**3GPP TSG RAN WG1 #100bis R1-200xxxx**

**e-Meeting, April 20th – 30th, 2020**

**Agenda Item:** 7.2.5.7

**Source:** Moderator (LG Electronics)

**Title:** Summary of [101-e-NR-L1enh-URLLC-IIoTenh-01]

**Document for:** Discussion and decision

# Introduction

According to discussion at the preparation phase, the following email thread is allocated by Chairman for further discussion:

[101-e-NR-L1enh-URLLC-IIoTenh-01] Email discussion on the following issues by 5/29 – Duckhyun (LGE)

* 3.1. Spec text in case of UE supporting 1 unicast PDSCH per slot
* 3.2. Text proposal for collision between dynamic PDSCH and multiple SPS PDSCHs
* 3.5. HARQ-ACK for SPS PDSCH cancelled by dynamic SFI/DCI
* 4.3. PUCCH resource selection for SPS HARQ-ACK and SR

To address the identified issues from companies’ contributions related to the above email thread, the suggestions for the issues are provided in Section 2. [In Section 3, a few open issues identified are listed up so companies are encouraged to provide your input/feedback in the next meeting in order to facilitate the discussion]. In section [4], the outcome from [101-e-NR-L1enh-URLLC-IIoTenh-01] are provided including all the agreements and all the endorsed TPs.

# Email discussions

## Issue 3.1: Spec text in case of UE supporting 1 unicast PDSCH per slot

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| [Agreement from RAN1#100b-e]Agreements:* Note: this supersedes the agreed TP to Sec. 5.1 in TS 38.214 from Email discussion [100b-e-NR-L1enh-URLLC-IIoTenh-03]
* Adopt the following text proposal for section 5.1 in TS 38.214:

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| 5.1        UE procedure for receiving the physical downlink shared channel**<**Unchanged text is omitted>If more than one PDSCH on a serving cell each without a corresponding PDCCH transmission are in a slot, ~~partially or fully overlapping in time, a UE is not required to receive a PDSCH among these PDSCHs other than one with the lowest configured~~ *~~sps-ConfigIndex~~*~~.~~ after resolving overlapping with symbols in the slot indicated as uplink by *tdd-ULDL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated*, a UE receives one or more PDSCHs without corresponding PDCCH transmissions in the slot as specified below.‒         Step 0: set *j*=0-number of selected PDSCH for decoding. Set *Q* to set of activated PDSCHs without corresponding PDCCH transmissions within the slot‒         Step 1: A UE receives one PDSCH with the lowest configured *sps-ConfigIndex* within *Q*, set *j*=*j*+1. Designate the received PDSCH as survivor PDSCH.‒        Step 2: The survivor PDSCH in step 1 and any other PDSCH(s) overlapping (even partially) with the survivor PDSCH in step 1 are excluded from *Q*. ‒        Step 3: Repeat step 1 and 2 until *Q* is empty or *j* is equal to the number of unicast PDSCHs in a slot supported by the UE **<**Unchanged text is omitted> |

 |

Since above agreement is addressing general procedure, there was a short discussion whether to remove or update a spec text for UE supporting 1 unicast PDSCH per slot. Following three options on this issue was listed in RAN1#100b-e, companies showed their preferences by contributions in this meeting.

**Option 1: Adopt the following text proposal for section 5.1 in TS 38.214:**

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| 5.1        UE procedure for receiving the physical downlink shared channel**<**Unchanged text is omitted>~~If a UE does not indicate a capability to receive more than one unicast PDSCH per slot, and if there is more than one PDSCH on a serving cell each without a corresponding PDCCH transmission in a slot, the UE is not required to receive a PDSCH among these PDSCHs other than one with the lowest configured~~ *~~sps-ConfigIndex~~* ~~on the serving cell.~~**<**Unchanged text is omitted> |

**Option 2: Adopt the following text proposal for section 5.1 in TS 38.214:**

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| 5.1        UE procedure for receiving the physical downlink shared channel**<**Unchanged text is omitted>If a UE does not indicate a capability to receive more than one unicast PDSCH per slot, and if there is more than one PDSCH on a serving cell each without a corresponding PDCCH transmission in a slot, after resolving overlapping with symbols in the slot indicated as uplink by *tdd-ULDL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated,* the UE is not required to receive a PDSCH among ~~these~~ PDSCHs other than one with the lowest configured *sps-ConfigIndex* on the serving cell.**<**Unchanged text is omitted> |

**Option 3: Keep the paragraph (no spec change)**

This option would not work properly. At least the text should take into account the aspect on conflict with semi-static UL.

