3GPP TSG-RAN WG1 Meeting #101-e R1- 20xxxxx

e-Meeting, May 25th – June 5th, 2020

Agenda Item: 6.2.1.3

Source: Moderator (Ericsson)

Title: Feature lead summary #2 for Multi-TB scheduling for LTE-MTC

Document for: Discussion, Decision

# Introduction

This document summarizes the email discussions [101-e-LTE-eMTC5-Multi-TB-01], [101-e-LTE-eMTC5-Multi-TB-02] and [101-e-LTE-eMTC5-Multi-TB-03]. These email discussions followed the preparatory email discussion [101-e-Prep-LTE-eMTC5-Multi-TB] which is summarized in [7].

# Issue #1: TDD HARQ-ACK bundling mechanism

RAN1#100bis-e discussed the TDD HARQ-ACK bundling mechanism for multi-TB scheduling without reaching a conclusion. The background and discussion are documented in the section about Issue #5 in [5]. Qualcomm contribution [2] provides the 36.212/213 TPs below. For detailed discussion, see contribution [2].

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| **--------------------------------------------Start of Text Proposal for 36.212-----------------------------------------** 5.3.3.1.12 Format 6-1A **<Unchanged parts are omitted>**  - Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2. This field is reserved when *multi-TB-DL-config* is enabled and multiple TBs are scheduled, or when the configured maximum repetition number is larger than 1 for MPDCCH, and not present when the format 6-1A CRC is scrambled with G-RNTI, or when the higher layer parameter *csi-NumRepetitionCE-r13* indicates more than one subframe.  **<Unchanged parts are omitted>**  **--------------------------------------------End of Text Proposal for 36.212-----------------------------------------**  **--------------------------------------------Start of Text Proposal for 36.213-----------------------------------------** 7.3.2.1 TDD HARQ-ACK reporting procedure for same UL/DL configuration **<Unchanged parts are omitted>**  For TDD and a BL/CE UE,  - if the UE is configured with *multi-TB-DL-config*, and multiple TBs are scheduled by a single DCI  - the UE is not expected to receive any other PDSCH transmission(s) or MPDCCH indicating downlink SPS releases, corresponding to which the UE shall report HARQ-ACK in any subframe(s) in which HARQ-ACKs are reported for the multiple TBs scheduled by the single DCI, according to subclause 10.2  - The UE behaviour for HARQ-ACK reporting is the same as that of a BL/CE UE with FDD, except:  - PUCCH resource(s) is (are) determined according to Subclause 10.1.3.1; and  - PUCCH(s) is (are) transmitted in a set of BL/CE UL subframe(s) according to Subclause 10.2 for TDD and BL/CE UEs.- else if, the UE is configured with *csi-NumRepetitionCE* equal to 1 and *mPDCCH-NumRepetition* equal to 1,  - the UE behaviour for HARQ-ACK reporting is the same as that of a non-BL/CE UE with TDD, except:  - PDCCH/EPDCCH is replaced by MPDCCH; and  - DCI format 1/1A/1B/1D/2/2A/2B/2C/2D is replaced by DCI format 6-1A; and  - DCI format 0/4 is replaced by DCI format 6-0A; and  - PUCCH is transmitted in a set of BL/CE UL subframe(s) according to Subclause 10.2 for TDD and BL/CE UEs;  - else  - the UE is not expected to receive more than one PDSCH transmission, or more than one of PDSCH and MPDCCH indicating downlink SPS releases, with transmission ending within subframe(s) , where  and  is defined in Table 10.1.3.1-1 intended for the UE;  - The UE behavior for HARQ-ACK reporting is the same as that of a BL/CE UE with FDD, except:  - PUCCH resource is determined according to Subclause 10.1.3.1; and  - PUCCH is transmitted in a set of BL/CE UL subframe(s) according to Subclause 10.2 for TDD and BL/CE UEs.  **<Unchanged parts are omitted>** 10.1.3 TDD HARQ-ACK feedback procedures **<Unchanged parts are omitted>**  For TDD and a BL/CE UE,  - if multiple TBs are not scheduled by a single DCI  - if the UE is configured with *csi-NumRepetitionCE* equal to 1 and *mPDCCH-NumRepetition* equal to 1,  - the UE may be configured with HARQ-ACK bundling or HARQ-ACK multiplexing;  - HARQ-ACK multiplexing can be configured only if *pucch-NumRepetitionCE-format1* equal 1 and HARQ-ACK multiplexing is performed according to the set of Tables 10.1.3-5/6/7  - else  - the UE is not expected to receive more than one PDSCH transmission, or more than one of PDSCH and MPDCCH indicating downlink SPS releases, with transmission ending within subframe(s) , where  and  is defined in Table 10.1.3.1-1 intended for the UE;  **<Unchanged parts are omitted>**  **--------------------------------------------End of Text Proposal for 36.213-----------------------------------------** |

