3GPP TSG RAN # 93e

RP-212003

13th September – 17th September 2021

Discussion on potential down scoping for paging enhancement in Rel-17 UE Power Saving

Agenda Item: 9.3.2.3

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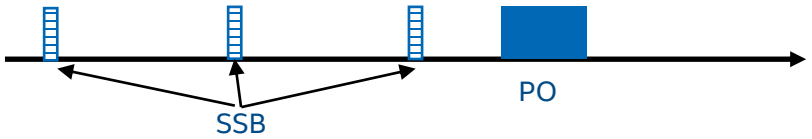
Paging Early Indication (PEI) in Rel-17

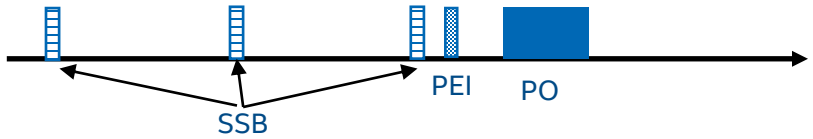
- In RAN1 106e, following options were discussed as PEI candidates, but no consensus was reached for down selection
  - PDCCH-based PEI
  - SSS-based PEI
- Two main concerns on PDCCH-based PEI (which are elaborated more in subsequent slides)
  - Meaningful power saving gain of PDCCH PEI in real/typical UE implementation is questionable
  - Amount of specification work for support of PDCCH PEI based on new DCI format may not be accommodated in two remaining meetings
- Although SSS-based PEI can result in higher power saving gain than PDCCH-based PEI, necessary specification work to support SSS-based PEI may not be completed in two meetings

On power saving gain of PEI candidates

- In our view, whether PDCCH PEI could result in meaningful power saving gain with respect to legacy paging is questionable
  - LS from RAN4 to RAN1 in R1-2104170 (R4-2105799) show that UE needs to have RS with separation of 2 ms or 2 slots to perform AGC and channel tracking → this implies at least 2 SSB processing is needed before detection of PDCCH PEI, since PEI may not be used for tracking itself
    - In poor link conditions, more than 2 SSB processing maybe necessary. Since UE may not know link condition when UE wakes up from deep sleep, it is expected that UE would take preparation for necessary CFO compensation assuming worst case
  - It is expected that PEI is placed close to the PO so that UE could potentially remain in deep sleep longer → this implies there may not be further SSB processing performed by the UE after PEI detection before PO; otherwise UE needs to stay wake-up till PO
    - Hence, UE's preparation in terms of number of SSBs processing before waking up to PO is common for PDCCH PEI as well in typical implementation
    - Power saving gain from skipping one or more SSBs compared to legacy paging may not be achievable for PDCCH PEI
- If SSS-based PEI is used, skipping one or more SSBs is possible assuming tracking functionality of the SSS-based signal to observe UE power saving.



Legacy Paging: Multiple SSB processing before PO may be required considering unknown link conditions before



With PDCCH PEI: Multiple SSB processing is required before detecting PDCCH PEI and paging PDCCH/PDSCH in the PO

Specification efforts needed for PEI candidates

- RAN1 specification work for paging enhancement didn't progress much at all, except the agreement on number of maximum UE sub-groups. The followings are still open:
  - PEI signal/channel design
  - Which signal/channel to carry UE sub-grouping indication (i.e., in PEI and/or paging DCI)
- In the Table below, we identify relevant areas (list is not exhaustive) for which significant specification work is needed for the PEI candidates
- Considering the fact that signal/channel design is still fully open, we are concerned that in next two meetings completion of necessary specification work of a good (but not rushed) PEI design is possible

Minimum Specification efforts needed for PDCCH PEI	Minimum Specification efforts needed for SSS PEI
• Details of the design of a new DCI format - Payload/contents, mapping of information bits to UE sub-groups and other information content, if any • Details of higher layer configuration, including SS • Details of the procedures of PEI monitoring, and identification of MOs before PO • Details of UE behavior regarding PEI detection (Behv- A and/or Behv- B)	• Details of higher layer configuration, such as - time/frequency resource allocation and sequence mapping to sub-groups; • Details of Common sequence definition and cover code design; • Details of monitoring occasions before PO • Details of UE behavior regarding PEI detection (Behv- A and/or Behv- B)

Summary of observations and proposal

- Observation 1: RAN1 specification work regarding PEI didn't progress at all, with all the details of PEI signal/channel design are still fully open
- Observation 2: Significant specification work is needed for both PDCCH and SSS-based PEIs which may not be completed in next two meetings.
- **Proposal: No PEI is supported in Rel-17.**

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