3GPP TSG-RAN WG4 Meeting # 102-e R4-2206480

Electronic Meeting, 21 February – 3 March 2022

**Source:** Sony

**Title:** WF on feasibility study on max power reduction for PRACH, PUCCH, and full-PRB PUSCH

**Agenda item:** 12.9.3.1

**Document for:** Approval

1. Background

The WI [1] is to study and if found feasible, specify support power reduction for PRACH, PUCCH, and full-PRB PUSCH, with a maximum reduction of e.g. 3 dB below sub-PRB PUSCH power for UEs supporting PUSCH sub-PRB resource allocation.

The WI has been discussed for several meetings including RAN4 #102-e [2].

This tdoc is a WF on feasibility study on max power reduction for PRACH, PUCCH, and full-PRB PUSCH. It is based on the discussions in RAN4 #102-e and the following contributions to RAN4 #102-e.

|  |  |  |
| --- | --- | --- |
| **TDoc** | **Title** | **Source** |
| R4-2204042 | On max power reduction for PRACH, PUCCH, and full-PRB PUSCH | Sony |
| R4-2205546 | RF impact analysis on R17 eMTC WID | Ericsson |

1. Discussion

**Summary of benefits / drawbacks of higher power sub-PRB transmission**

The advantages and drawbacks of supporting power reduction for PRACH, PUCCH, and full-PRB PUSCH, with a maximum reduction of e.g. 3 dB below sub-PRB PUSCH power for UEs supporting PUSCH sub-PRB resource allocation have been studied.

One company observed that [5]:

* If the output power were kept the same for PUSCH sub-PRB but reduced for PRACH, PUCCH and full-PRB PUSCH, there will be an MCL loss for the channels subject to a power reduction which translates into a coverage loss.
* From control channel coverage point of view, the new power behaviour UE will be the same with a power class UE of which the rated power is 3 dB less.
* If only PUSCH sub-PRB transmissions were boosted, there might not be benefits in terms of coverage since the MCL of full-PRB PUSCH and other physical channels would remain the same.
* From a resource utilization perspective, simulation results showed that even if a 3dB power boosting were applied to sub-PRB using ℼ /2-BPSK no gain would be observed with respect to a non-boosted sub-PRB transmission using QPSK.
* Reducing the full-PRB transmission power generally is against the UE rated power definition.

One company observed that, for higher relative power transmission of sub-PRB PUSCH, the benefits summarized in Table 1 are obtained.

Table 1 – Benefits of higher relative power for sub-PRB PUSCH transmission

|  |  |  |
| --- | --- | --- |
| **Aspect** | **Network benefit** | **UE benefit** |
| Coverage | Improved coverage for higher data rates in CE Mode B.  Improved coverage in CE Mode A. | Improved coverage for higher data rates in CE Mode B.  Improved coverage in CE Mode A. |
| Spectral efficiency | Improved spectral efficiency. |  |
| Battery lifetime |  | Improved battery lifetime / less frequency battery replacement cycles / smaller batteries |
| Latency | Reduced application latency. | Reduced application latency. |

Note1: the table assumes that the coverage of PUSCH, PRACH and full-PRB PUSCH is balanced (equal) in CE Mode B when the full-PRB PUSCH supports a data rate of 1400bps. When PUSCH supports a higher data rate, e.g. 3000kbps, the system UL coverage is limited by the coverage of the full-PRB PUSCH.

Note2: the table assumes that the coverage bottleneck of CE Mode A is due to full-PRB PUSCH.

**Potential approaches to specifying max power reduction**

The following approaches to specifying max power reduction of physical channels relative to the transmit power of the sub-PRB PUSCH were identified:

* Alt A: Follow the framework of NR pi/2 BPSK power boosting if RAN4 decides that there is an overall gain from the subPRB boosting.

- Focus on PC5 CAT-M1 device for the potential power boosting to PC3 on subPRB transmission

* Alt B: Define full power transmission for 2-of-3 sub-PRB and allow power reduction for full-PRB PUSCH, PRACH and PUCCH

- Add supplementary MPR for full PRB transmissions for UE CAT-M1 PC3 and PC5

There was insufficient time to progress the above two alternatives in Rel-17.

**Summary**

It is apparent that a study of the benefits and drawbacks of higher relative power transmission has been performed. It is also apparent that there is insufficient allotted time available to specify this feature in the Rel-17 specifications.

1. Way forward

The following proposals are made:

**Proposal 1: The status report for this work item indicates that the following have been studied:**

* **Benefits and drawbacks of power reduction for PRACH, PUCCH, and full-PRB PUSCH, with a maximum reduction of e.g. 3 dB below sub-PRB PUSCH power for UEs supporting PUSCH sub-PRB resource allocation**
* **Potential approaches that could be taken for specifying power reduction for PRACH, PUCCH, and full-PRB PUSCH, with a maximum reduction of e.g. 3 dB below sub-PRB PUSCH power for UEs supporting** **PUSCH sub-PRB resource allocation**

**Proposal 2: RAN4 recommends that the WID objective is modified to focus on the “study the feasibility” aspect:**

* + For UEs supporting PUSCH sub-PRB resource allocation, study the feasibility of  ~~and if found feasible~~ specifying support of power reduction for PRACH, PUCCH, and full-PRB PUSCH, with a maximum reduction of e.g. 3 dB below sub-PRB PUSCH power. [LTE-MTC] [RAN4]

According to usual 3GPP procedures, companies could aim to progress the specification of this work in TEI18, if there is sufficient support.

1. Reference
2. RP-211340, “WID revision: Additional enhancements for NB-IoT and LTE-MTC”, *Huawei, HiSilicon*
3. R4-2206420, “Email discussion summary for [102-e][120] LTE\_NR\_Other\_WI, *Moderator (Huawei)*
4. R4-2204042, “On max power reduction for PRACH, PUCCH, and full-PRB PUSCH”, *Sony*
5. R4-2205546, “RF impact analysis on R17 eMTC WID”, *Ericsson*
6. R4-2114344, “RF impact analysis on Rel-17 eMTC WID”, *Ericsson*