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Agenda Item:

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Title: Proposal for PCH Modifications in TDD

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Summary

In the documents [1] and [2] a particular paging channel structure was proposed for the use in UTRA TDD mode. This structure allows for an efficient sleep mode by introducing paging sub-channels, superframe cycles and paging indicators that indicate the presence of paging messages in a paging sub-channel. However, there are some drawbacks of this scheme regarding the possibility of sharing resources and its flexibility.

Recently, there has been a change of the paging structure in UTRA FDD mode as well, see [3] and [4]. The separate transmission of paging indicators and paging messages in different channels, namely the physical paging indicator channel (PICH) and the transport paging channel (PCH), has been approved as a valuable concept to enhance the system.

In this paper we show how this FDD concept can be essentially adopted for the TDD mode as well, extending the current proposal from [1]. This will lead to a harmonization between both modes and overcomes the above mentioned drawbacks of the current proposal from [1].

1 Introduction

In this section we will shortly summarise the concepts in [1] and [3]. In [1] for UTRA TDD a time division of the PCH has been proposed in such a way that two consecutive time slots of the CCPCH carrying the PCH form a paging sub-channel. Each paging sub-channel corresponds to a paging group of UEs. There exists a fixed association between a paging group, i.e. a paging sub-channel, and the UE, which is given by the UE ID for example. In each paging sub-channel a paging indicator is transmitted to indicate the presence of a paging message in this particular sub-channel. This avoids unnecessary attempts to decode non-present paging messages. Since DTX is not allowed on the CCPCH that carries the PCH, dummy bits have to be sent in the case that there is no paging message.

The following disadvantages are seen in this concept:

- The capacity of the paging channel has to be designed for the maximum possible or average paging load. It is not possible to share the resources of the PCH with a different channel with similar characteristics for the case that no paging messages are to be sent. Instead, dummy bits have to be transmitted that unnecessarily increase the interference.

- The rigid link between the paging indicator and the paging sub-channel doesn't allow any flexibility in changing the number of paging indicators to increase the sleep mode efficiency. Thus, either the overall capacity for the PCH has to be increased also, although this might not be necessary, or the setup delay increases by defining larger superframe cycles.

- To reduce the average setup time, interleaving should be used for the paging indicators as well as for the paging messages. On the other hand this decreases the reliabilty of the decoding of the paging indicator, since for the interleaving case the number of the available symbols per slot is halved. This implies that the receiver has to be kept open for both of the two consecutive PCH, i.e. about 10 ms, which reduces the efficiency of the scheme in terms of power consumption.

The UTRA FDD mode uses two separate channels for the transmission of the paging indicators and the paging messages. In [4] it is proposed to share the same resources, i.e. the same physical channel for PCH and FACH messages. The paging indicators are transmitted on a particular physical channel, the paging indicator channel (PICH). There exists a fixed assignment (timing) between the paging indicators, that indicate the presence of a paging message for a particular group of mobiles, and the radio frame in which the corresponding paging message is transmitted on the PCH.

This FDD scheme doesn't suffer from the above mentioned drawbacks. However, for the following reason it cannot be adopted to TDD in a straightforward manner: Since the necessary capacity for the PICH is quite small, in TDD the PICH should not be sent continuously as in FDD, but it will use a few time slots of the superframe only. Thus, a fixed timing between paging indicators and the corresponding paging messages is not feasible, since this would restrict the capacity of the PCH too much. In the following section we describe an efficient solution how to incorporate the separation of a paging indicator channel and a paging channel in the UTRA TDD mode.

2 Definition of the PICH in TDD

We propose that each n^{th} PCH on the CCPCH is substituted by the PICH. Each UE belongs to one paging indicator group and, in sleep mode, it listens only to those time slots in which its corresponding paging indicators are transmitted. The assignment of UEs to paging indicator groups is unique and is given by the UE ID. The paging indicator indicates a paging message for one or more UEs that belong to the corresponding paging indicator group.

The paging indicators, consisting of 2, 4 or 8 symbols, are transmitted in a normal burst (type 1 or 2) as seen in figure 5. The proposed grouping distributes the PIs homogeneously over the full burst. A smaller PI length allows to increase the number of paging indicator groups per PICH, thus increasing the sleep mode efficiency. The PI may be repeated within one superframe. The repetition factor allows for a trade off between highest sleep mode efficiency (RF_{PI}=1) and smaller access delay (RF_{PI}>1). The number of paging indicator groups N_{PIG} per superframe is given by the number of time slots per superframe N_{PICH}, used for the PICH, the length L_{PI} of the paging indicator symbols, the burst type BT and the repetition factor of the paging indicators, RF_{PI}. Figure 1 shows an example for L_{PI}=4, BT 1, N_{PICH}=4, RF_{PI}=2.

