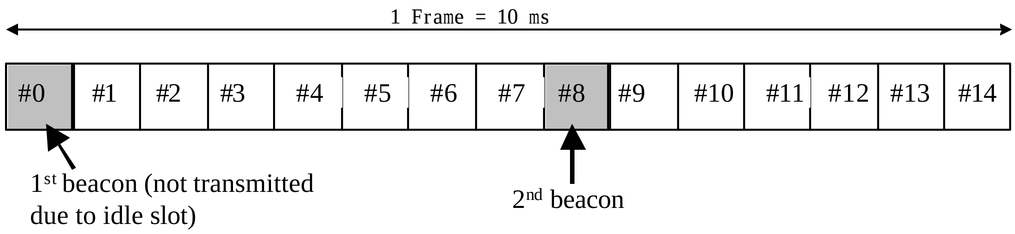

Figure 1: One TDD frame with beacon locations

Simulation results [5] about the uplink power control according to formula 1 have shown, that the required signal energy must be increased with the delay between the uplink transmission and the most recent beacon transmission to achieve a certain raw BER.

To maintain the quality of service (i.e. BER) in the uplink slots after an idle slot with a blanked beacon the UE may increase its transmission power by a certain value power_inc_UP. The maximum value for this increase will be signalled by UTRAN.
By increasing the transmission power in the affected slots, the interference in the neighbouring will increase very slightly. A worst case estimation leads to an negligible average increase of the interference of 0.04 dB. The details can be found in the annex.

The power control of R99 terminals, who are not aware of IPDLs will be based completely on the long term average value. This is achieved by signalling the ? parameter to be 0. The uplink power control for R4 terminal and beyond will be calculated as follows:

$$P_{UL} = ?_{IPDL} L_{P\text{-}CCPCH} + (1-?_{IPDL}) L_0 + I_{BTS} + SIR_{TARGET} + \text{power\_inc\_UP} + \text{Constant value} \quad (2)$$

Because the ? parameter is set to 0 to avoid backward compatibility problems with R99 terminals the new $?_{IPDL}$ parameter will be used. The behaviour of the power control in frames without idle periods according to formula 2 is identical to power control as described in the R99 specifications, i.e. the parameter power_inc_UP is 0.
Only in frames with idle periods and only in the slots between the blanked beacon and the next beacon, power control is only based on the long term average path loss. In these slots the UE may increase its transmission power by the power_inc_UP. The maximum value for this increase is set by UTRAN.

3 Cell search

Cell search is based on monitoring the SCH codes. In order not to loose performance (e.g. for handover from GSM to TDD) the transmission of the SCH codes will not be switched off during an idle period. Of course, this applies only if the position of the SCH is identical to the occurrence of an idle slot.
The idle periods are configured as proposed in [2]. During an idle period all transmissions are switched off, except for the SCH.

4 Conclusion

Idle periods are necessary for UP in UTRA-TDD if OTDOA methods are applied.
If beacon channels are used for UP the uplink power control shall be modified as described to maintain the quality of service in frames with idle periods and to solve the backward compatibility issue for R99 terminals.
It is proposed to send a Liaison Statement to WG2 about the power control and the cell search and to approve the corresponding CRs for incorporation of UP in UTRA-TDD.

Annex

In [5] simulations have been performed about the weighted open loop power control scheme as it is specified in TS 25.224.

The results of the simulations can be found in figure 2. For the simulations the ? -parameter is defined as: ? = 1-(D-1)/6. D is the delay, expressed in number of slots, between the uplink slot and the most recent downlink slot. If the delay is greater than 6 slots, than the normal power control uses only the average path loss estimation.

As can be seen from figure 2, the required signal energy increases with the delay D.

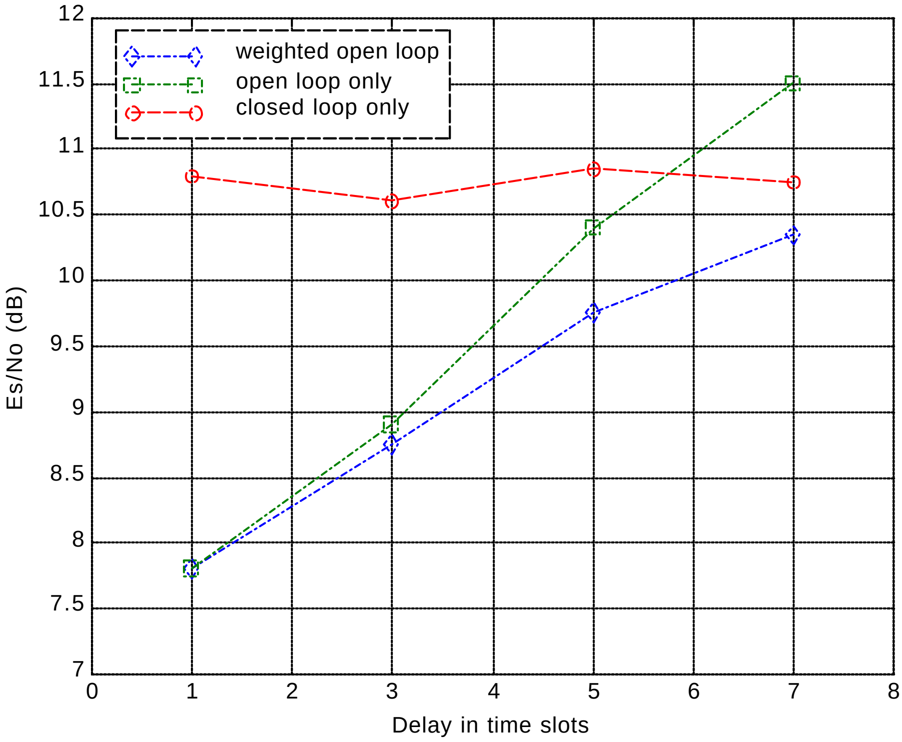

Figure 2: Required Es/No for BER=0.01 vs. delay at 30 km/h, simulation results from Tdoc R1-99-972 [5]

Table 1 summarises the needed increase in signal energy from figure 2 as a function of the delay D if the power control is only based on the long term average path loss:

Delay D in slots	Increase in signal energy
1	2.55 dB
2	2.05 dB
3	1.55 dB
4	1.05 dB
5	0.65 dB
6	0.30 dB

Table 1: Needed power increase

Table 1 has to been read as follows: If the delay is only one slot (D=1) than the Es/No must be 7.75 dB (compare figure 2) for a raw BER of 0.01. The transmission power must be increased by 2.55 dB if power control is only based on the long term average path loss to maintain this BER.

The highest positioning update rate (approximately 1 Hz) results in a maximum of 6 frames with idle periods (P-CCPCH will be switched off in two consecutive frames) within 100 frames. The transmission power has to be increased in a total of 36 slots out of 1500 slots (=100 frame x 15 slots). Assuming now perfect power control in all other slots, this leads to mean average increase of 0.04 dB.

References

[1] Tdoc R1-00-1355: LCS for 3.84 Mcps TDD, source: Siemens

[2] Tdoc R1-01-0014: Clarifications about TDD-LCS and IPDL scheme proposal, source: Siemens

[3] Tdoc R1-01-0118: Simulation results on TDD LCS, source: Siemens

[4] TS 25.224: Physical Layer Procedures (TDD) V3.5.0

[5] Tdoc R1-99-972: Performance of Weighted Open Loop Scheme for Uplink Power Control in Tdd Mode, source: InterDigital

[6] Tdoc R1-01-0174: IPDL scheme for location services in TDD mode, LS to WG2.