**3GPP TSG RAN WG1 #100bis-e R1-2002429**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on UE features for additional enhancements for NB-IoT

Agenda Item: 6.2.5.2

**Document for:** **Discussion and Decision**

# **Introduction**

This contribution summarizes the discussions and proposals in AI 6.2.5.2 regarding UE features for additional enhancements for NB-IoT.

In R1-2001485 [1] which is the version after [100e-LTE-Rel-16-UEFeatures] email discussion, there are following feature groups for additional enhancements for NB-IoT.

* 2-1 UE-group wake-up signal (Group WUS) with a wake-up time before the first associated PO (without group resource alternation)
* [2-2] UE-group WUS with a wake-up time before the first associated PO (with group resource alternation)
* 2-3 Transmission in preconfigured UL resources (PUR) (with potential UE-specific cyclic shift for DMRS)
* [2-4] PUR with serving cell RSRP for TA validation
* 2-5 PUR with L1 ACK
* 2-6 Multi-TB scheduling for unicast in DL with a single DCI (Interleaved transmission)
* 2-7 Multi-TB scheduling for unicast in DL with a single DCI (Non-interleaved transmission)
* 2-8 Multi-TB scheduling for unicast in UL with a single DCI (Interleaved transmission)
* 2-9 Multi-TB scheduling for unicast in UL with a single DCI (Non-interleaved transmission)
* 2-10 Multi-TB scheduling for unicast in DL in a single DCI (HARQ bundling for HARQ-ACK feedback to interleaved transmission)
* 2-11 Multi-TB scheduling for SC-MTCH
* 2-12 Resource reservation
  + DL resource reservation with subframe-level, slot-level and symbol-level granularity of NB-IoT non-anchor carriers.
* 2-13 Resource reservation
  + UL resource reservation with subframe-level, slot-level and symbol(s)-level granularity of NB-IoT non-anchor carriers.
* 2-14 Quality report in Msg3 for non-anchor access
* 2-15 Quality report in connected mode
* 2-16 NRS on a non-anchor carrier for paging

Based on the discussions summarized in Section 2-9, following is the suggested list of issues to be discussed and priority order considering RAN2 impact especially for capability signaling design.

**FL proposal of list of issues/proposals and priority:**

* **1st priority issues (such as a certain FG is necessary or not):**
  + **[2-2]**
    - **Whether FG2-2 is a separate FG (i.e., remove bracket) or FG2-2 is removed and added as a component in FG2-1**
      * **Whether this issue should be discussed with [1-2] jointly or individually**
  + **2-4**
    - **Whether FG2-4 is a separate FG (i.e., remove bracket) or FG2-4 is removed and added as a component in FG2-3**
      * **Whether this issue should be discussed with [1-7] jointly or individually**
  + **2-5**
    - **Whether FG2-5 is kept as a separate FG or FG2-5 is removed and added as a component in FG2-3**
      * **Whether this issue should be discussed with 1-9 jointly or individually**
  + **2-12 and 2-13**
    - **Whether or not to introduce separate FGs for slot/symbol level resource reservation for FG2-12 and 2-13**
      * **Whether this issue should be discussed with 1-23 to 1-26 jointly or individually**
* **2nd priority issues (that seem not have signaling impact and hence can be postponed):**
  + **2-3**
    - **Whether or not 'with potential UE-specific cyclic shift for DMRS' in the bracket of FG name is removed**
  + **2-6 and 2-8**
    - **Whether or not multi-TB unicast in DL(UL) with non-interleaved transmission is a prerequisite for the support of multi-TB unicast in DL(UL) with interleaved transmission**
  + **2-11**
    - **Whether or not to change FG name to "Multi-TB SC-MTCH with scheduling gap"**
  + **2-14**
    - **Regarding to ‘Mandatory/Optional’ column, whether or not to change ‘Optional without capability signalling' to 'Up to RAN2'**

Companies are encouraged to check above FL proposals and to provide feedback if any in below.

|  |  |
| --- | --- |
| Company | Comment |
|  |  |
|  |  |
|  |  |

# **[2-2]: UE-group WUS with group resource alternation**

In [1], FG2-2 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the eNB to know if the feature is supported** | **Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs)** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Capability interpretation for mixture of FDD/TDD** | **Note** | **Mandatory/Optional** |
| 2. NB\_IOTenh3 | [2-2] | UE-group WUS with a wake-up time before the first associated PO (with group resource alternation) |  | 2-1 | Yes | N/A | The network cannot wake-up a group of users with one wake-up signal | Per UE | FDD only | N/A | If UE does not support group resource alternation and the eNB enables group resource alternation, UE falls back to Rel-15 NWUS when Rel-15 NWUS is configured or no NWUS when Rel-15 NWUS is not configured.  FFS: whether to keep this feature group 2-2 separately or put it as a component of FG 2-1 | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [3] | Qualcomm | Remove brackets for FG2-2 and Keep FG2-1/2-2 as separate FGs. |
| [4] | Ericsson | **Proposal 1 Keep GWUS with/without group resource alternation as two separate FGs.** |
| [5] | Huawei, HiSilicon | Proposal 1: FG 2-2 (group resource alternation) is a component of FG 2-1. |

