**3GPP TSG RAN meeting #92e RP-21xxxx**

**Electronic Meeting, June 14-18, 2021**

## Status Report to TSG

**Agenda item:** 10.6.1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **WI / SI Name** | Additional enhancements for NB-IoT and LTE-MTC | | | | |
| included in this status report | Study Item:  No | Core part:  Yes | Performance part:  Yes | | Testing part:  No |
| **Acronym** | NB\_IOTenh4\_LTE\_eMTC6 | | | | |
| **Unique ID** | 860044 | | | | |
| **TSG Tdoc of latest approved WI/SI description (if any)** | RP-201306 | | | | |
| **Target Completion Date**  **(indicate if changed)** | Study Item: | Core part: 03/2022 | Performance part: 09/2022 | Testing part: | |
| **Overall Completion level** | Study Item: | Core part:  55% | Performance Part: 0% | Testing part: | |

Note: Overall completion level percentage numbers should use one of the colors below:

* xx%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |  |
| --- | --- | --- |
| **Leading WG** | | RAN WG 1 |
| **Rapporteur** | **Name** | Yubo YANG  Emre YAVUZ |
| **Company** | Huawei  Ericsson |
| **Email** | yangyubo1@huawei.com  emre.yavuz@ericsson.com |

## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.  
 One time unit (TU) corresponds to ~ 2 hours in the meeting.  
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.  
 Note: If no Excel table is attached, then this means no time budget change.*

**Additional explanations/motivations for the time budget changes in the attached Excel table:**

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

## 2.1 RAN1

#### 2.1.1 Agreements

In RAN1#104b-e meeting, 28 contributions [1-28] were submitted, and the following agreements were achieved.

For NB-IoT 16-QAM:

Agreement

Confirm the working assumption that the following TBS indices are introduced for downlink with modification in RED:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 |
| 16 | ~~328~~296 | 632 | 968 | 1288 | 1608 | 1928 | 2600 | 3240 |
| 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 | 2856 | 3624 |
| 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 | 3112 | 4008 |
| 19 | 408 | 840 | 1288 | 1736 | 2152 | 2600 | 3496 | 4264 |
| 20 | 440 | 904 | 1384 | 1864 | 2344 | 2792 | 3752 | 4584 |
| 21 | 488 | 1000 | 1480 | 1992 | 2472 | 2984 | 4008 | 4968 |

Agreement

Confirm the working assumption:

* For standalone and guardband deployments, the downlink TBS entries between 14 (TBS of 2856 for I\_SF=7) and 21 are used for 16QAM.

Agreement

For both uplink and downlink

* 16-QAM is not applied to C-RNTI from CSS.
* 16-QAM is not applied to EDT.

Working Assumption

The DCI size is not increased to support 16-QAM in uplink and downlink.

Agreement

The following options on the indication of downlink 16-QAM can be considered:

* Option 1: MCS field is increased to 5 bits to indicate modulation and TBS, and repetition field is reduced to 3 bits to indicate the repetition number;
* Option 2: MCS field is 4 bits to indicate TBS, and repetition field is reduced to 3 bits to indicate the repetition number;
  + 1 bit is used to indicate legacy QPSK or 16QAM
* Option 3: MCS field is 4 bits to indicate modulation and TBS
  + A reserved state of MCS field indicates use of 16QAM,
  + Repetition field indicates 16QAM MCS if 16QAM is indicated to be used.
* Option 4: MCS is 4 bits,
  + If repetition is indicated as one, 16QAM and QPSK can be indicated by MCS field;
  + If repetition is indicated larger than one, the legacy QPSK MCS can be indicated by MCS field.
* Option 5: {repetition, MCS} are indicated by 8 bits (a combination of the MCS field and repetition field)
* Note: other options are not precluded.

Agreement

For downlink power allocation to support 16QAM:

* For standalone and guard-band deployments:
  + Option 1: Two power ratios are signaled
    - NPDSCH EPRE to NRS EPRE in symbols with NRS
    - NPDSCH EPRE to NRS EPRE in symbols without NRS
  + Option 2: the power ratio of NPDSCH EPRE to NRS EPRE in symbols with NRS is signaled, assuming the same transmit power of different symbols.
  + Option 3: the power ratio of NPDSCH EPRE to NRS EPRE in symbols without NRS is signaled, assuming the same transmit power of different symbols.
  + If the signaling(s) is(are) not indicated, the legacy power allocation is used.
    - i.e., the ratio of NPDSCH EPRE to NRS EPRE is 0dB for one NRS antenna port, and -3dB for two NRS antenna ports
* For inband deployments, the power ratio of NRS EPRE to CRS EPRE is signaled in addition to the signaling for standalone and guard-band deployments.
  + FFS to reuse the existing parameter nrs-CRS-PowerOffset.
* FFS: Whether UE specific or cell-specific or carrier-specific signaling is used

Agreement

If 16-QAM is configured for NPDSCH, the channel quality report for 16-QAM is based on NPDSCH transport block that achieves an error probability not exceeding 10% BLER.

For eMTC 14-HARQ:

Agreement

In Rel-17, for the 14 HARQ processes feature, PUCCH repetition is not supported with HARQ-ACK bundling.

Conclusion

In Rel-17, the 14 HARQ processes feature is not supported when the multi-TB grant feature is enabled.