Proposal 1 Consider the above 36.212/213 TPs for TDD HARQ-ACK bundling.

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| **Company** | **Comments on Proposal 1 [101-e-LTE-eMTC5-Multi-TB-01]** |
| Qualcomm | We had some offline discussion during the preparation phase, maybe we can go with the following modification:  - if the UE is configured with *multi-TB-DL-config*, and multiple TBs are scheduled by a single DCI  - the UE is not expected to receive any other PDSCH transmission(s) or MPDCCH indicating downlink SPS releases within downlink subframe(s) having corresponding HARQ-ACK transmission in any subframe(s) in which HARQ-ACKs are reported for the multiple TBs scheduled by the single DCI, according to subclause 10.2 |
| ZTE,Sanechips | We are fine with the wording above. |
| Nokia, NSB | We are fine with the TP with Qualcomm’s modification |
| Lenovo &MotoM | We are fine with the TP with modification |
| Huawei, HiSilicon | We are fine with the TP with modifications. |
| Ericsson | We are fine with the TP with modification.  Perhaps it should say “SPS release” instead of “SPS releases”? |
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# Issue #3: Clarification of sub-PRB symbol counter reset

RAN1#100e agreed on a 36.211 clarification regarding symbol counter reset for NB-IoT. Huawei/HiSilicon contribution [1] proposes the following corresponding clarification for LTE-MTC.

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| 5.6A.2 Modulation scheme π/2-BPSK **<Unchanged parts are omitted>**  where is the number of transport blocks defined in clause 8.0 of 3GPP TS 36.213 [4]. If >1 and interleaving between codewords is applied according to clause 8.0 of 3GPP TS 36.213 [4], then the symbol counter  is reset at the start of the first PUSCH codeword transmission and incremented for each symbol during the transmission of the PUSCH codewords . For other cases, the symbol counter  is reset at the start of each PUSCH codeword transmission and incremented for each symbol during the transmission of the PUSCH codeword.  **<Unchanged parts are omitted>** |

Proposal 3 Consider the above 36.211 TP for clarification of sub-PRB symbol counter reset.

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| **Company** | **Comments on Proposal 3 [101-e-LTE-eMTC5-Multi-TB-02]** |
| Qualcomm | Looks OK |
| ZTE,Sanechips | OK |
| Nokia, NSB | We are fine with the TP |
| Lenovo&MotoM | OK |
| Huawei, HiSilicon | We support this TP as the change makes the spec clearer and it’s aligned with NB-IoT. |
| Ericsson | We are fine with the TP |
| SONY | Fine with TP |
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# Issue #4: Clarification of SPS handling

During the RAN1#100bis-e email discussion “[100b-e-LTE-NB\_IoTenh3-Multi-TB-02]” for NB-IoT, it was noted that there may be a need to clarify e.g. the DCI encoding in case of simultaneous configuration of SPS and the multi-TB feature also for LTE-MTC. Qualcomm contribution [2] provides the 36.212 text proposal below.

