TSG-RAN Working Group 2 (Radio layer 2 and Radio layer 3)
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Title: **Discontinuous Reception in Idle and Connected mode**

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1 Introduction

This contribution proposes a Discontinuous Reception (DRX) concept to be used on paging channels and definitions supporting the concept. The DRX concept discussed support both Idle and UTRAN Connected mode. The concept aims at providing a DRX that is flexible enough to provide a good compromise between call setup delay, battery power consumption and different DRX requirements from different UE's and Core Network domains.

2 Definitions

The following definitions are used in this contribution.

Paging occasions: The time instances where it is possible to receive initial paging information.

Initial paging information: This information indicates if the UE need to continue to read more paging information and eventually receive a page message.

Initial paging occasion: The paging occasion the UE use as starting point for its DRX cycle.

DRX cycle: The individual time interval between reading initial paging information for a specific UE.

Maximum DRX cycle: The time interval for the longest possible DRX cycle in a cell.

3 DRX concept description and discussion

3.1 Example of usage of the DRX concept

The following figure illustrates and give examples of the usage of the definitions stated for the proposed DRX concept.

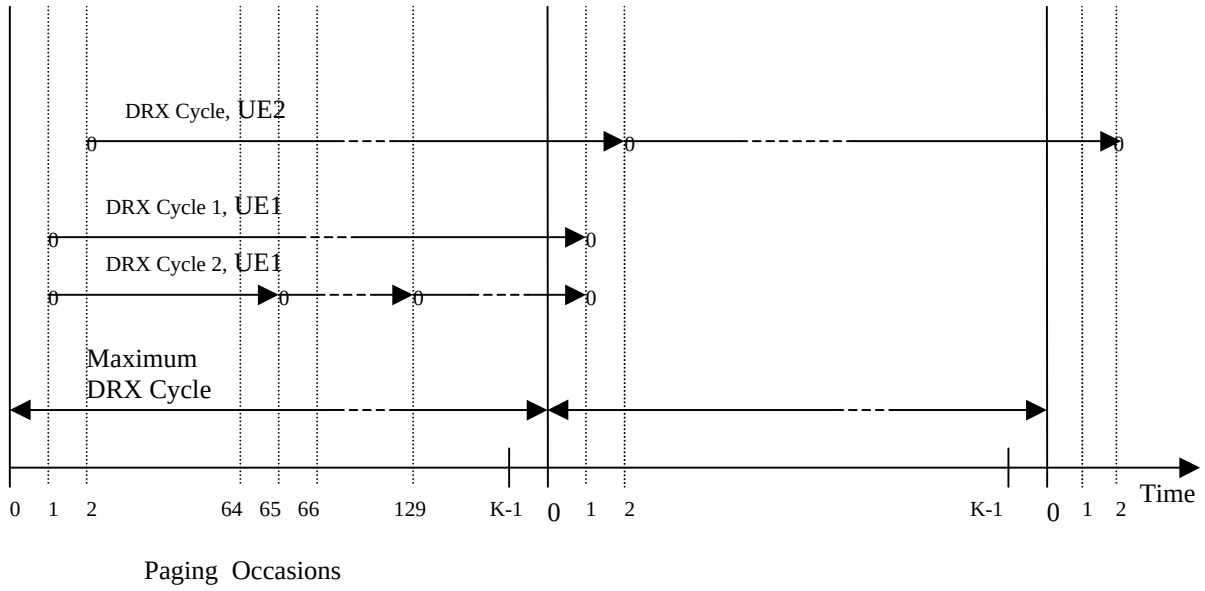

Figure 1: Example of usage of DRX concept.

The "0" used in the figure indicates the paging occasions where the UE reads initial paging information.

UE1 have a DRX cycle 1 that is the maximum length DRX cycle = K paging occasions long and an Initial Paging Occasion calculated to be 1. UE1 have also a second DRX cycle that is 64(2^8) paging occasions long. Note that the initial paging occasion is always the same for DRX cycle 1 and 2 and the DRX cycle 1 is always a multiple of DRX cycle 2.

