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Agenda Item: Ad Hoc 29
Source: Siemens AG
Title: Clarifications about TDD-LCS and IPDL scheme proposal
Document for: Discussion and Approval

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1 Introduction

At the last RAN-WG1 meeting it has been shown for the TDD mode, that idle periods in the downlink transmission (IPDLs) are necessary to provide sufficient accuracy and coverage for location services (LCS) [1]. This document addresses the questions which have been raised and gives an updated scheme for IPDLs.

2 Uplink power control

It should be noted that only when the beacon channel is used for the LCS measurements, open loop power control is affected. However, the proposed scheme provides the flexibility to use other appropriate channels as well [1].
In UMTS-TDD mode an open loop power control is used for the uplink transmission of the DPCHs. The transmitter power of the UE is calculated by [2]:

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

where $L_{P\text{-}CCPCH}$ represents the measured path loss and L_0 the long term average path loss and ? 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 carrying the BCH.
As already shown [1][3], LCS for TDD requires to switch off all transmissions in the serving cell for one slot to overcome the hearability problem, i.e. it requires to use IPDLs. Ceasing the beacon channel results in a wrong path loss estimation.
The following methods are suitable for sufficient uplink power control in frames with idle periods, when the beacon channel is switched off:

?? Occurrence of the IPDLs only once per frame and the average frequency for the frames with IPDLs shall not exceed a certain value to limit the impact on open loop power control.

?? If the transmission of a beacon channel is switched off by the IPDLs, the UEs shall use the long term average path loss for power control in the frames with IPDLs.
In [4] the performance of the open loop power control is investigated. It is shown, that the required Es/No value to achieve a given BER increases with the delay between the uplink slot transmission and most recent downlink slot used for the path loss estimation. For higher speeds (60 km/h) and delays greater than 2 slots the required Es/No values keep approximately constant, especially if the power control is fully based on the long term average path loss. The reason for this is, that the mean properties of the channel are constant for a longer time than a few slots. Even if the delay increases up to 30 slots, the impact of the power control on the system performance will not change significantly.
For velocities lower than 60 km/h there will be a minimum value for the delay to have constant Es/No values, if only the long term average path loss is used for power control. The lower the velocity the slower will be the changes of the mobile channel.

?? If synchronisation case 2 applies for the cell, than 2 independent beacon channels are present. Because only one of these two beacon channels is switched off, the second one can provide the path loss estimation for the power control.

?? R99 terminals which are not capable of supporting IPDLs are signalled the ? parameter to be 0. So they use only the long term average value of the path loss.. The R4 terminals may use an additional parameter ($?_{R4}$) for the weighting of the actual path loss and the long term average. The normal ? parameter is valid for R99 terminals (and will be set to zero) while the R4 terminals will use the new $?_{R4}$ parameter in frames without IPDLs and ignore the normal ? parameter.

The update rate of the UEs position depends on the service the operators offer. To get a rough estimate about the impact on the open loop power control, it is assumed that a new position must be available every second, this may be applicable even for car navigation. Each position calculation needs approximately 3 measurements. Altogether 3 slots with beacon channels have to be idle. A typical IPDL rate can vary between 3 Hz and 0.3 Hz for a position update rate between 1 Hz and 0.1 Hz.

3 Update of the IPDL scheme

Channels with beacon characteristics or the paging indicator channel have the best properties for the LCS measurements. As already mentioned in [1], the IPDLs in TDD are realised by switching off the transmission for a whole slot.

If the P-CCPCH is used for the LCS purpose, a small change of the current proposed IPDL scheme can be beneficial. The TTI of the BCH is 20ms, so one BCH transport block is transmitted in two consecutive frames. If one of the BCH slots of these two frames falls in an idle slot, the information after deinterleaving and decoding will be erroneous and the transport block is lost. To avoid the transmission of useless information, an IPDL scheme with 2 consecutive frames with no beacon channel transmission should be allowed. The slot with the P-CCPCH in the first frame of the 2 consecutive frames shall be idle, i.e. no transmission takes place. In the same slot in the next frame only the transmission of the P-CCPCH is switched off. This slot can be used for handover measurements or other downlink transmissions.

The following scheme is proposed for the IPDLs:

Two modes for the idle periods exist: continuous mode and burst mode. In continuous mode the idle periods are active all the time. In burst mode the idle periods are arranged in bursts. The bursts are separated by a period where no idle periods occur.

The following parameters are signalled to the UE via higher layers:

IP_Status: This is a logic value that indicates if the idle periods are arranged in continuous or burst mode.

IP_Spacing: The number of 10 ms radio frames between the start of a radio frame that contains an idle period and the next radio frame that contains the next idle period. Note that there is at most one idle period in a radio frame.

IP_Start: The number of the first frame with idle periods.

IP_Slot: The number of the slot that has to be idle [0..14].

IP_PCCPCH: This logic value indicates, if the P-CCPCH is switched off in two consecutive frames. The first of these two frames contains the idle period.

Additionally in the case of burst mode operation the following parameters are also communicated to the UE.