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| 5.3.3.1.10 Format 6-0A **<Unchanged parts are omitted>**  - Scheduling TBs for Unicast – 12 bits. This field is only present if *multi-TB-UL-config* is enabled and the DCI is mapped onto the UE-specific search space given by C-RNTI as defined in [3]. This field schedules one TB if the CRC of the DCI is scrambled by SPS C-RNTI.  - If one TB is scheduled  - 5 bits set to zero  - HARQ process number – 3 bits  - New data indicator – 1 bit  - Redundancy version – 2 bits  - Frequency hopping flag – 1 bit, where value 0 indicates frequency hopping is not enabled and value 1 indicates frequency hopping is enabled as defined in clause 5.3.4 of [2]. If frequency hopping is not enabled by higher layers, this field is set to 0.  - If two TBs are scheduled  - 2 bits set to zero  - HARQ index with offset – 6 bits provide the HARQ index + offset, with an offset of +8 and HARQ index as defined in 8.0 of [3]  - New data indicators – 2 bits, one for each scheduled TB in increasing order of HARQ process ID  - Redundancy version for TB 1 – 1 bit  - Redundancy version for TB 2 – 1 bit. If Repetition number is > 1 and frequency hopping is enabled by higher layers then this bit is a Frequency hopping flag for the TBs, and TB2 uses the redundancy version for TB1.  - If four TBs are scheduled  - 1 bit set to zero  - HARQ index with offset – 7 bits provide the HARQ index + offset, with an offset of +36 and HARQ index as defined in 8.0 of [3]  - New data indicators – 4 bits, one for each scheduled TB in increasing order of HARQ process ID  - If six TBs are scheduled  - HARQ index with offset – 6 bits provide the HARQ index + offset, with an offset of +27 and HARQ index as defined in 8.0 of [3]  - New data indicators – 6 bits, one for each scheduled TB in increasing order of HARQ process ID  - If eight TBs are scheduled  - 3 bits set to one  - New data indicators – 8 bits, one for each scheduled TB in increasing order of HARQ process ID  - Redundancy version for all TBs – 1 bit. If Repetition number is > 1 and frequency hopping is enabled by higher layers then this bit is a Frequency hopping flag for the TBs, and the redundancy version for all TBs starts at 0.  **<Unchanged parts are omitted>** 5.3.3.1.12 Format 6-1A **<Unchanged parts are omitted>**  - Scheduling TBs for Unicast – 12 bits. This field is only present if *multi-TB-DL-config* is enabled and the DCI is mapped onto the UE-specific search space given by C-RNTI as defined in [3]. This field schedules one TB if the CRC of the DCI is scrambled by SPS C-RNTI.  - If one TB is scheduled  - 5 bits set to zero  - HARQ process number – 3 bits  - New data indicator – 1 bit  - Redundancy version – 2 bits  - Frequency hopping flag – 1 bit, where value 0 indicates frequency hopping is not enabled and value 1 indicates frequency hopping is enabled as defined in clause 6.4.1 of [2]. If the UE is configured with 64QAM for PDSCH and the repetition number field indicates no PDSCH repetition, this field is the MSB bit of the extended Modulation and coding scheme field, as specified in Table 7.1.7.1-1 of [3]. If the UE is not configured with 64QAM for PDSCH and frequency hopping is not enabled by higher layers, this field is set to 0.  - If two TBs are scheduled  - 2 bits set to zero  - HARQ index with offset – 6 bits provide the HARQ index + offset, with an offset of +8 and HARQ index as defined in 7.1.7.2 of [3]  - New data indicators – 2 bits, one for each scheduled TB in increasing order of HARQ process ID  - Redundancy version for TB 1 – 1 bit  - Redundancy version for TB 2 – 1 bit. If the UE is configured with 64QAM for PDSCH and the repetition number field indicates no PDSCH repetition then this bit is the MSB bit of the extended Modulation and coding scheme field. If Repetition number is > 1 and frequency hopping is enabled by higher layers then this bit is a Frequency hopping flag for the TBs. In these cases TB2 uses the redundancy version for TB1.  - If four TBs are scheduled  - 1 bit set to zero  - HARQ index with offset – 7 bits provide the HARQ index + offset, with an offset of +36 and HARQ index as defined in 7.1.7.2 of [3]  - New data indicators – 4 bits, one for each scheduled TB in increasing order of HARQ process ID  - If six TBs are scheduled  - HARQ index with offset – 6 bits provide the HARQ index + offset, with an offset of +27 and HARQ index as defined in 7.1.7.2 of [3]  - New data indicators – 6 bits, one for each scheduled TB in increasing order of HARQ process ID  - If eight TBs are scheduled  - 3 bits set to one  - New data indicators – 8 bits, one for each scheduled TB in increasing order of HARQ process ID  - Redundancy version for all TBs – 1 bit. If the UE is configured with 64QAM for PDSCH and the repetition number field indicates no PDSCH repetition then this bit is the MSB bit of the extended Modulation and coding scheme field. If Repetition number is > 1 and frequency hopping is enabled by higher layers then this bit is a Frequency hopping flag for the TBs. In these cases the redundancy version for all TBs starts at 0.  **<Unchanged parts are omitted>** |