Agreement

In Rel-17, for the 14 HARQ process feature the HARQ-ACK delay solution will be down-selected in RAN1#105-e from:

* Alt-1: The HARQ-ACK delay is determined through an expression consisting of different subframe types (Using a similar principle as the PDSCH scheduling delay).
  + FFS: The expression consisting of different subframe types.
  + FFS: Signaling Details.
* Alt-2: The HARQ-ACK delay is determined following the legacy approach. That is, the “HARQ-ACK delay” is kept expressed in terms of “absolute subframes”.
  + FFS: The percentage of presence of non-BL/CE DL subframes and non-BL/CE UL subframes to be handled.
  + FFS: HARQ-ACK delay values and length of the HARQ-ACK delay set.
  + FFS: Signaling Details.

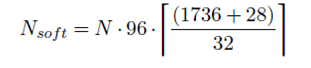
The following aspects will be considered towards the down-selection of one of the two alternatives (i.e., Alt-1 or Alt-2) for the HARQ-ACK delay solution:

* Total number of bits required in DCI
* Scenarios that can be handled, including:
  + different numbers of scheduled HARQ processes per burst (including dynamically switching between more than 10 HARQ processes and 10 or less HARQ processes)
  + different % of invalid subframes for both 10 and 40 SF long bitmaps
* Robustness against loss of DCIs
* Flexibility
* RRC signaling overhead

For eMTC maximum DL TBS of 1736 bits:

Agreement

The working assumption on the value of N is confirmed for the calculation of the number of soft channel bits based on the equation:



where *N*=8.

Agreement

The soft channel bits for UEs supporting maximum DL TBS of 1736 bits is 43008 bits.

Agreement

Send an LS to RAN2 informing them of RAN1’s decisions on the following:

* The soft channel bits for UEs supporting maximum DL TBS of 1736 bits is 43008 bits.
* The 1736 bits DL TBS feature is enabled by unicast RRC configuration.

**R1-2103942** LS on Agreements Related to Support of a maximum DL TBS of 1736 bits as a Rel-17 optional UE capability RAN1, Sony

In RAN1#105-e meeting, 20 contributions [29-48] were submitted, and the following agreements were achieved.

For NB-IoT 16-QAM:

**Agreement**

Support 16-QAM for multi-TB scheduling.

**Working Assumption**

Support 16-QAM for NPUSCH in PUR procedure.

* FFS on support of 16-QAM for NPDSCH in PUR procedure.

**Agreement**

Confirm the working assumption.

The DCI size is not increased to support 16-QAM in uplink and downlink.

**Agreement**

For the indication of 16-QAM in downlink:

* The “Modulation and coding scheme” field in DCI Format N1 is utilized as in legacy for scheduling QPSK.
* One reserved state in the “Modulation and coding scheme” field in DCI Format N1 is utilized to indicate the use of 16QAM.
* The “Repetition number” field in DCI Format N1 is utilized to indicate the TBS indices for 16-QAM in DL when the reserved state in MCS field is indicated.
* FFS: The manner of distinguishing the different ranges of TBS indices for “Stand-alone/Guard-band” (i.e., I\_TBS indices from 14 to 21) and “In-band” (i.e., I\_TBS indices from 11 to 17) deployments.

**Working Assumption**

For downlink power allocation to support 16QAM:

* For standalone and guard-band deployments:
  + One power ratio is signaled optionally
    - NPDSCH EPRE to NRS EPRE in symbols without NRS
  + The same transmit power is assumed across different symbols.
  + If the signaling is not indicated, the legacy power allocation is used.
    - i.e., the ratio of NPDSCH EPRE to NRS EPRE is 0dB for one NRS antenna port, and -3dB for two NRS antenna ports
* UE specific signaling is used

**Agreement**

Introduce a new term in uplink power control of NPUSCH using 16-QAM. FFS on the details.

**Agreement**

When configured with downlink 16-QAM, the channel quality can be reported in MAC CE.

* FFS on support in Msg3 in connected mode

**Agreement**

On the indication of downlink 16-QAM, when the reserved state in MCS field is indicated, the “Repetition number” field in DCI Format N1 is utilized to indicate the TBS indices

* From 14 to 21 for standalone/guardband deployments,
* From 11 to 17 for inband deployment.
* FFS: How UE distinguishes the deployment

**Working Assumption**

For the indication of 16-QAM in uplink

* The “Modulation and coding scheme” field in DCI Format N0 is utilized as in legacy for scheduling QPSK.
* One reserved state in the “Modulation and coding scheme” field in DCI Format N0 is utilized to indicate the use of 16QAM.
* The “Repetition number” field in DCI Format N0 is utilized to indicate the TBS indices (i.e., I\_TBS indices from 14 to 21) for 16-QAM in UL.

**Agreement**

For CQI table for downlink 16-QAM, down-select between following options in RAN1#106-e:

* Option 1: More than three candidate values for 16-QAM are added in the legacy table.
  + FFS: Which of the legacy entries are removed
* Option 2: Three candidate values for 16-QAM are added in the legacy table.
* Option 3: A new CQI table is defined for 16-QAM based on the eMTC table (CQI Tables in 36.213) as a starting point

**Agreement**

For downlink power allocation to support 16QAM:

* For inband deployments, a power ratio is signaled in addition to the signaling for standalone and guard-band deployments which in this case applies to “symbols with NRS” and “symbols without NRS nor CRS”. Down-select from the following options in RAN1#106-e:
  + Alt 1:
    - The existing parameter nrs-CRS-PowerOffset is reused for same PCI case, and is signaled for different PCI case.
    - The same transmit power of different symbols is assumed as to derive from *nrs-CRS-PowerOffset* the NPDSCH EPRE in symbols with CRS.
  + Alt 2:
    - the power ratio between NPDSCH EPRE and NRS EPRE in symbols with CRS is signaled
  + FFS: NPDSCH EPRE to NRS EPRE in symbols with NRS

FFS: Whether UE specific or cell-specific or carrier-specific signaling is used

For eMTC 14-HARQ:

**Agreement**

In Rel-17, for the 14 HARQ process feature the HARQ-ACK delay solution will be supported with multiple solutions: Alt-1 for full flexibility and Alt-2e for support of legacy delay

Alt-1: The HARQ-ACK delay is determined through an expression consisting of different subframe types (Using a similar principle as the PDSCH scheduling delay).