Companies shows preferences by contributions in this meetings:

* Option 1: vivo, CATT, Samsung, Spreadtrum, LG
	+ Reasons: Previous agreement already covers a UE incapable of the receiving more than one unicast PDSCH per slot
* Option 2: ZTE
	+ Option 2 is more explicit for the case that UE does not indicate a capability to receive more than one unicast PDSCH per slot.

## FL suggestion on issue 3.1

Based on contributions, Both Option 1 and Option 2 seems work. If there is no differences on the UE behavior, I would like to suggest to take simpler one.

**Proposal 1: Take Option 1 as agreed TP to reflect previous agreements.**

Companies are encouraged to provide your feedback (or editorial correction) if any on above proposal.

**Comment:**

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| Company | Comment if any |
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## Issue 3.2: Text proposal for collision between dynamic PDSCH and SPS PDSCHs

[Open issues to be discussed from [IIoTenh-01] in RAN1#100b-e]

In RAN1#100bis-e, the following agreement has been made. But TP has not been made due to lack of time.

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| **Agreements:** If dynamic scheduled PDSCH is overlapped with multiple SPS PDSCHs after resolving overlapping for SPS PDSCHs, the reference SPS PDSCH for the 14 symbols is an SPS PDSCH having the earliest starting symbol among SPS PDSCHs overlapped with dynamic scheduled PDSCH after resolving overlapping for SPS PDSCHs.  |

For your information, this is a related part of TS 38.214:

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| The UE is not expected to decode a PDSCH scheduled in a serving cell with C-RNTI or MCS-C-RNTI and another PDSCH scheduled in the same serving cell with CS-RNTI if the PDSCHs partially or fully overlap in time except if the PDCCH scheduling the PDSCH with C-RNTI or MCS-C-RNTI ends at least 14 symbols before the start of the PDSCH with CS-RNTI without the corresponding DCI, in which case the UE shall decode the PDSCH scheduled with C-RNTI or MCS-C-RNTI. |

Current specification is considering two of PDSCH. If multiple SPS PDSCH are required to receive and overlapped with dynamic PDSCH, some of them may meet timeline but others may not. In this case, UE shall decode dynamic PDSCH for some SPS PDSCH, at same time UE is not expected to decode both dynamic PDSCH and others SPS PDSCH. The agreement was made in order to solve the problem by defining reference SPS PDSCH and dropping whole SPS PDSCHs if the reference SPS PDSCH meets the timeline.

In [4], following figure shows an example of that



Figure: Dynamic PDSCH overlapped with multiple SPS PDSCHs.

For this issue, Following TP and proposals are provided by companies’ contributions.

**<Samsung, [8]>**

***Proposal 2: Support to revise following text in TS 38.214.***

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| The UE is not expected to decode a PDSCH scheduled in a serving cell with C-RNTI or MCS-C-RNTI and another PDSCH scheduled in the same serving cell with CS-RNTI if the PDSCHs partially or fully overlap in time after resolving overlapping for PDSCHs without corresponding PDCCH transmissions except if the PDCCH scheduling the PDSCH with C-RNTI or MCS-C-RNTI ends at least 14 symbols before the earliest starting symbol of the PDSCH(s) with CS-RNTI without the corresponding DCI, in which case the UE shall decode the PDSCH scheduled with C-RNTI or MCS-C-RNTI. |

**<Nokia, [4]>**

**Proposal 1: If the 14-symbol timeline for overwriting SPS PDSCH with a dynamic PDSCH is not fulfilled for a first SPS PDSCH, but fulfilled for subsequent SPS PDSCH(s), the UE does not receive any of the SPS PDSCHs overlapping with the dynamic PDSCH.**

**<LG, [10]>**

Note that the red text in the below TP has been already endorsed in RAN1#100bis-e (R1-2003141).

