**3GPP TSG RAN WG1 Meeting #103-e R1-2009754**

**e-Meeting, October 26th – November 13th, 2020**

**Title: [draft]** LS on Paging Enhancement

**Response to:**

**Release:** Rel-17

**Work Item:** NR\_UE\_pow\_sav\_enh-Core

**Source:** MediaTek, RAN1

**To:** RAN2

**Cc:**

**Contact Person:**

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**Attachments:** None

**1. Overall Description:**

RAN1 discussed paging enhancement and reached the following agreements in RAN1 #103-e meeting:

Agreements:

Observation: For NR idle/inactive-mode UEs with 10% group paging rate, paging early indication without UE sub-grouping can achieve the following power saving gains w.r.t. Rel-16:

* [0%] - [22.8%] where the baseline assumes 1 SS burst for synchronization before PO reception
  + Note: [0%] means UE can apply the baseline behavior if the time offset between the utilized SS burst and PO is small.
* [5.0%] - [32.0%]  where the baseline assumes 2 SS bursts for synchronization before PO reception
* [10.2%] - [67.7%]  where the baseline assumes 3 SS bursts for synchronization before PO reception

The power saving gains will become lower for higher group paging rate.

The power saving gains are dependent on the assumptions about placement of PEI and PO relative to SSB.

The power saving gains may vary with different paging early indication design.

Agreements:

Observation: For NR idle/inactive-mode UEs, UE sub-grouping indication within a PO can provide the following power saving gains w.r.t. Rel-16:

* If the original group paging rate is 10%:
  + [0.3%] - [1.1%] where the baseline assumes 1 SS burst for synchronization before PO reception
  + [0.4%] - [0.8%] where the baseline assumes 2 SS bursts for synchronization before PO reception
  + [0.3%] - [1.0%] where the baseline assumes 3 SS bursts for synchronization before PO reception
* Some sources also evaluated performance if the original group paging rate is in the range between 20% and 80% and showed following results:
  + [0.7%] - [7.6%] where the baseline assumes 1 SS burst for synchronization before PO reception
  + [0.8%] - [3.0%] where the baseline assumes 2 SS bursts for synchronization before PO reception
  + [0.5%] - [4.7%] where the baseline assumes 3 SS bursts for synchronization before PO reception

The number of UE sub-groups evaluated ranges from 2 to 16.

Some companies show concern on assuming group paging rate larger than 60%.

Note: It is FFS in RAN1 another group paging rate > 10% for the evaluation of Rel-17 paging enhancement.

Agreements:

Observation: For NR idle/inactive-mode UEs, UE sub-grouping indication carried in paging early indication can provide the following power saving gains w.r.t Rel-16:

* If the original group paging rate is 10%:
  + [10.6%] –[19.1%] where the baseline assumes 1 SS burst for synchronization before PO reception
  + [16.0%] –[36.0%] where the baseline assumes 2 SS bursts for synchronization before PO reception
  + [14.3%] –[46.0%] where the baseline assumes 3 SS bursts for synchronization before PO reception
* Some sources also evaluated performance if the original group paging rate is in the range between 20% and 60% and showed following results:
  + [8.0%] –[19.1%] where the baseline assumes 1 SS burst for synchronization before PO reception
  + [18.1%] –[34.0%] where the baseline assumes 2 SS bursts for synchronization before PO reception
  + [20.6%] –[42.0%] where the baseline assumes 3 SS bursts for synchronization before PO reception

The additional power saving gains w.r.t. paging early indication without UE sub-grouping are given as follows:

* If the original group paging rate is 10%:
  + [0.6%] –[2.7%] where the baseline assumes 1 SS burst for synchronization before PO reception
  + [0.6%] –[4.0%] where the baseline assumes 2 SS bursts for synchronization before PO reception
  + [0.6%] –[4.7%] where the baseline assumes 3 SS bursts for synchronization before PO reception
* Some sources also evaluated performance if the original group paging rate is in the range between 20% and 60% and showed following results:
  + [1.3%] –[8.0%] where the baseline assumes 1 SS burst for synchronization before PO reception
  + [2.1%] –[13.0%] where the baseline assumes 2 SS bursts for synchronization before PO reception
  + [3.3%] –[16.1%] where the baseline assumes 3 SS bursts for synchronization before PO reception

The number of UE sub-groups evaluated ranges from 2 to 16.

The power saving gains are dependent on the assumptions about placement of PEI and PO relative to SSB.

Note: It is FFS in RAN1 another group paging rate > 10% for the evaluation of Rel-17 paging enhancement.

Note: Not all sources providing results for paging early indication without UE sub-grouping also provide results for paging early indication with UE sub-grouping.

Agreements:

Observation:For NR idle/inactive-mode UEs with 10% group paging rate, cross-slot scheduling with K0 = 1, which can be supported by Rel-15/Rel-16 for Type 2 CSS, can provide the following power saving gains w.r.t. same-slot scheduling (K0 = 0):

* [<1%] –[2.5%] where the baseline assumes 1 SS burst for synchronization before PO reception
* [<1%] -[1.6%] where the baseline assumes 2 SS bursts for synchronization before PO reception
* [<1%] -[1.44%] where the baseline assumes 3 SS bursts for synchronization before PO reception

One source shows that cross-slot scheduling with K0 = 32, which cannot be supported by Rel-15/Rel-16 for Type 2 CSS, can provide the following power saving gains w.r.t. same-slot scheduling (K0 = 0):

* [0%] where the baseline assumes 1 SS burst for synchronization before PO reception
* [6.3%] where the baseline assumes 3 SS bursts for synchronization before PO reception

The power saving gain will become lower with higher group paging rate.

Agreements**:** For NR idle/inactive-mode paging enhancement, paging early indication before paging occasion is supported from RAN1 perspective

FFS: Physical layer design based on DCI, SSS or TRS/CSI-RS

**2. Actions:**

**To RAN2:**

RAN1 respectfully asks RAN2 to take the above information into account for RAN2’s future works. RAN1 also kindly asks RAN2 to inform RAN1 if there is anything that RAN1 should take into consideration in the physical layer design for this feature, including any other progress RAN2 has made in this WI which may have RAN1 impact.

**3. Date of Next RAN1 Meetings:**

TSG RAN WG1 Meeting #104-e 25 Jan. - 05 Feb., 2021 e-Meeting

TSG RAN WG1 Meeting #104-bis-e 12 Apr. - 20 Apr., 2021 e-Meeting