Proposal 4 Consider the above 36.212 TP on SPS handling.

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| **Company** | **Comments on Proposal 4 [101-e-LTE-eMTC5-Multi-TB-02]** |
| Qualcomm | Looks OK |
| ZTE,Sanechips | OK |
| Nokia, NSB | We are fine with the TP |
| Lenovo&MotoM | OK |
| Huawei, HiSilicon | We are fine with the TP, but it seems not a reasonable case to us to configure SPS and multi-TB simultaneously. |
| Ericsson | We are fine with the TP |
| SONY | Fine with TP |
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# Issue #5: No scheduling gap after last SC-MTCH TB

RAN1#100e agreed to eliminate the scheduling gap insertion after the last TB in a SC-MTCH multi-TB transmission for NB-IoT. ZTE contribution [3] provides a 36.213 TP for a similar change for LTE-MTC. For detailed discussion, see contribution [3].

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| 7.1.11 PDSCH subframe assignment for BL/CE UE **<Unchanged parts are omitted>**  - for ,  - if the UE is configured with higher layer parameter *multi-TB-DL-Unicast-Interleaving-config*, and PDSCH corresponding to a MPDCCH with DCI CRC scrambled by C-RNTI and where  for BL/CE UE configured with CEModeA,  for BL/CE UE configured with CEModeB,  - BL/CE DL subframes  with  are associated with TB*r+*1 ,  - otherwise,  - BL/CE DL subframes  with  are associated with TB*r+*1 ,.  - for  and PDSCH corresponding to an MPDCCH with DCI CRC scrambled by G-RNTI,  - If higher layer parameter *multiTB-Gap* is configured*,* a scheduling gap with a length equal to the indicated value of *multiTB-Gap* is inserted between TB*r* and TB*r+*1, *r=*0,2.*..,NTB*-2*.*  **<Unchanged parts are omitted>** |

Proposal 5 Consider above 36.213 TP for removal of scheduling gap after last SC-MTCH TB.

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| **Company** | **Comments on Proposal 5 [101-e-LTE-eMTC5-Multi-TB-02]** |
| Qualcomm | The TP is a bit confusing, but probably we can be OK after a couple of clarifications:  - Why is the gap only introduce between every other couple of TBs?  - The proposal says “removal of scheduling gap after last SC-MTCH TB”, but the TP is introducing the functionality of gaps, correct? |
| ZTE,Sanechips | Perhaps the confusion is caused by a typo in the TP:  It should be *r=*0,1,2.*..,NTB*-2*.* |
|  | We missed a '1' in the equation, sorry about this.  The intention is to capture the agreement and use the exact same wording as in NB-IoT (the agreement for both WI are same) , then specs are aligned. |
| Nokia, NSB | We are fine with the TP with typo correction from ZTE |
| Qualcomm | Thanks for the clarification, we would be OK with the latest clarification from ZTE. |
| Lenovo&MotoM | OK |
| Huawei, HiSilicon | We are fine with the TP with additional correction. |
| Ericsson | We are fine with the TP with additional correction. |
| SONY | Fine with the TP with additional correction. |

# Issue #6: TDD DL HARQ process indication

ZTE contribution [3] proposes that the DCI size should be the same for all TDD UL/DL configurations when the multi-TB feature is configured. For detailed discussion, see contribution [3].

Proposal 6 Discuss and decide whether to specify that the DCI size should be the same for all TDD UL/DL configurations when the multi-TB feature is configured.