* + Without using more than 6 bits
  + FFS: How to minimize the overhead by using joint encoding

Alt-2e: The HARQ-ACK delay is determined following the legacy approach. That is, the “HARQ-ACK delay” is kept expressed in terms of “absolute subframes”.

* + The HARQ-ACK delay values and the length of the HARQ-ACK delay set will be based on
    - Alt-2e: “3 bits (same as legacy)”
    - FFS: Whether HARQ delay set is to use range1 or range2

RRC signaling will be used to configure between Alt-1 and Alt-2e

FFS: Signaling details

FFS: Joint encoding

**Working Assumption**

The PDSCH scheduling delay and HARQ-ACK delay are jointly encoded in a single DCI field:

* The field uses no more than 7 bits if Alt-1 is configured.
* The field is 5 bits if Alt-2e is configured.
* FFS: Details of the joint encoding.
* FFS: Legacy DCI fields that might be re-purposed for the jointly encoded solution of Alt-1 and Alt-2e respectively.

Note: Alt-1 expresses the HARQ-ACK delay as: (y) BL/CE DL subframe + 1 subframe + (z) BL/CE UL subframes, where y = {0, 1, 2, … 11} and z = {1, 2, 3}.

**Conclusion:**

In Rel-17, for the 14 HARQ processes feature:

When the HARQ-ACK delay is configured to use Alt-1 “PUCCH using Repetition = 1 is postponed”, whereas when the HARQ-ACK delay is configured to use Alt-2e “PUCCH using Repetition = 1 is not postponed (legacy behavior)”.

**Agreement**

In Rel-17, the 14 HARQ processes feature is applicable for HD-FDD Cat M1 UEs in CE Mode A only.

#### 2.1.2 Remaining Open issues

* + Remaining details on support of 16-QAM, including confirmation of support for PUR, indication of 16-QAM in uplink, a new term in the power control of NPUSCH, I\_TBS indices and the distinction of the deployment modes, and further down-selection and confirmation of downlink power allocation. [NB-IoT]
  + Extend the NB-IoT channel quality reporting based on the framework of Rel-14—16, to support 16-QAM in DL, including the down-selection of CQI table for 16-QAM. [NB-IoT]
  + Remaining details to support additional PDSCH scheduling delay for introduction of 14-HARQ processes in DL, for HD-FDD Cat M1 UEs, including DCI design, etc. [LTE-MTC]

## 2.2 RAN2

#### 2.2.1 Agreements

Contributions [49]– [72] were submitted to RAN2#113b-e meeting.

Contributions [73]– [101] were submitted to RAN2#114-e meeting.

**NB-IoT neighbour cell measurements and corresponding measurement triggering before RLF**

RAN2 discussed NB-IoT neighbour cell measurements and corresponding measurement triggering before RLF and made the following agreements.

|  |
| --- |
| RAN2#113bis-e agreements: None  RAN2#114-e agreements:   * The criteria to start measurements is based on a combination of serving cell quality threshold (option b) and variance of the serving cell quality (option c) * Configuration of the criteria to start the measurements is supported.   + FFS whether any further information needs to be provided by NW * FFS whether any assistance information from UE is needed. * FFS if/how to support ‘early’ RLF. |

**NB-IoT carrier selection based on the coverage level and associated carrier specific configuration**

RAN2 discussed NB-IoT carrier selection based on the coverage level and associated carrier specific configuration and made the following agreements.

|  |
| --- |
| RAN2#113bis-e agreements: None  RAN2#114-e agreements:   * Rel-17 paging carriers and the legacy paging carriers should be exclusive. * RAN2 assumes S1AP/NGAP update is not needed. * Carrier selection criteria does not include power boosting or service * FFS: For option 1, whether DRX can be part of the carrier selection criteria * Rel-17 paging carrier configuration is provided in broadcast signalling. * Select between the following sub-options: * Option 1c: Network enables UE to select a Rel-17 paging carrier by providing the coverage information (CEL/Rmax) for the carrier selection to the UE in dedicated signalling * Option 2a: NW indicates the carrier to use explicitly via dedicated signalling based on information determined within the NW. * FFS for both options whether there is a report from the UE to suggest a carrier or provide a metric report * Working assumption: UE metric for determining carrier suitability and selection is based on measured NRSRP. FFS whether to use a hysteresis/longer averaging/timer * For option 1, upon cell change, FFS: * Alt 1: based on previously determined CEL and broadcasted paging carrier configuration in the new cell. * Alt 2: UE needs to perform fallback mechanism. * For option 2, upon cell change, UE needs to perform fallback mechanism. * Whenever the R17 coverage based carrier criteria is met, UE uses the R17 coverage based carrier, otherwise UE should use the fallback mechanism * For both options, fall back carrier is legacy paging carrier based on UE\_ID |

**NB-IoT: 16-QAM for unicast in UL and DL**

RAN2 discussed 16-QAM for unicast in UL and DL and made the following agreements.