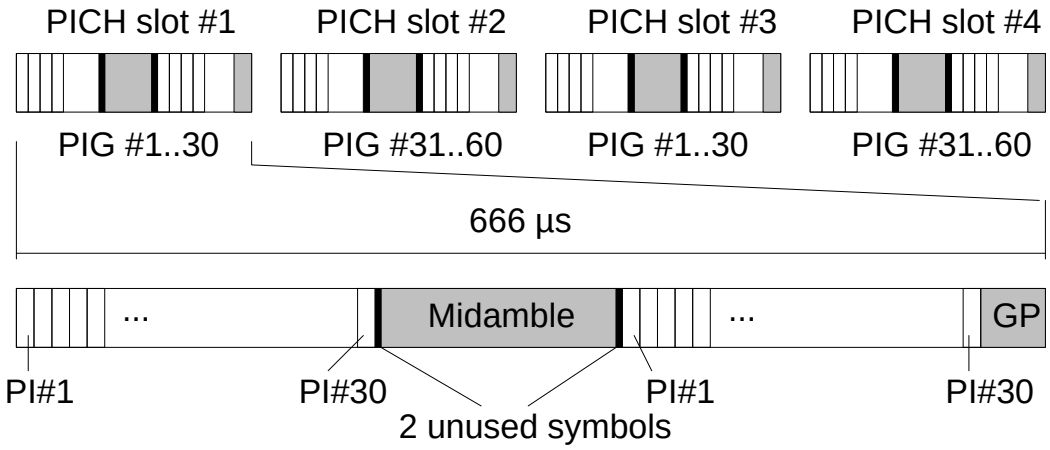

Figure 1 Example of PI Transmission in PICH Bursts

3 Structure of the PCH in TDD

As in the proposal [1], the paging messages for a UE are transmitted on the paging sub-channel that is associated with a paging group. A paging sub-channel consists of two consecutive time slots of the CCPCH carrying the PCH. The assignment of UEs to a paging group is unique and is given by the UE ID. The assignment of UEs to paging indicator groups is independent of the assignment of UEs to paging groups. Thus, the number of paging indicator groups and paging groups can be chosen independently, see figure 2.

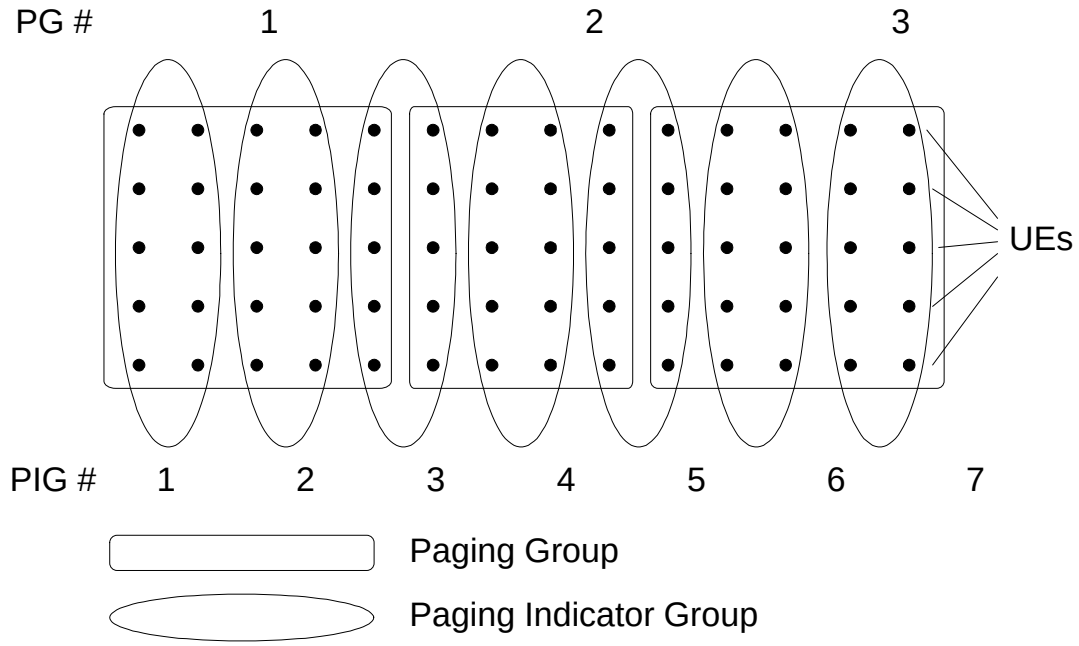

Figure 2 Independent Assignment of UEs to Paging Indicator Groups (PIG) and Paging Groups (PG)

The independent assignment of UEs to paging indicator groups and paging groups allows for a flexible adaptation of the PICH and PCH to the desired system characteristics. The number of paging indicator groups influences sleep mode efficiency and access delay, whereas the number of paging groups depends on the capacity that is provided for paging messages.

As in FDD mode the PCH may be used for FACH messages also. Therefore, the same interleaving provides the possibility of substituting PCH by FACH messages.

4 Conclusion

We propose to adopt the introduction of PICH for the transmission of paging indicators and PCH for the transmission of paging messages in the TDD mode. The PICH substitutes every n^{th} PCH on the CCPCH. It carries paging indicators that allow for a reliable indication that paging messages are transmitted to a paging indicator group of UEs. The paging messages is then transmitted in a paging sub-channel that is associated with a paging group of UEs. In the previous chapters we have shown the advantages of this new scheme.

5 References

[1] 3GPP TSG RAN WG1 TDoc (99)615, Proposal for a Paging Channel Structure in TDD Mode
[2] 3GPP TSG RAN WG1 TDoc (99)718, Revised Text Proposal for a PCH Structure in TDD
[3] 3GPP TSG RAN WG1 TDoc (99)604, Proposal for a Modified PCH Structure, revised
[4] 3GPP TSG RAN WG1 TS 25.211, Physical channels and mapping of transport channels onto physical channels (FDD)