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| 5.1 UE procedure for receiving the physical downlink shared channel**<Unchanged text is omitted>**The UE is not expected to decode a PDSCH scheduled in a serving cell with C-RNTI or MCS-C-RNTI and one or multiple PDSCHs scheduled in the same serving cell with CS-RNTI if the PDSCHs partially or fully overlap in time after resolving overlapping for PDSCHs without corresponding PDCCH transmissions except if the PDCCH scheduling the PDSCH with C-RNTI or MCS-C-RNTI ends at least 14 symbols before the start of the earliest PDSCH among these PDSCHs with CS-RNTI without the corresponding DCI, in which case the UE shall decode the PDSCH scheduled with C-RNTI or MCS-C-RNTI. |

## FL suggestion on issue 3.2

To remove ambiguity mentioned above, it seems necessary to change current specification. At least, uncaptured agreement should be captured. Based on contributions, I tried to merge provided TP to capture previous agreement.

**Proposal 2: Adopt following TP for section 5.1. in TS 38.214
(Note:** that the blue text in the below TP has been already endorsed in RAN1#100bis-e)

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| The UE is not expected to decode a PDSCH scheduled in a serving cell with C-RNTI or MCS-C-RNTI and ~~another~~ one or multiple PDSCH(s) scheduled in the same serving cell with CS-RNTI if the PDSCHs partially or fully overlap in time after resolving overlapping for PDSCHs without corresponding PDCCH transmissions except if the PDCCH scheduling the PDSCH with C-RNTI or MCS-C-RNTI ends at least 14 symbols before the earliest starting symbol of the PDSCH(s) with CS-RNTI without the corresponding DCI, in which case the UE shall decode the PDSCH scheduled with C-RNTI or MCS-C-RNTI. |

Companies are encouraged to provide your feedback (or editorial correction) if any on above proposal.

**Comment:**

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| Company | Comment if any |
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## Issue 3.5 HARQ-ACK for SPS PDSCH cancelled by dynamic SFI/DCI

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| Agreements:HARQ-ACK feedback for a SPS PDSCH is included in the HARQ-ACK codebook when the SPS PDSCH is cancelled by DCI/dynamic SFI in which case NACK is generated for the SPS PDSCH.* For type-1 codebook, the main bullet is not applied if only a single HARQ-ACK bit, for an SPS PDSCH, is mapped on a PUCCH; otherwise, the main bullet is applied.
* For type-2 codebook, the main bullet is applied.
 |

For your convenience, the “tentative” TP can be provided as below so **companies are encouraged to check it out and to bring the TP for capturing RAN1 intention properly.**

Tentative TP proposal:

**Adopt the following text proposal for section 9.1.2 in TS 38.213**

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| 9.1.2  Type-1 HARQ-ACK codebook determination<unnecessary part is omitted>within the cid:image002.png@01D61E3A.180D7580 occasions for candidate PDSCH receptions as determined in Clause 9.1.2.1, the UE determines a HARQ-ACK codebook only for the SPS PDSCH release or only for the PDSCH reception or only for the SPS PDSCH receptions according to corresponding cid:image002.png@01D61E3A.180D7580 occasion(s) on respective serving cell(s), where the value of counter DAI in DCI format 1\_0 is according to Table 9.1.3-1 and HARQ-ACK information bits in response to more than one SPS PDSCH reception~~s~~ that the UE is configured to receive are ordered according to the following pseudo-code; otherwise, the procedures in Clause 9.1.2.1 and Clause 9.1.2.2 for a HARQ-ACK codebook determination apply.**<**Unchanged text is omitted>while $c<N\_{cells}^{DL}$ Set $s=0$ – SPS PDSCH configuration index: lower indexes correspond to lower RRC indexes of corresponding SPS configurations while $s<N\_{c}^{SPS}$Set $n\_{D}=0$ – slot index while $n\_{D}<N\_{c}^{DL}$if UE is configured to receive a SPS PDSCH in slot $n\_{D}$ for SPS PDSCH configuration $s$ on serving cell $c$, ~~and~~ except that the SPS PDSCH is not required to be received among overlapping SPS PDSCHs, if any according to [6, TS 38.214], or based on a UE capability for a number of PDSCH receptions in a slot according to [6, TS 38.214], or due to overlapping with a set of symbols indicated as uplink by *tdd-ULDL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated*$\tilde{o}\_{j}^{ACK}$ = HARQ-ACK information bit for this SPS PDSCH reception $j=j+1$;end if$n\_{D}=n\_{D}+1$;end while$s=s+1$;end while$c=c+1$;end while**<**Unchanged text is omitted> |