|  |
| --- |
| RAN2#113bis-e agreements:   * Working assumption: For the UE supporting 16-QAM, the L2 buffer size is 12000 bytes. * Working assumption: Support of 16-QAM has separate UE capabilities for DL and UL   RAN2#114-e agreements: None |

**eMTC: 14-HARQ processes in DL, for HD-FDD Cat M1 UEs**

RAN2 discussed 14-HARQ processes in DL, for HD-FDD Cat M1 UEs and made the following agreements.

|  |
| --- |
| RAN2#113bis-e agreements:   * 14 HARQ activation is configured by dedicated RRC signalling. * Working assumption: No change to current L2 buffer size requirement   RAN2#114-e agreements: None |

**eMTC: maximum DL TBS of 1736 bits**

RAN2 discussed 14 maximum DL TBS of 1736 bits and made the following agreements.

|  |
| --- |
| RAN2#113bis-e agreements:   * DL TBS of 1736 bits is configured by dedicated RRC signalling. * FFS: Whether to update L2 buffer size requirement   RAN2#114-e agreements: None |

#### 2.2.2 Remaining Open issues

* For NB-IoT, support of NB-IoT neighbour cell measurements and corresponding measurement triggering before RLF, including details of the measurement triggering condition, other configuration than the criteria to start the measurements, whether any assistance information from UE is needed and whether/how to support early RLF.
* For NB-IoT, support of NB-IoT carrier selection based on the coverage level and associated carrier specific configuration, including down-selection of options and details for the options.
* For NB-IoT, RAN2 aspects to introduce support 16-QAM for unicast in DL and UL.
* For eMTC, RAN2 aspects to introduce support for 14-HARQ processes in DL for HD-FDD Cat M1 UEs.
* For eMTC, RAN2 aspects to introduce support for DL TBS of 1736 bits for HD-FDD Cat. M1 UEs in CE mode A.

## 2.3 RAN3

#### 2.3.1 Agreements

In RAN3#113-e meeting, 13 contributions [102-114] were submitted, and the following progresses were achieved:

- Updated work plan noted.

- Support for Carrier Selection and Carrier Specific Configuration

- WA: Both EPC and 5GC scenarios are supported.

- For CE based carrier selection, RAN3 needs to wait for RAN2 further progress.

- For other objectives of this WI, currently there is no RAN3 impacts based on the progresses of other groups. Note that this does not preclude RAN3 impacts pop up in the future discussion.

#### 2.3.2 Remaining Open issues

Support for Carrier Selection and Carrier Specific Configuration.

## 2.4 RAN4

#### 2.4.1 Agreements

**For RF:**

In RAN4#98b-e meeting, 7 contributions [115-121] were submitted, and the following agreements were achieved.

R4-2105432 Way forward on BS RF requirements for R17 NB-IoT 16QAM Huawei, HiSilicon, Ericsson

The following issues have been identified:

1. NB-IoT RB power dynamic range for in-band or guard band operation or NB-IoT operation in NR in-band

RAN4 will decide whether to use the same QPSK requirements for 16QAM.

1. EVM limit for 16QAM DL

RAN4 will decide whether to define 12.5% as the limit

1. 16QAM FRC for BS Rx Characteristics

RAN4 will decide whether new 16QAM FRC is needed for NB-IoT BS RF tests.

R4-2105433 Way forward on UE RF requirements for R17 NB-IoT 16QAM Nokia

On EVM limit

* + RAN4 will decide whether to set the limit to 12.5%.

On In-band Emission limit

* + RAN4 will decide whether to change the current IBE mask and include the EVM limit.

On MPR simulation assumptions

* + I/Q image: 25 dB, Carrier leakage: 25 dBc, CIM3: 60 dB
  + PA calibration point: MPR=0 for single-tone (worst case among 3.75 kHz pi/2 BPSK and pi/4 QPSK, 15 kHz pi/2 BPSK and pi/4 QPSK)
  + Whether to include EVM limit: Yes. Companies should declare which option(s) below is(are) used
    - Option 1: 12.5%.
    - Option 2: Other values which should be clearly stated.
  + Whether to include IBE mask: Yes. Companies should declare which option(s) below is(are) used
    - Option 1: Use the existing NB-IoT IBE mask (=).
    - Option 2: Include the EVM limit in the IBE mask ().
    - Option 3: Other options are not precluded but should be clearly stated.
  + Whether to include 12-tone: Yes. Simulate allocations of 3, 6, and 12 tones.
  + Power classes to be considered: 3, 5
    - Power class 6 is optional for simulation results in RAN4#99-e.

In RAN4#99-e meeting, 10 contributions [122-131] were submitted, and the following agreements were achieved.

R4-2107901 WF on max power reduction for PRACH, PUCCH, and full-PRB PUSCH Ericsson

The WID objective asking the feasibility of the sub-PRB power boosting relative to the other physical channel (PRACH, PUCCH and full-PRB PUSCH). RAN4 concludes two options to proceed the feasibility:

1. Legacy UE power class, New MPR for sub-PRB allocation, and new MPR for PRACH, PUCCH and full-PRB PUSCH.
   1. 0 dB MPR for sub-PRB allocation, but with MPR for PRACH, PUCCH, and full-PRB PUSCH
2. Legacy UE power class, legacy MPR for PRACH, PUCCH, and full-PRB PUSCH, new MPR for sub-PRB allocation
   1. Sub-PRB allocation power can be boosted relative to the corresponding UE power class nominal output power

Company are encouraged to bring analysis on the feasibility of above two options in next meeting.