UE2 have the maximum length DRX cycle in the cell that is K paging occasions long and an Initial Paging Occasion calculated to be 2.

Note that all DRX cycles in a cell is always a multiple of the maximum DRX cycle for that cell.

The upper limit for K =M is determined by the periodicy of the Cell System Frame Number (SFN), see [1], broadcasted on BCH expressed as number of paging occasions. K should be a multiple of the number of paging occasions possible during a frame, in order for the DRX cycle to be periodical also with regards to the frame structure. This enables the UE to use the cell SFN as a reference for choosing the initial paging occasion. IMSI and the number of paging occasions during the chosen Maximum DRX cycle will determine the initial paging occasion.

If the selectable DRX cycles can be expressed as 2^n where n is an integer the paging occasions for a particular UE using different DRX cycles in parallel will coincide, i.e. different CN domains may page the UE at the same paging occassion.

If K is a multiple of the number of paging occasions possible during a frame and K can be expressed as 2^i where i is an integer, it is possible to define DRX cycles ranging from 1,2,4 to M. If K can not be expressed as 2^i where i is an integer, different values of K will allow for different minimum DRX cycles. However the special case when the UE listens to all paging occasions may also exist. Note also that the maximum DRX cycle will always be allowed.

Examples:

Assume K is chosen to be 8*72 frames = 8*288= 2304 paging occasions long. The possible DRX cycles will be 2304, 1152, 576, 288, 144, 72, 36, 18 and 9 paging occasions (5.76 seconds down to 22.5 ms).

Assume K is chosen to be 8* 64 frames=2^8 =2048 paging occasions long. The possible DRX cycles will be 2048, 1024, 512, 256, 128, 64, 32, 16, 8, 4, 2, and 1.

The sliding in absolute time for the paging occasions as indicated in [1] can be achieved by not defining a paging occasion in absolute time but rather as the resulting time instance after the sliding time offset have been applied. Then the sliding will have a periodicy by itself and be defined by the cell SFN.

3.2 Suggested properties of the DRX

The following properties of DRX are suggested:

- It should be possible to use separate DRX cycles in Idle Mode for the different CN domains.
- It should be possible to use separate DRX cycles for a UE in Cell Connected state and URA Connected state.

- The default DRX cycles for the different CN domains and Cell Connected state and URA Connected state are broadcasted in each cell.
- The DRX cycles for Idle mode within a location or routing area should be handled by respective CN domain.
- The DRX cycles for UTRAN Connected mode should be handled by UTRAN.
- In Idle mode the UE use the broadcasted or individually assigned DRX cycles.
- In Idle mode the UE may request an individual DRX cycle (e.g. at attachment or at location update) to each CN.
- In UTRAN Connected mode the UE use the broadcasted or individually assigned DRX cycles.
- In UTRAN Connected mode the UE may request individual DRX cycles (e.g. at Cell/URA update) to be associated with Cell Connected or URA Connected state.
- IMSI, the paging group cycle, and the Cell System Frame Number broadcasted in a cell define the initial paging occasion for a particular UE.

3.3 Suggested DRX parameters

The following DRX parameters is suggested to be broadcasted in each cell:

- The Maximum DRX cycle used in the cell.
- The Cell System Frame Number.
- Min, max and default DRX cycle for each CN domain.
- Min, max and default DRX cycle for URA Connected state
- Min, max and default DRX cycle for Cell Connected state.

4 Proposals

Include the definitions in chapter 2 of this document in chapter 3.1of 3GPP 25.304, [2].

Add a new chapter “Discontinuous Reception” to 3GPP 25.304, [2].

It is also proposed to edit and send a liaison statement to WG1 and ask for their opinion of the proposed DRX concept and definitions.

5 References

[1] TS 25.211 V2.0.0, Physical channels and mapping of transport channels onto physical channels (FDD)
[2] 3GPP 25.304 V1.0.0;"UE Procedures in Idle Mode", 1999-04