Burst_Start: The SFN where the first burst of idle periods starts.

Burst_Length: The number of idle periods in a burst of idle periods.

Burst_Freq: The number of radio frames between the start of a burst and the start of the next burst.

In burst mode, the first burst starts in the radio frame with SFN = Burst_Start. The n^{th} burst starts in the radio frame with SFN = Burst_Start + n? Burst_Freq. The sequence of bursts according to this formula continues up to and including the radio frame with SFN = 4095. At the start of the radio frame with SFN = 0, the burst sequence is terminated (no idle periods are generated) and at SFN = Burst_Start the burst sequence is restarted with the first burst followed by the second burst etc., as described above.

Continuous mode is equivalent to burst mode, with only one burst spanning the whole SFN cycle of 4096 radio frames, this burst starting in the radio frame with SFN = 0. In case of continuous mode the parameter IP_Start defines the first frame with idle periods.

The time slot that has to be idle is defined by two values: IP_Frame(x) and IP_Slot. IP_Frame(x) defines the x^{th} frame within a burst in which the slot with the number IP_Slot has to be switched off.

The actual frame with idle periods within a burst is calculated as follows:

IP_Frame(x) = IP_Start + (x-1) ? IP_Spacing with x = 1, 2, 3, ...

If the parameter IP_PCCPCH is set to 1, then the P-CCPCH will not be transmitted in the frame IP_Frame(x) +1 within a burst.

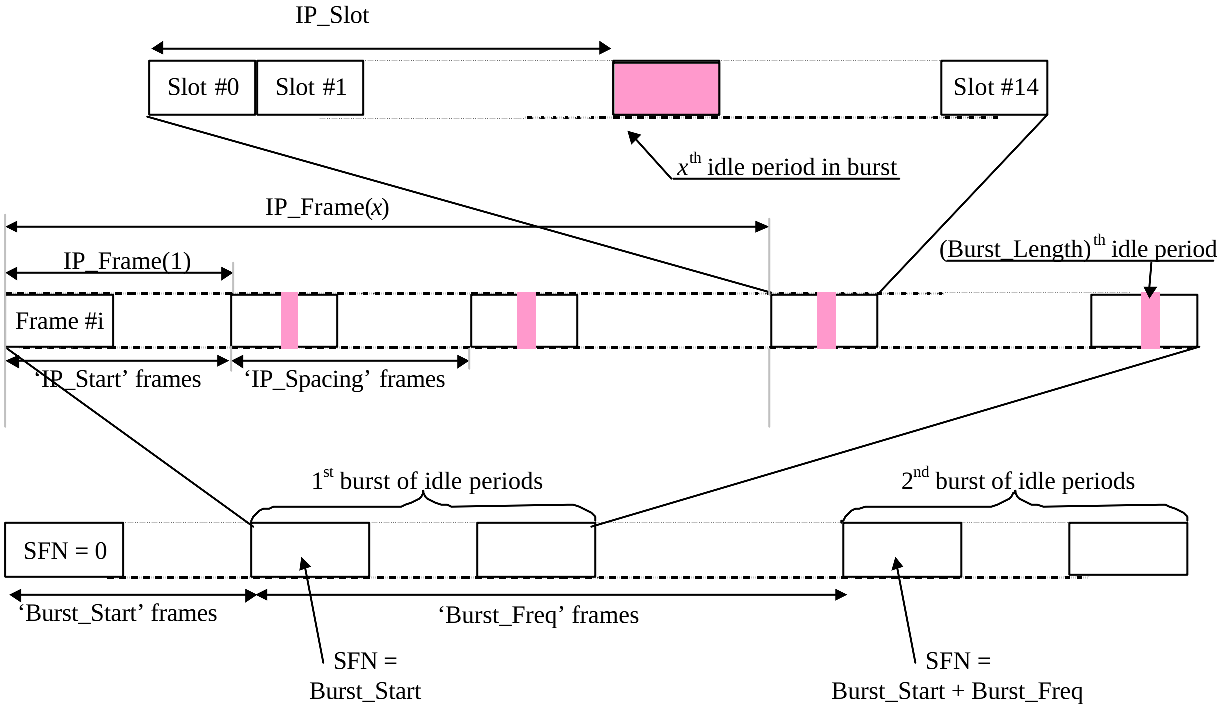

Figure 1: Timing of IPDLs in the 3.84 Mcps TDD mode

4 Conclusion

If LCS is based on the same beacon channel as used for the path loss estimation, uplink power control in frames with IPDLs shall be based on the long term average path loss. Backward compatibility for R99 terminals is achieved by applying different weighting parameters for R99 and R4 terminals.

It is recommended to include the proposed IPDL scheme for TDD in the Technical Report TR 25.847 and send a Liasion Statement to WG2.

5 References

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

[2] TS 25.224: Physical Layer Procedures (TDD), V3.5.0 (draft)

[3] Tdoc R1-00-1123: Air Interface Methods for TDD Location Services, source: Siemens

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