**For RRM:**

In RAN4#98b-e meeting, 8 contributions [132-139] were submitted, and the following agreements were achieved.

Neighbour cell measurements in scenarios A/C

* UE can perform neighbour cell measurement without gaps and without causing interruptions to serving cell when the carrier frequencies of serving cell and of measurement neighbour cell are same (scenarios A/C).

Neighbour cell measurements in scenarios B/D/E

* When the carrier frequencies of serving cell and of measurement neighbour cell are different (scenarios B/D/E), UE can perform neighbour cell measurement without gaps without causing interruptions to serving cell using any occasion where the UE is not scheduled which includes any of the following:
  + Vacant slots not scheduled for data transmission, i.e. when not required to do data transmission/reception
  + When not required to do NPDCCH monitoring
  + During the DRX inactive period i.e. when the UE is configured with DRX.

Cell detection time

* Normal coverage:
  + 1400 ms in DRX and non-DRX for an unknown cell.
  + 80 ms in DRX and non-DRX for an unknown cell when signal quality is sufficient for cell detection on first attempt, whilst for a known cell it is 0 ms.
    - Note: no definition in RAN4 about conditions of sufficient signal quality for the first attempt cell detection
* Enhanced coverage:
  + 14800 ms in DRX and non-DRX for an unknown cell.
  + 80 ms in DRX and non-DRX for an unknown cell when signal quality is sufficient for cell detection on first attempt, whilst for a known cell it is 0 ms.
    - Note: no definition in RAN4 about conditions of sufficient signal quality for the first attempt cell detection
* The time needed for cell detection subjects to the actual measurement occasions, and the overall time for cell detection will be longer if UE is configured to perform neighbour cell measurement on multiple frequency layers.

Measurement time

|  |  |  |
| --- | --- | --- |
| Coverage mode | Measurement period in DRX and non-DRX | |
|  | NRS based NRSRP | NSSS based NRSRP |
| Normal coverage | 800 ms | 1600 ms |
| Enhanced coverage | 1600 ms | 1600 ms |

* The time needed for measurement subjects to the actual measurement occasions, and the overall time for measurement will be longer if UE is configured to perform neighbour cell measurement on multiple frequency layers.

Known cell conditions

* The neighbour cell can be considered as known if it has been measured within the last 5 seconds and during which the cell remains detectable; otherwise the neighbour cell can be considered as unknown.

Valid NRSRP measurement definition

* RAN4 has discussed the validity time of a NRSRP measurement and concluded that there is no such definition in current specification.

**R4-2105800** Reply LS on neighbour cell measurement in NB-IoT RRC\_CONNECTED state, Huawei, HiSilicon

In RAN4#99-e meeting, 5 contributions [140-144] were submitted, and the following agreements were achieved.

RRM work Scope:

* Define RRM requirements for neighbour cell measurements in RRC Connected state before RLF of NB-IoT

Structures to capture the RRM requirements for neighbour cell measurement of NB-IoT:

* The new neighbour cell measurement requirements are introduced in a separate section, and exact section number and detailed structures are FFS

Starting and stopping triggering of CONNECTED mode neighbour cell measurement of NB-IoT:

* RAN4 shall wait for RAN2 conclusions on the exact conditions for starting and stopping CONNECTED mode neighbour cell measurements

#### 2.4.2 Remaining Open issues

**For RF core part:**

Specify 16-QAM for unicast in UL and DL, including the EVM for 16-QAM in downlink and uplink, 16-QAM FRC, IBE mask and MPR for uplink 16-QAM. [NB-IoT]

For UEs supporting PUSCH sub-PRB resource allocation, study and if found feasible for the concluded options, 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. [LTE-MTC]

**For RRM core part:**

Specify RRM requirements for connected mode neighbour cell measurement of NB-IoT, including conditions for neighbor cell measurement, and multiple carriers operation. [NB-IoT]

**For performance part:**

Specify necessary performance requirements, measurement accuracy requirements and test cases related to the above-mentioned enhancements and core requirements. [NB-IoT][LTE-MTC]

## 2.5 RAN5

#### 2.5.1 Agreements

#### 2.5.2 Remaining Open issues

#### 2.5.3 Remaining Open issues with cross-WG dependencies

## 2.6 RAN6

#### 2.6.1 Agreements

#### 2.6.2 Remaining Open issues

## 3. Detailed progress in SA/CT WGs since last TSG meeting (for all involved WGs)

NOTE: This section only needs to be filled in for WI/SIs where there is a corresponding relevant WI/SI in SA/CT.

## 3.1 SAx/CTs

#### 3.1.1 Agreements with cross-TSG impacts

#### 3.1.2 Remaining Open issues with cross-TSG impacts

NOTE: This section should also flag any critical dependencies that need TSG attention.

## 4. References

NOTE: This can be e.g. a list of all related Tdocs in the affected WGs since last TSG, references to LSs, produced TRs/TSs, the work/study item description or status reports of previous TSGs.