* The first part makes the pseudo-code in 9.1.2 be applied to the case for multiple HARQ-ACK bits only for SPS PDSCHs (without DG PDSCH) on a PUCCH (and not to be applied to the case for single HARQ-ACK bit for an SPS PDSCH).
* The second part is to include A/N bits for cancelled SPS PDSCH by dynamic SFI/DCI in the codebook for the case for multiple HARQ-ACK bits only for SPS PDSCHs without DG PDSCH on a PUCCH (for both type-1 and type-2 codebook).

The update of “or due to overlapping with a set of symbols indicated as uplink by *tdd-ULDL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated*” comes from QC’s offline comment to make sure that A/N bit for the cancelled SPS PDSCH by semi-static UL is not included in the codebook as in Rel-15.

For this issue, Following TP and proposals are provided by companies’ contributions.

**<ZTE, [1]>**

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| 9.1.2 Type-1 HARQ-ACK codebook determination...If a UE reports HARQ-ACK information in a PUCCH only for - a SPS PDSCH release indicated by DCI format 1\_0 with counter DAI field value of 1, or- a PDSCH reception scheduled by DCI format 1\_0 with counter DAI field value of 1 on the PCell, or - SPS PDSCH reception~~s~~within the cid:image002.png@01D61E3A.180D7580 occasions for candidate PDSCH receptions as determined in Clause 9.1.2.1, the UE determines a HARQ-ACK codebook only for the SPS PDSCH release or only for the PDSCH reception or only for ~~the~~ one SPS PDSCH reception~~s~~ according to corresponding cid:image002.png@01D61E3A.180D7580 occasion(s) on respective serving cell(s), where the value of counter DAI in DCI format 1\_0 is according to Table 9.1.3-1 and HARQ-ACK information bits in response to more than one SPS PDSCH reception~~s~~ that the UE is configured to receive are ordered according to the following pseudo-code; otherwise, the procedures in Clause 9.1.2.1 and Clause 9.1.2.2 for a HARQ-ACK codebook determination apply.**<**Unchanged text is omitted> |

**<Nokia, [4]>**

**Proposal 6: Adopt the following text proposal to capture the RAN1#100-bis-e agreement of “HARQ-ACK feedback for a SPS PDSCH is included in the HARQ-ACK codebook when the SPS PDSCH is cancelled by DCI/dynamic SFI in which case NACK is generated for the SPS PDSCH.”**

**<Samsung, [8]>**

***Proposal 5: For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits smaller than or equal to 11, if UCI only contains all known NACKs for the cancelled SPS PDSCHs in the HARQ-ACK codebook, UE does not transmit the PUCCH.***

***Proposal 7: For a Type-1 HARQ-ACK codebook, if a UE does not indicate the capability to receive more than one unicast PDSCH per slot, for an active BWP of a serving cell, following two alternatives can be considered,***

***Alt 1: it can be up to gNB’s implementation to ensure HARQ-ACK codebook construction.***

***Alt 2: when UE receives an SPS release DCI in a slot, UE will transmit HARQ-ACK for the release DCI and does not need to receive any SPS PDSCH in this slot.***

## FL suggestion on issue 3.5

Based on the contributions, TP is needed with some modification.