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| **Company** | **Comments on Proposal 6 [101-e-LTE-eMTC5-Multi-TB-03]** |
| Qualcomm | It is a bit unclear what is the objective here. Is the objective to increase the 12-bits STFU field to 13-bits for UL/DL config 0 and have full flexibility? |
| ZTE,Sanechips | The intention is for all TDD configurations , a total of 13 bits should be used for STFU+ processes grouping field.  Of course this applies to UL/DL config 0. Whether to use the extra bit to support full flexibility it's up to further discussion (ran1 may not have that consensus). We can first try to agree the current proposal. |
| Nokia, NSB | We are fine to have the same DCI size for all UL/DL configurations |
| Qualcomm | So, if we agree to proposal 6 as it is (and nothing more), essentially we are agreeing to the following TP, no?  - Multi-TB HARQ processes group – 1 bit, where value 0 indicates that the Scheduling TBs for Unicast Field applies to the first group of 8 HARQ process and value 1 indicates the second group. This field is only present for TDD operation and if the Scheduling TBs for Unicast Field is present.  If I recall correctly (please correct me if I am wrong), even for legacy DCI the size is not common for different TDD UL/DL configurations. For example, UL index or DAI have different number of bits depending on the configuration.  So, two observations:   1. We do not see any advantage to adopt the TP above – we don’t find any benefit to adding that additional bit. 2. There is some usefulness in adding 1 more bit to allow full flexibility for some TDD UL/DL configs. We do not have a terribly strong view on this issue, but we feel it is a bit too big of a change at this stage. Having said this, if there is a clear support for this optimization, we will not object. |
| ZTE,Sanechips | Regarding how to use the 1 more bit if we agree to use 13bits ,we now actually think using the bit to support full flexibility maybe a better approach considering the benefit for the scheduler. |
| ZTE,Sanechips | With regard to QC’s comments(#2) above, yes the TP is correct. But the another important aspect is the for each TDD configuration the UL/DL DCI size should be the same and the benefit is clear. If we don’t have the TP then UL and DL of the same TDD configuration may have different DCI size. |
| Ericsson | This does not seem like a critical correction, so we do not think a change is motivated at this late stage. |
| SONY | ZTE wrote: “But the another important aspect is the for each TDD configuration the UL/DL DCI size should be the same and the benefit is clear.”  Just so it is crystal clear and so that everyone is on the same page, could you please just state what the benefit is in this email thread? |
| ZTE,Sanechips | If UL/DL size is not the same, usually we will add padding to avoid the increase of BD.  BTW, in anyway, the spec needs to clarify for Config#1~#5 UL if processes grouping field exists or not. |

# Issue #7: Realization of UL early termination

ZTE [3] and Ericsson [4] discuss the realization of UL early termination. ZTE proposes to specify DCI support for indicating that individual HARQ process(es) should be terminated (rather than always all of them), whereas Ericsson proposes to check whether some updates in 36.213 are needed in order to ensure that the UE monitors the DL for DCI transmissions during the UL resource reservation gaps. For detailed discussion, see contributions [3] and [4].

Proposal Discuss the realization of UL early termination and produce TP(s) if necessary.