1. R1-2103763 Work plan of Rel-17 enhancements for NB-IoT and LTE-MTC Huawei, Ericsson
2. R1-2102357 Support of 16QAM for unicast in UL and DL in NB-IoT Huawei, HiSilicon
3. R1-2102652 Support of 16-QAM for NB-IoT Nokia, Nokia Shanghai Bell
4. R1-2102680 Switching point between QPSK and 16QAM and DCI design for 16QAM in R17 MediaTek Inc.
5. R1-2102857 Discussion on UL and DL 16QAM for NB-IoT ZTE
6. R1-2103067 Support of 16-QAM for NB-IoT Qualcomm Incorporated
7. R1-2103531 Support 16QAM for NBIoT Lenovo, Motorola Mobility
8. R1-2103723 Support of 16-QAM for unicast in UL and DL in NB-IoT Ericsson
9. R1-2103853 Feature lead summary #1 on 104b-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)
10. R1-2103954 Feature lead summary #2 on 104b-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)
11. R1-2102358 Support of 14-HARQ processes in DL for HD-FDD MTC UEs Huawei, HiSilicon
12. R1-2102653 Support of 14-HARQ processes in DL for eMTC Nokia, Nokia Shanghai Bell
13. R1-2102858 Remaining issues on 14-HARQ processes in DL for eMTC ZTE
14. R1-2103068 Support of 14 HARQ processes and scheduling delay Qualcomm Incorporated
15. R1-2103464 Design considerations to support 14-HARQ Feature for LTE-M Sierra Wireless, S.A.
16. R1-2103724 Support of 14 HARQ processes in DL in LTE-MTC Ericsson
17. R1-2103859 Feature Lead Summary [104b-e-LTE-Rel17\_NB\_IoT\_eMTC-02] 1st check point Moderator (Ericsson)
18. R1-2103860 Feature Lead Summary [104b-e-LTE-Rel17\_NB\_IoT\_eMTC-02]: 2nd check point Moderator (Ericsson)
19. R1-2102359 Support of a max DL TBS of 1736 bits in LTE-MTC Huawei, HiSilicon
20. R1-2102654 Support of a maximum DL TBS of 1736 bits for eMTC Nokia, Nokia Shanghai Bell
21. R1-2102859 Remaining issues on DL TBS increase for eMTC ZTE
22. R1-2103069 Support of larger TBS for eMTC Qualcomm Incorporated
23. R1-2103313 Remaining issues for support of DL TBS of 1736 bits for eMTC Sony
24. R1-2103462 Design considerations to support DL TBS of 1736 bits for LTE-M Sierra Wireless, S.A.
25. R1-2103725 Support of a maximum DL TBS of 1736 bits in LTE-MTC Ericsson
26. R1-2104086 Feature Lead Summary [104b-e-LTE-Rel17\_NB\_IoT\_eMTC-03] Moderator (Sony)
27. R1-2104087 Summary of NWM discussion for [104b-e-LTE-Rel17\_NB\_IoT\_eMTC-03] Moderator (Sony)
28. R1-2103942 LS on Agreements Related to Support of a maximum DL TBS of 1736 bits as a Rel-17 optional UE capability RAN1, Sony
29. R1-2104288 Support of 16QAM for unicast in UL and DL in NB-IoT Huawei, HiSilicon
30. R1-2104548 Support of 16-QAM for NB-IoT Nokia, Nokia Shanghai Bell
31. R1-2104716 Discussion on UL and DL 16QAM for NB-IoT ZTE
32. R1-2104819 Support of 16-QAM for NB-IoT Qualcomm Incorporated
33. R1-2105374 Support 16QAM in NB-IOT Release 17 MediaTek Inc.
34. R1-2105622 Support 16QAM for NBIoT Lenovo, Motorola Mobility
35. R1-2105889 Support of 16-QAM for unicast in UL and DL in NB-IoT Ericsson
36. R1-2106042 Feature lead summary #1 on 105-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)
37. R1-2106104 Feature lead summary #2 on 105-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)
38. R1-2106219 Feature lead summary #3 on 105-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)
39. R1-2104289 Support of 14-HARQ processes in DL for HD-FDD MTC UEs Huawei, HiSilicon
40. R1-2104549 Support of 14-HARQ processes in DL for eMTC Nokia, Nokia Shanghai Bell
41. R1-2104717 Remaining issues on 14-HARQ processes in DL for eMTC ZTE
42. R1-2104821 Support of 14 HARQ processes and scheduling delay Qualcomm Incorporated
43. R1-2105890 Support of 14 HARQ processes in DL in LTE-MTC Ericsson
44. R1-2106028 Feature Lead Summary [105-e-LTE-Rel17\_NB\_IoT\_eMTC-02] checkpoint#1 Moderator (Ericsson)
45. R1-2106029 Feature Lead Summary [105-e-LTE-Rel17\_NB\_IoT\_eMTC-02] checkpoint#2 Moderator (Ericsson)
46. R1-2104718 Remaining issues on DL TBS of 1736 bits for CE mode A ZTE
47. R1-2105891 On the L2 Buffer Size for NB-IoT and LTE-M UEs Ericsson
48. R1-2105939 Discussion on DL PAPR for 16-QAM of NB-IoT Huawei, HiSilicon
49. R2-2103014 Condition for NB-IoT connected mode neighbour cell measurement Qualcomm Incorporated
50. R2-2103015 Determining paging carrier suitability Qualcomm Incorporated
51. R2-2103176 Carrier selection enhancement MediaTek Inc.
52. R2-2103191 Signalling procedure for connected mode measurements support for reestablishment time reduction Nokia, Nokia Shanghai Bells
53. R2-2103192 Further analysis on paging carrier selection options Nokia, Nokia Shanghai Bells
54. R2-2103241 Further discussion on the corresponding measurement before RLF Spreadtrum Communications