**Based on above, following points should be discussed for FG2-2.**

* **Whether FG2-2 is a separate FG (i.e., remove bracket) or FG2-2 is removed and added as a component in FG2-1**
  + **Whether this issue should be discussed with [1-2] jointly or individually**

# **2-3: PUR with potential UE-specific cyclic shift for DMRS**

In [1], FG2-3 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the eNB to know if the feature is supported** | **Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs)** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Capability interpretation for mixture of FDD/TDD** | **Note** | **Mandatory/Optional** |
| 2. NB\_IOTenh3 | 2-3 | Transmission in preconfigured UL resources (PUR)  (with potential UE-specific cyclic shift for DMRS) |  |  | Yes | N/A | UE cannot transmit without an UL grant | Per UE | FDD only | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list. | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | ***Proposal 3: For FG 2-32, update the FG name to 'Transmission in preconfigured UL resources (PUR)'.*** |

**Based on above, following points should be discussed for FG2-3.**

* **Whether or not 'with potential UE-specific cyclic shift for DMRS' in the bracket of FG name is removed**

# **[2-4]: PUR with serving cell RSRP for TA validation**

In [1], FG2-4 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the eNB to know if the feature is supported** | **Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs)** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Capability interpretation for mixture of FDD/TDD** | **Note** | **Mandatory/Optional** |
| 2. NB\_IOTenh3 | [2-4] | PUR with serving cell RSRP for TA validation |  | 2-3 | Yes | N/A | PUR will not use serving cell RSRP for TA validation | Per UE | FDD only | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list.  TA validation mechanisms based on ‘Serving cell changes’, ‘TA timer for idle mode’ and ‘TA always valid’ are mandatory for PUR UEs  FFS: whether to keep this feature group 2-4 separately or put it as a component of FG 2-3 | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [3] | Qualcomm | Remove brackets for FG2-4 and Keep FG2-3/2-4 as separate FGs. |
| [4] | Ericsson | **Proposal 2 Discuss whether there is reason from IODT point of view to keep PUR with serving cell RSRP for TA validation as a separate feature group.** |
| [5] | Huawei, HiSilicon | Proposal 2: FG 2-4 (PUR with serving cell RSRP for TA validation) is a component to FG 2-3. |

**Based on above, following points should be discussed for FG2-4.**

* **Whether FG2-4 is a separate FG (i.e., remove bracket) or FG2-4 is removed and added as a component in FG2-3**
  + **Whether this issue should be discussed with [1-7] jointly or individually**

# **2-5: PUR with L1 ACK**

In [1], FG2-5 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the eNB to know if the feature is supported** | **Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs)** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Capability interpretation for mixture of FDD/TDD** | **Note** | **Mandatory/Optional** |
| 2. NB\_IOTenh3 | 2-5 | PUR with L1 ACK |  | 2-3 | Yes | N/A | PUR will not use L1 ACK | Per UE | FDD only | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list. | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [5] | Huawei, HiSilicon | Proposal 3: FG 2-5 (PUR with L1 ACK) is a component of FG 2-3. |

**Based on above, following points should be discussed for FG2-5.**

* **Whether FG2-5 is kept as a separate FG or FG2-5 is removed and added as a component in FG2-3**
  + **Whether this issue should be discussed with 1-9 jointly or individually**

# **2-6 and 2-8: Multi-TB unicast in DL with interleaved transmission**

In [1], FG2-6 and FG2-8 are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the eNB to know if the feature is supported** | **Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs)** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Capability interpretation for mixture of FDD/TDD** | **Note** | **Mandatory/Optional** |
| 2. NB\_IOTenh3 | 2-6 | Multi-TB scheduling for unicast in DL with a single DCI  (Interleaved transmission) |  | Two HARQ processes | Yes | N/A | The network cannot schedule transmission of multiple TBs in DL with a single DCI (interleaved transmission) | Per UE | FDD only | N/A |  | Optional with capability signalling |
| 2-8 | Multi-TB scheduling for unicast in UL with a single DCI  (Interleaved transmission) |  | Two HARQ processes | Yes | N/A | The network cannot schedule transmission of multiple TBs in UL with a single DCI (interleaved transmission) | Per UE | FDD only | N/A |  | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [4] | Ericsson | **Proposal 5 Support of multi-TB unicast in DL with non-interleaved transmission is a prerequisite for support of multi-TB unicast in DL with interleaved transmission.**  **Proposal 6 Support of multi-TB unicast in UL with non-interleaved transmission is a prerequisite for support of multi-TB unicast in UL with interleaved transmission.** |