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| **Company** | **Comments on Issue #7 [101-e-LTE-eMTC5-Multi-TB-03]** |
| Qualcomm | Cancelling individual TBs will be kind of tricky, and actually can lead to quite some degradation. For example, if we have 8 TBs and we cancel one, the eNB cannot perform channel estimation (since the UE will lose phase coherence in the subframes in which it was supposed to transmit the completed TB).  For the 213 TP, will provide feedback when a TP is available. |
| ZTE,Sanechips | First of all, since the specs already support early termination, the issue here is to clarify if the early termination applies to all the TBs scheduled by the DCI , or some individual TB (since the DCI has extra bits to indicate these TB)   1. If the early termination only applies for all the TBs, then for multi-TB the eNB has to wait for all the TB to succeed, the use case of this feature is severely reduced. For example, for 8TB DCI, the eNB has to wait all the TB to succeed, during which many TBs may already succeed. 2. The channel estimation should not an issue, considering even now maybe invalid frames exists so the phase coherence issue already exists so this is not new 3. The feature provides extra flexibility for eNB and UE to save power consumption if the eNB seems feasible , remember the eNB can always choose when to use therefore it can also choose not to use if the condition does not permit. |
| Nokia, NSB | We agree clarification is needed about how early termination will work here. We have a slight preference to be able to indicate early termination of individual TB or group of TBs. |
| Lenovo &MotoM | We prefer to indicate early termination of individual TB. It is a large waste to wait 8TB successfully detected and get an early transmission termination indication. It is too late. If we don’t support early termination for individual TB, we hope to disable the early termination feature, although we have agreement to support it. |
| Huawei, HiSilicon | We prefer indication of early termination of some individual TBs. This is beneficial in terms of UE power cost and resources. |
| Ericsson | This does not seem like a critical correction, so we do not think a change is motivated at this late stage. The DCI definitions for PUSCH multi-TB transmission in CE mode A and B already supports termination of the PUSCH transmission for the purpose of terminating a PUSCH transmission when eNB has successfully decoded all TBs and for the purpose of terminating a PUSCH transmission when eNB wants to free up resources for other transmissions (in which case RLC retransmission may be triggered). The only thing that might need to be checked is whether some clarification is needed in 36.213 regarding MPDCCH monitoring during UL gaps, but potentially it is already clear enough. |
| SONY | Our understanding is that the early termination feature is about freeing up resources for other transmissions (the eNB scheduled a multi-TB transmission and later on regrets that decision since it wants to schedule a “smartphone”). So we do not think that the eNB needs to early terminate some transmissions and not others (it early terminates the whole MTBG).  In response to Ericsson’s comment, we think that the UE does need to monitor for MPDCCH during the UL gaps (in case there is early termination signaling). We have assumed that this is implicitly understood, but would be OK/supportive of this functionality being stated in 36.213. |
| ZTE,Sanechip | For the use case of ' early termination feature is about freeing up resources for other transmissions', I am not sure this is the intention when company agree to have this feature.  One problem of this usage is if eNB does this , the UE will assume all these TB are successfully transmitted. Then the next time the eNB schedule new transmission these information bit will be skipped. The error will only be corrected by higher layer , which usually is costly (retransmission and delay etc)  So what I can see the current status is 3 companies prefer to early terminate all TBs, while 8 (or 4 depending if you count the 'buddy' company) prefer eNB can terminate individual TB(s).  I wonder if we can follow the majorities here since this is usually what we do when we have two alternatives to choose. |

# Issue #9: Clarification of CSI reporting

Ericsson contribution [4] proposes to discuss an issue with the CSI reporting that was originally brought up in an earlier ZTE contribution [6], where it is proposed that the CSI report is carried in the first TB and that other details are the same as in legacy operation.

Proposal RAN1 concludes that for multi-TB PUSCH transmission with aperiodic CSI reporting, the CSI is transmitted with the first TB. No TP is needed.

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| **Company** | **Comments on proposed RAN1 conclusion [101-e-LTE-eMTC5-Multi-TB-01]** |
| Qualcomm | Looks OK. |
| ZTE,Sanechips | Support this. |
| Nokia, NSB | We support this proposal |
| Lenovo&MotoM | OK |
| Huawei, HiSilicon | OK |
| Ericsson | We are fine with the proposal |
| SONY | Seems OK |
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# References

1. [R1-2003540](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2003540.zip), “Corrections on scheduling of multiple transport blocks”, Huawei, HiSilicon

1. [R1-2003782](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2003782.zip), “Scheduling of multiple DL/UL transport blocks”, Qualcomm Incorporated

1. [R1-2003792](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2003792.zip), “Remaining issues on scheduling enhancement for MTC”, ZTE

1. [R1-2004656](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2004656.zip), “Corrections for Multi-TB scheduling for LTE-MTC”, Ericsson

1. [R1-2002796](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2002796.zip), “Feature lead summary #2 for Multi-TB scheduling for LTE-MTC”

1. [R1-2001852](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2001852.zip), “Remaining issues on scheduling enhancement for MTC”, ZTE

1. [R1-2004696](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2004696.zip), “Feature lead summary #1 for Multi-TB scheduling for LTE-MTC”