55. R2-2103242 Further discussion on enhanced paging carrier selection and NPRACH carrier selection Spreadtrum Communications
56. R2-2103320 RAN2 aspects of measurement in connected mode ZTE Corporation, Sanechips
57. R2-2103321 Details of CEL-based paging carrier selection ZTE Corporation, Sanechips
58. R2-2103364 Consideration on supporting 14 HARQ for eMTC ZTE Corporation, Sanechips
59. R2-2103365 Consideration on supporting 16QAM for NB-IoT ZTE Corporation, Sanechips
60. R2-2103394 Neighbor cell measurements triggering before RLF Lenovo, Motorola Mobility
61. R2-2103486 Neighbour cell measurements in RRC\_CONNECTED Huawei, HiSilicon
62. R2-2103487 Summary of [Post113-e][351][NBIOT R17] Paging carrier selection Huawei
63. R2-2103488 Discussion on 16-QAM for NB-IoT Huawei, HiSilicon
64. R2-2103489 Support of 14 HARQ Processes in DL, for HD-FDD Cat M1 UEs Huawei, HiSilicon
65. R2-2103490 Support of DL TBS of 1736 bits for HD-FDD Cat. M1 UEs Huawei, HiSilicon
66. R2-2103925 Discussion on Fast RLF Recovery procedures in NB-IoT Ericsson
67. R2-2103926 Support of 16-QAM for unicast in UL and DL in NB-IoT Ericsson
68. R2-2103927 Comparing solution for NB-IoT paging carrier selection Ericsson
69. R2-2104042 Work plan of Rel-17 enhancements for NB-IoT and LTE-MTC Ericsson, Huawei
70. R2-2104450 Report of [AT113bis-e][301][NBIOT/eMTC R17] NB-IoT Carrier Selection (Qualcomm) Qualcomm Incorporated
71. R2-2104451 RAN2 agreements for Rel-17 NB-IoT and LTE-MTC Document Rapporteur (Ericsson)
72. R2-2104653 Reply LS on neighbour cell measurement in NB-IoT RRC\_CONNECTED state (R4-2105800; contact: Huawei RAN4
73. R2-2104706 LS on Agreements Related to Support of a maximum DL TBS of 1736 bits as a Rel-17 optional UE capability (R1-2103942; contact: Sony) RAN1
74. R2-2104725 Reply LS on neighbour cell measurement in NB-IoT RRC\_CONNECTED state (R4-2105800; contact: Huawei) RAN4
75. R2-2105224 Analysis on connected mode signalling procedure changes for Re-establishment time reduction Nokia, Nokia Shanghai Bells
76. R2-2105225 Further analysis on paging carrier selection options Nokia, Nokia Shanghai Bells
77. R2-2105314 Remaining issues for measurement in connected mode ZTE Corporation, Sanechips
78. R2-2105317 Further discussion on CEL-based paging carrier selection ZTE Corporation, Sanechips
79. R2-2105318 Further discussion on 16QAM for NB-IoT ZTE Corporation, Sanechips
80. R2-2105363 Further discussion on 14 HARQ and DL TBS of 1736bits for eMTC ZTE Corporation, Sanechips
81. R2-2105543 Discussion on the remaining issue of reestablishment-time-reduction Spreadtrum Communications
82. R2-2105544 Further discussion on enhanced paging carrier selection and NPRACH carrier selection Spreadtrum Communications
83. R2-2105642 Simplified Static solution THALES
84. R2-2105657 Triggering RLF cell selection before T3010 expiry Huawei, HiSilicon
85. R2-2105658 Clarification on Paging carrier selection Huawei, HiSilicon
86. R2-2105659 Guildelines for the design of coverage based paging carrier selection Huawei, HiSilicon
87. R2-2105660 Support of DL TBS of 1736 bits for HD-FDD Cat. M1 Ues Huawei, HiSilicon
88. R2-2105661 Report of email discussion [351] NB-IoT RLF measurements (Huawei) Huawei
89. R2-2105828 Neighbor cell measurements triggering before RLF Lenovo, Motorola Mobility
90. R2-2105918 Consideration on neighbour cell measurement in RRC connected state Qualcomm Incorporated
91. R2-2105919 Considerations on the two paging carrier selection schemes Qualcomm Incorporated
92. R2-2106076 Analysis of Rmax based solution and carrier-based solution Ericsson
93. R2-2106078 Support of 16-QAM for unicast in UL and DL in NB-IoT Ericsson
94. R2-2106080 Discussion on connected mode measurement in NB-IoT Ericsson
95. R2-2106158 Total L2 Buffer Size for NB-IoT and LTE-M UEs Ericsson
96. R2-2106198 Carrier selection enhancement MediaTek Inc.
97. R2-2106289 Measurement before radio link failure MediaTek Inc.
98. R2-2106380 Network configuration for paging carrier selection Nokia Solutions & Networks (I)
99. R2-2106466 Summary of NB-IoT AI 9.1.3 carrier selection based on coverage level Ericsson
100. R2-2106601 [AT114-e][301][NBIOT/eMTC R17] NB-IoT Carrier Selection (Ericsson) Ericsson
101. R2-2106603 Report of [AT114-e][302][NBIOT/eMTC R17] NB-IoT/eMTC Other (ZTE) ZTE (email discussion rapporteur)
102. R3-211588 Discussion on Carrier Selection and Carrier Specific Configuration ZTE
103. R3-211589 36.413 (Rel-17) Introduction of CEL based paging carrier selection for Option 1 ZTE