Except for the discussion on the TP, some companies raise issues such as PUCCH power control and order between SFI and SPS overlapping handling. Those issues will be discussed after the conclusion for tentative TP.

**Proposal 3: Adopt the following text proposal for section 9.1.2 in TS 38.213**

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| 9.1.2  Type-1 HARQ-ACK codebook determination<unnecessary part is omitted>If a UE reports HARQ-ACK information in a PUCCH only for - a SPS PDSCH release indicated by DCI format 1\_0 with counter DAI field value of 1, or- a PDSCH reception scheduled by DCI format 1\_0 with counter DAI field value of 1 on the PCell, or - SPS PDSCH reception(s)within the cid:image002.png@01D61E3A.180D7580 occasions for candidate PDSCH receptions as determined in Clause 9.1.2.1, the UE determines a HARQ-ACK codebook only for the SPS PDSCH release or only for the PDSCH reception or only for ~~the~~ one SPS PDSCH reception~~s~~ according to corresponding cid:image002.png@01D61E3A.180D7580 occasion(s) on respective serving cell(s), where the value of counter DAI in DCI format 1\_0 is according to Table 9.1.3-1 and HARQ-ACK information bits in response to more than one SPS PDSCH reception~~s~~ that the UE is configured to receive are ordered according to the following pseudo-code; otherwise, the procedures in Clause 9.1.2.1 and Clause 9.1.2.2 for a HARQ-ACK codebook determination apply.**<**Unchanged text is omitted>while $c<N\_{cells}^{DL}$ Set $s=0$ – SPS PDSCH configuration index: lower indexes correspond to lower RRC indexes of corresponding SPS configurations while $s<N\_{c}^{SPS}$Set $n\_{D}=0$ – slot index while $n\_{D}<N\_{c}^{DL}$if UE is configured to receive a SPS PDSCH in slot $n\_{D}$ for SPS PDSCH configuration $s$ on serving cell $c$, ~~and~~ except that the SPS PDSCH is not required to be received among overlapping SPS PDSCHs, if any according to [6, TS 38.214], or based on a UE capability for a number of PDSCH receptions in a slot according to [6, TS 38.214], or due to overlapping with a set of symbols indicated as uplink by *tdd-ULDL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated*$\tilde{o}\_{j}^{ACK}$ = HARQ-ACK information bit for this SPS PDSCH reception $j=j+1$;end if$n\_{D}=n\_{D}+1$;end while$s=s+1$;end while$c=c+1$;end while**<**Unchanged text is omitted> |

Companies are encouraged to provide your feedback (or editorial correction) if any on above proposal.

**Comment:**

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| Company | Comment if any |
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## Issue 4.3: PUCCH resource selection for SPS HARQ-ACK and SR

In Rel-16 a UE can have multiple SPS PDSCH configurations and a corresponding HARQ-ACK information that the UE needs to report can be larger than 2 bits. The current specifications do not capture the case of multiplexing SR with more than 2 HARQ-ACK information bits corresponding to multiple SPS PDSCHs. Samsung propose to include a reference to section 9.2.1 (multiple SPS PDSCHs) in addition to section 9.2.3 (one SPS PDSCH) and provide corresponding TP as follows.

**<Samsung, [8]>**

**Proposal 9: Capture multiplexing of SR with HARQ-ACK from multiple SPS PDSCH by adding a reference to clause 9.2.1 as follows.**

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| 9.2.5.1 UE procedure for multiplexing HARQ-ACK or CSI and SR in a PUCCH\*\*\* Unchanged text is omitted \*\*\*If a UE would transmit a PUCCH with  HARQ-ACK information bits in a resource using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 in a slot, as described in Clauses 9.2.1 and 9.2.3,  bits representing a negative or positive SR, in ascending order of the values of *schedulingRequestResourceId* and *schedulingRequestIDForBFR*, are appended to the HARQ-ACK information bits and the UE transmits the combined  UCI bits in a PUCCH using a resource with PUCCH format 2 or PUCCH format 3 or PUCCH format 4 that the UE determines as described in Clauses 9.2.1 and 9.2.3. If one of the SRs is a positive LRR, the value of the  bits indicates the positive LRR. An all-zero value for the  bits represents a negative SR value across all  SRs. \*\*\* Unchanged text is omitted \*\*\* |

## FL suggestion on issue 4.3

The proposal seems concrete and necessary.