**Based on above, following points should be discussed for FG2-6 and FG2-8.**

* **Whether or not multi-TB unicast in DL(UL) with non-interleaved transmission is a prerequisite for the support of multi-TB unicast in DL(UL) with interleaved transmission**

# **2-11: Scheduling gap for Multi-TB SC-MTCH**

In [1], FG2-11 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the eNB to know if the feature is supported** | **Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs)** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Capability interpretation for mixture of FDD/TDD** | **Note** | **Mandatory/Optional** |
| 2. NB\_IOTenh3 | 2-11 | Multi-TB scheduling for SC-MTCH | 1. Scheduling of multiple transport blocks for SC-MTCH in a single DCI  2. Scheduling of multiple transport blocks for SC-MTCH in a single DCI with scheduling gaps | SC-PTM | No | N/A | The network cannot schedule transmission of multiple TBs with a single DCI | Per UE | FDD only | N/A | The basic multicast (SC-PTM) functionality was introduced for LTE-M/NB-IoT in Rel-14 without capability signaling. | Up to RAN2 |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | ***Proposal 1: UE supporting multi-TB SC-MTCH should support scheduling gap.***   * ***Change FG name to "Multi-TB SC-MTCH with scheduling gap".*** |

**Based on above, following points should be discussed for FG2-11.**

* **Whether or not to change FG name to "Multi-TB SC-MTCH with scheduling gap"**

# **2-12 and 2-13: Subframe/slot/symbol-level resource reservation**

In [1], FG12 and FG2-13 are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the eNB to know if the feature is supported** | **Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs)** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Capability interpretation for mixture of FDD/TDD** | **Note** | **Mandatory/Optional** |
| 2. NB\_IOTenh3 | 2-12 | Resource reservation  DL resource reservation with subframe-level, slot-level and symbol-level granularity of NB-IoT non-anchor carriers. |  |  | Yes | N/A | NB-IoT transmission may collide with NR transmission | Per UE | Yes | N/A | FFS: Whether to introduce separate indications for subframe/slot/symbol levels | Optional with capability signalling |
| 2-13 | Resource reservation  UL resource reservation with subframe-level, slot-level and symbol(s)-level granularity of NB-IoT non-anchor carriers. |  |  | Yes | N/A | NB-IoT transmission may collide with NR transmission | Per UE | Yes | N/A | FFS: Whether to introduce separate indications for subframe/slot/symbol levels | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | ***Proposal 2: For Rel-16 NB-IoT enhancement, one indication for symbol-level/slot level and another separate indication for subframe level should be used for DL/UL resource reservation.*** |
| [3] | Qualcomm | We would like to have separate indications for all resource reservation FG. |
| [4] | Ericsson | **Proposal 3 Introduce two separate indications for DL resource reservation with subframe-level and slot-/symbol-level granularity, respectively.**  **Proposal 4 Introduce two separate indications for UL resource reservation with subframe-level and slot-/symbol-level granularity, respectively.** |
| [5] | Huawei, HiSilicon | **Proposal 4：Separate indication to slot/symbol level resource reservation is not supported in feature groups 2-12 and 2-13.** |

**Based on above, following points should be discussed for FG2-12 and FG2-13.**

* **Whether or not to introduce separate FGs for slot/symbol level resource reservation for FG2-12 and 2-13**
  + **Whether this issue should be discussed with 1-23 to 1-26 jointly or individually**

# **2-14: Quality report in Msg3 for non-anchor access**

In [1], FG2-14 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the eNB to know if the feature is supported** | **Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs)** | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Capability interpretation for mixture of FDD/TDD** | **Note** | **Mandatory/Optional** |
| 2. NB\_IOTenh3 | 2-14 | Quality report in Msg3 for non-anchor access | 1. Quality report in Msg3 for non-anchor access in IDLE mode | Non-anchor carrier for paging/RACH, non-anchor carrier for unicast | No | N/A | The network cannot receive the quality report for non-anchor carriers in IDLE mode | Per-UE | FDD only | N/A |  | Optional without capability signalling |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [3] | Qualcomm | Although this is something minor, probably better to put “Up to RAN2”, since the indication of support/no support may be implicit in the msg3 encoding. |

**Based on above, following points should be discussed for FG2-14.**

* **Regarding to ‘Mandatory/Optional’ column, whether or not to change ‘Optional without capability signalling' to 'Up to RAN2'**

# **References**

[1] R1-2001485 RAN1 UE features list for Rel-16 LTE after RAN1#100-E Moderator (AT&T, NTT DOCOMO, INC.)

[2] R1-2001858 Discussion on UE features for additional enhancements for NB-IoT ZTE

[3] R1-2002182 UE features for NB-IoT　 Qualcomm Incorporated

[4] R1-2002511 On the RAN1 UE feature list for Rel-16 NB-IoT　 Ericsson

[5] R1-2002605 Rel-16 UE features for NB-IoT　 Huawei, HiSilicon