**3GPP TSG RAN WG1 #101 R1-** **20xxxxx**

**May 25th – June 5th, 2020**

**Agenda item:** 7.2.5.4

**Source:** Qualcomm

**Title:** Summary of the Remaining Issues on HARQ and Scheduling Enhancements for URLLC

**Document for:** Discussion and Decision

# 1 Introduction

In this document, proposals related to out-of-order operation for NR URLLC are summarized. The related conclusion from RAN1 #99 is as follows:

**Conclusion:**

* *For Rel. 16 URLLC, no support of out-of-order/overlap PDSCH/HARQ and out-of-order/overlap PUSCH operation.*

In the RAN1#100b meeting, the following agreement on scheduling/HARQ enhancements was reached:

***Agreements:***

* *If a UE is scheduled with a first PDSCH and a second PDSCH which is starting later than the first PDSCH on a given serving cell, the corresponding PUCCHs carrying HARQ-ACK with different priorities can overlap in time.*
	+ *FFS: For supporting this feature, a new FG, separate from FG 12-1, will be introduced.*
	+ *FFS: The PUCCH associated with the second PDSCH cannot be scheduled for transmission at or earlier than PUCCH associated with the first PDSCH.*

# 2 Proposals

**Issue #1: “Overlapping PUCCHs carrying HARQ-ACK with different priorities”**

The related proposals are captured in the following table:

|  |  |
| --- | --- |
| **Company**  | **Proposal** |
| ZTE | * No new FG is needed.
* No additional restrictions for supporting PUCCH+PUCCH overlap for carrying HARQ-ACK of PDSCHs scheduled on the same carrier is needed.
 |
| vivo | * 1st preference: separate UE feature is not needed.
	+ The starting symbol of PUCCH associated with the second PDSCH can be scheduled for transmission at or earlier than the starting symbol of PUCCH associated with the first PDSCH.
* 2nd preference: a new FG, separate from FG 12-1 can be introduced. UE feature definition as following:
	+ The starting symbol of PUCCH associated with the second PDSCH is scheduled for transmission earlier than the starting symbol of PUCCH associated with the first PDSCH.
 |
| Ericsson | * The FG discussion should be handled as part of the UE feature discussion.
* No additional restrictions for supporting PUCCH+PUCCH overlap for carrying HARQ-ACK of PDSCHs scheduled on the same carrier is needed.
 |
| Nokia/NSB | * Do not introduce a new UE feature group, separate from FG 12-1, for the support of two PUCCHs carrying HARQ-ACK with different priorities overlapping in time.
* In case two PUCCHs carrying HARQ-ACK with different priorities overlapping in time, the PUCCH associated with the second PDSCH can be scheduled for transmission at or earlier than PUCCH associated with the first PDSCH.
 |
| OPPO | * If a UE is scheduled with a low-priority PDSCH and a high-priority PDSCH which is starting later than the low-priority PDSCH on a given serving cell, the corresponding PUCCHs carrying HARQ-ACK with different priorities can overlap in time.
	+ It is not expected that earlier PUCCH corresponds with low priority PDSCH
 |
| Huawei/HiSi | * No new FG is introduced to support overlapping PUCCH carrying HARQ-ACK with different priorities.
* If a UE is scheduled with a first PDSCH and a second PDSCH which is starting later than the first PDSCH on a given serving cell, the corresponding PUCCHs carrying HARQ-ACK with different priorities can overlap in time and the PUCCH associated with the second PDSCH can be scheduled for transmission at or earlier than PUCCH associated with the first PDSCH.
 |
| NTT DOCOMO | * Separate FG is not needed for supporting PUCCH carrying HARQ-ACK with different priorities overlapping in time.
* Two PUCCHs carrying HARQ-ACK with different priorities associated with two PDSCHs scheduled on the same carrier in one slot/sub-slot can be overlapping in time regardless of the order of the two PUCCH resources as long as the two PUCCH resources are in the same slot/sub-slot and dropping timeline is satisfied.
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# 4 Summary of the Proposals

Regarding the remaining FFS points, the companies’ views can be summarized as follows:

1. New FG for supporting PUCCH/PUCCH collision carrying HARQ-ACK with different priorities for PDSCHs scheduled on the same carrier:
	* No: ZTE, vivo (1st preference), Nokia/NSB, HW/HiSi, NTT
	* Discuss as part of UE feature discussion: Ericsson
	* Yes: vivo (2nd preference)
2. Restrictions for collision handling:
	* No restriction: ZTE, vivo (1st preference), Ericsson, Nokia/NSB, HW/HiSi, NTT DOCOMO
	* Introducing restriction: vivo (2nd preference), OPPO

The feature lead recommendation then is:

1. No email discussion for introducing a new FG; it can be discussed under the UE feature discussion.
2. Conclude that no scheduling restriction for handling PUCCH/PUCCH collision carrying HARQ-ACK with different priorities for PDSCHs scheduled on the same carrier is needed (related to the second FFS point.)

# 4 References

**[1] R1-2003320, “*Remaining issues on scheduling/HARQ enhancements for NR URLLC*,” ZTE**

**[2] R1-2003390, “*Enhancements for scheduling/HARQ*,” vivo**

**[3] R1-2003442, “*Remaining issue of scheduling/HARQ for NR URLLC*,” Ericsson**

**[4] R1-2003580, “*Maintenance of Rel. 16 URLLC scheduling/HARQ enhancements*,” Nokia, NSB**

**[5] R1-2004117, “*Enhancements to scheduling and HARQ*,” OPPO**

**[6] R1-2004156, “*Corrections on operation of out-of-order*,” Huawei, HiSilicon**

**[7] R1-2004392, “*Remaining issue for scheduling and HARQ enhancements for URLLC*,” NTT DOCOMO**