104. R3-211590 36.413 (Rel-17) Introduction of paging carrier information for Option 2 ZTE
105. R3-211649 Support of Carrier Selection based on coverage level Nokia, Nokia Shanghai Bell
106. R3-211650 Support of Carrier Selection based on coverage level Nokia, Nokia Shanghai Bell
107. R3-211916 Work plan of Rel-17 enhancements for NB-IoT and LTE-MTC Huawei, Ericsson
108. R3-211917 Consideration on NB-IoT Carrier Selection Huawei
109. R3-211918 Support of Additional enhancements for NB-IoT and LTE-MTC Huawei
110. R3-211919 Consideration on Rel-17 enhancements for NB-IoT and LTE-MTC Huawei
111. R3-212355 Discussion on NB-IoT paging carrier selection Ericsson
112. R3-212673 CB: # 1101\_IOT\_Gen - Summary of email discussion Ericsson - moderator
113. R3-212674 CB: # 1102\_IOT\_Main - Summary of email discussion Huawei - moderator
114. R3-212715 Response paper to R3-211588, R3-211590, R3-211650, R3-211918 Ericsson
115. R4-2107255 Work plan of Rel-17 enhancements for NB-IoT and LTE-MTC Huawei, HiSilicon, Ericsson
116. R4-2104458 Proposals on BS RF requirements for support of 16QAM in NB-IoT Nokia, Nokia Shanghai Bell
117. R4-2107245 BS RF impact analysis on R17 NB\_IoT Ericsson
118. R4-2104651 MPR for NB-IoT 16-QAM Nokia
119. R4-2107246 UE RF impact analysis on R17 NB\_IoT Ericsson
120. R4-2107258 MPR Simulation Assumptions for 16QAM NB-IoT Uplink Huawei, HiSilicon
121. R4-2107244 RF impact analysis on Rel-17 eMTC WID, Ericsson
122. R4-2108978 EVM limit in NB-IoT IBE mask Nokia, Nokia Shanghai Bell
123. R4-2109386 Proposals on BS RF requirements for support of 16QAM in NB-IoT Nokia, Nokia Shanghai Bell
124. R4-2109387 Proposals on support of power reduction for PRACH, PUCCH, and full-PRB PUSCH in MTC Nokia, Nokia Shanghai Bell
125. R4-2109948 MPR for NB-IoT 16-QAM Nokia, Nokia Shanghai Bell
126. R4-2111061 Proposals on support of power reduction for PRACH, PUCCH, and full-PRB PUSCH in MTC Nokia, Nokia Shanghai Bell
127. R4-2111190 RF impact analysis on Rel-17 eMTC WID Ericsson
128. R4-2111191 BS RF impact analysis on R17 NB\_IoT Ericsson
129. R4-2111192 UE RF impact analysis on R17 NB\_IoT Ericsson
130. R4-2111295 Discussion on UE RF requirements for 16QAM NB-IoT uplink Huawei,HiSilicon
131. R4-2111296 Discussion on BS RF requirements for 16QAM NB-IoT DL Huawei,HiSilicon
132. R4-2105826 Email discussion summary: [98-bis-e][226] LS\_reply\_R2-2102165\_NBIOT, Moderator (Huawei)
133. R4-2105800 Reply LS on neighbour cell measurement in NB-IoT RRC\_CONNECTED state, Huawei, HiSilicon
134. R4-2105849 WF on neighbour cell measurement in NB-IoT RRC\_CONNECTED state in Rel-17, Ericsson
135. R4-2104429 Reply LS on neighbour cell measurement in NB-IoT RRC\_CONNECTED state, ZTE Corporation
136. R4-2106345 Discussion of neighbor cell measurements in RRC\_CONNECTED for Rel-17 NB-IoT, Qualcomm Incorporated
137. R4-2106857 Reply LS on neighbour cell measurement in NB-IoT RRC\_CONNECTED state, Ericsson
138. R4-2106985 Reply LS on neighbour cell measurement in NB-IoT RRC\_CONNECTED state, Huawei, HiSilicon
139. R4-2107185 Discussion on neighbour cell measurements in NB-IoT RRC\_CONNECTED state, Nokia, Nokia Shanghai Bell
140. R4-2108412 Email discussion summary: [99-e][240] NB\_IOTenh4\_LTE\_eMTC6\_RRM, Moderator (Huawei)
141. R4-2108369 WF on RRM requirements of Rel-17 Additional enhancements for NB-IoT and LTE-MTC, Huawei, HiSilicon
142. R4-2110275 On the scope of work on RRM core requirements for Additional enhancements for NB-IoT and LTE-MTC, Nokia, Nokia Shanghai Bell
143. R4-2110346 Discussion on neibour cell measurement in CONNECTED state for NB-IoT Rel-17, Huawei, HiSilicon
144. R4-2111250 Discussions on RRM requirements for release 17 WI on eMTC and NB-IoT, Ericsson

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28.01.2021 minor adaptations for RAN #91e

09.11.2020 minor adaptations for RAN #90e

31.08.2020 minor adaptations for RAN #89e

20.04.2020 minor adaptations for RAN #88e

18.02.2020 minor adaptations for RAN #87e

14.11.2019 minor adaptations for RAN #86

18.08.2019 minor adaptations for RAN #85

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v04.71 10.02.2016 minor adaptations for RAN #71

v04.70 30.10.2015 minor adaptations for RAN #70

v04.69 12.08.2015 minor adaptations for RAN #69

v04.68 21.05.2015 minor adaptations for RAN #68

v04.67 01.02.2015 minor adaptations for RAN #67

v04.66 16.11.2014 minor adaptations for RAN #66

v04.65 16.08.2014 minor adaptations for RAN #65

v04.64 22.05.2014 minor adaptations for RAN #64

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