**Proposal 4: Adopt the following text proposal for section 9.2.5.1 in TS 38.213**

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| 9.2.5.1 UE procedure for multiplexing HARQ-ACK or CSI and SR in a PUCCH\*\*\* Unchanged text is omitted \*\*\*If a UE would transmit a PUCCH with  HARQ-ACK information bits in a resource using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 in a slot, as described in Clauses 9.2.1 and 9.2.3,  bits representing a negative or positive SR, in ascending order of the values of *schedulingRequestResourceId* and *schedulingRequestIDForBFR*, are appended to the HARQ-ACK information bits and the UE transmits the combined  UCI bits in a PUCCH using a resource with PUCCH format 2 or PUCCH format 3 or PUCCH format 4 that the UE determines as described in Clauses 9.2.1 and 9.2.3. If one of the SRs is a positive LRR, the value of the  bits indicates the positive LRR. An all-zero value for the  bits represents a negative SR value across all  SRs. \*\*\* Unchanged text is omitted \*\*\* |

Companies are encouraged to provide your feedback (or editorial correction) if any on above proposal.

**Comment:**

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| Company | Comment if any |
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# Open issues to be discussed

For section 3, it is recommended for companies to take into account the issues carefully and to come back with sufficiently specific options/preference/suggestions to the next meeting so that we can complete RAN1 works on the relevant functionalities with respect to specification.

# Final outcome from [101-e-NR-L1enh-URLLC-IIoTenh-01]

# References

1. R1-2003323, Remaining issues on SPS enhancements, ZTE
2. R1-2003393, Other issues for URLLC, vivo
3. R1-2003445, Remaining Issue of Other Enhancements for NR URLLC/IIoT, Ericsson
4. R1-2003582, Maintenance of Rel-16 URLLC/IIoT SPS enhancements, Nokia, Nokia Shanghai Bell
5. R1-2003625, Remaining issues on IIoT, CATT
6. R1-2003710, Remaining issues on DL SPS enhancement for URLLC, NEC
7. R1-2003741, Corrections for DL SPS and intra-UE prioritization involving CG PUSCH, Intel Corporation
8. R1-2003869, Remaining issues for Others, Samsung
9. R1-2003982, Remaining issues on enhanced DL SPS for IIoT, Spreadtrum Communications
10. R1-2004034, Remaining issues of other aspects for URLLC/IIOT, LG Electronics
11. R1-2004120, DL SPS enhancement, OPPO
12. R1-2004125, Remaining issues on intra-UE prioritization for URLLC, MediaTek Inc.
13. R1-2004184, Discussion on RAN2 LS on Intra-UE Prioritization, Sony
14. R1-2004227, Remaining Issues in eURLLC/IIoT, Apple
15. R1-2004394, Remaining issues for SPS enhancement for Rel-16 URLLC, NTT DOCOMO, INC
16. R1-2004461, Remaining issues on uplink collision handling and SPS for URLLC, Qualcomm Incorporated
17. R1-2004611, Corrections on other aspects for URLLC/IIOT enhancements, Huawei, HiSilicon
18. R1-2003347, Discussion on Intra-UE Prioritization, vivo
19. R1-2003583, Discussion on RAN2 LS on Intra-UE Prioritization, Nokia, Nokia Shanghai Bell
20. R1-2004433, Discussion on Intra-UE prioritization, Qualcomm Incorporated
21. R1-2003345, Draft reply LS on Intra-UE Prioritization, ZTE
22. R1-2003348, Draft reply LS on Intra-UE Prioritization, vivo
23. R1-2003584, [Draft] Reply LS on Intra-UE Prioritization, Nokia
24. R1-2003589, Draft LS reply on Intra-UE Prioritization, CATT
25. R1-2004124, [Draft] Rely LS on Intra UE prioritization, OPPO