**3GPP TSG RAN WG1 #108-e R1-22xxxxx**

**e-Meeting, February 21st – March 3rd, 2022**

**Agenda item:** 8.16.9

**Source:** Moderator (NTT DOCOMO, INC.)

**Title:** [draft]Summary on UE features for NB-IoT and LTE-MTC enhancements

**Document for:** Discussion and Decision

# **Introduction**

This document summarizes contributions submitted to AI 8.16.9 regarding UE features for NB-IoT and LTE-MTC enhancements and captures the following email discussion.

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| [108-e-R17-UE-features-NB-IoT-eMTC-01] Email discussion on UE features for NB-IoT and LTE-MTC enhancements – Shinya (DOCOMO)* 1st check point: February 25
* Final check point: March 3
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In the updated RAN1 UE features list for Rel-17 LTE after RAN1 #107-e [1], there are following feature groups for NB-IoT and LTE-MTC enhancements.

* 1-1 16-QAM for unicast NPDSCH
* 1-2 16-QAM for unicast NPUSCH
* 1-3 14 HARQ processes for PDSCH for HD-FDD Cat. M1 UEs
* 1-4 A maximum DL TBS of 1736 bits for HD-FDD Cat. M1 UEs in CE mode A only

In this round of the discussion, companies are requested to provide comments on the proposals and questions tagged FL1.

# **1-1 to 1-2: 16-QAM for unicast NPDSCH/NPUSCH**

In [1], FGs 1-1 to 1-2 are captured as below.

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| 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 |
| 1. NB\_IOTenh4\_LTE\_eMTC6 | 1-1 | 16-QAM for unicast NPDSCH | 1. Reception of unicast NPDSCH modulated with 16-QAM2. CQI report to support 16-QAM modulation3. Downlink power allocation for 16-QAM | Category NB-2 | Yes | N/A | The network cannot schedule a unicast NPDSCH modulated with 16-QAM for the UE | Per UE | [Yes] | N/A | It is RAN1 assumption that 16-QAM for unicast in DL is compatible with all other NB-IoT features in connected-mode plus PUR | Optional with capability signaling |
| 1. NB\_IOTenh4\_LTE\_eMTC6 | 1-2 | 16-QAM for unicast NPUSCH | 1. Transmission of unicast NPUSCH modulated with 16-QAM2. New term in the UE’s transmit power control equation. | Category NB-2 | Yes | N/A | The network cannot schedule a unicast NPUSCH modulated with 16-QAM for the UE | Per UE | [Yes] | N/A | It is RAN1 assumption that 16-QAM for unicast in UL is compatible with all other NB-IoT features in connected-mode plus PUR | Optional with capability signaling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

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| [2] | Huawei, HiSilicon | For Rel-17 NB-IoT UE features *16-QAM for unicast NPDSCH* and *16-QAM for unicast NPUSCH,* the need of FDD/TDD differentiation is [Yes] in the preliminary version*.* Regarding support of 16-QAM, we failed to see the difference between TDD and FDD. Furthermore, for the legacy NB-IoT, the MCS table for unicast NPDSCH and unicast NPUSCHis the same for TDD and FDD. Therefore, the need of FDD/TDD differentiation should be no for UE features 16-QAM for unicast NPDSCH and 16-QAM for unicast NPUSCH.**Proposal 1: The need of FDD/TDD differentiation should be no for UE features 16-QAM for unicast NPDSCH and 16-QAM for unicast NPUSCH.**One remaining issue is whether reporting types of FGs 1-1, 1-2, 1-3 and 1-4 are per UE or per band. As from RAN1 point of view, there’s no problem in supporting the reporting types as per UE. In addition, regarding the large signaling overhead, reporting type of per UE is preferred.**Proposal 2: The reporting type of FGs 1-1, 1-2, 1-3 and 1-4 is per UE.** |
| [3] | ZTE, Sanechips | **Per UE or Per band**For type of FGs 1-1, 1-2, 1-3 and 1-4, whether they are per UE reported or per band reported has been initially discussed in last meeting. For 16-QAM (FGs 1-1 and 1-2), some contributions mentioned 1-1 and 1-2 have RF impact (Tx and Rx EVM), so it makes sense to have these per band. However, in practice, 1) MTC 64QAM is per UE. Similarly, we do not see any issue to adopt the similar method.2) The EVM in LTE or NR is the same across all bands [2]. We do not see the necessity to set16-QAM as per band.Therefore, at least for 16-QAM, it should not be per band. Regarding 14-HARQ processes (FG 1-3) and 1736bits (FG 1-4), these two features would not have impact on the RF and also there would not exist the IODT issues. Therefore, we do not see any reason to set it as per band. ***Proposal 1: The type of FGs 1-1, 1-2, 1-3 and 1-4 should be Per UE.*****Need of FDD/TDD differentiation**For 16-QAM, if TDD is supported, there are some RAN1 impacts and RAN4 impacts as mentioned in [3]

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| 1. Recently it has been found that supporting 16-QAM for TDD won’t be transparent from a RAN1 perspective nor from a RAN4 perspective.
2. The foreseen RAN1 impacts from supporting 16-QAM for TDD NB-IoT are:
* In legacy TDD NB-IoT, NPDSCH can be transmitted on DwPTS.
* For NPDSCH without repetition, rate matching is used for the Resource Element (RE) mapping into the special subframe.
* The RE mapping on special subframes including rate matching aspects would have to be discussed for supporting 16-QAM in TDD NB-IoT.
1. The foreseen RAN4 impacts from supporting 16-QAM for TDD NB-IoT are:
* Define dedicated UE demodulation requirements for 16QAM in TDD NB-IoT in TS 36.101.
* Define a BS conformance test (Test Model) for 16-QAM in TDD NB-IoT in TS 36.141.
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From RAN1 perspective, the rate matching issue for supporting TDD for 16-QAM are similar with QPSK, which is actually the remaining issue. As for the RAN4 impacts, we can ask RAN4 to decide whether to support TDD for 16-QAM.***Proposal 2: From RAN1 perspective, rate matching issue for supporting TDD for 16-QAM can be further discussed.*** |
| [4] | Nokia, NSB | * **FGs 1-1, 1-2, 1-3, 1-4**: per UE
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| [5] | DOCOMO | * 1-1: 16-QAM for unicast NPDSCH
	+ At the RAN1#107-e meeting, some companies pointed that FGs 1-1 and 1-2 have RF impact (Tx and Rx EVM) and hence the type of FGs 1-1 and 1-2 should be per band, while some other companies argued that the RF impact should be discussed and confirmed in RAN4 [2].
	+ We think the type of FGs 1-1 and 1-2 can be per UE with FDD/TDD differentiation same as Rel-16 eMTC/NB-IoT FGs, but we can also accept asking RAN4 to make a decision on the type of FGs 1-1 and 1-2.
* 1-2: 16-QAM for unicast NPUSCH
	+ Same as above
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| [6] | Qualcomm | One of the most contentious issues in the last meeting was whether the features for eMTC and NB-IoT were “per UE” or “per band”.In our view, the newly introduced features should be “per band” for the following reason: with the introduction of NTN IOT, there should be a way to differentiate the capability of using 16-QAM or 14 HARQ processes for terrestrial and non-terrestrial cases. “Per band” capability indication allows for this indication.**Observation 1: All the IOT features should be “per band” to allow differentiation of support of a feature in terrestrial and non-terrestrial networks.**For support of 16-QAM, in line with the observation above, we propose the type of this feature to be “per band”. For the particular case of 16-QAM, there is an additional reason to make this feature “per band”: different frequency bands may have different difficulties to meet the necessary RF requirements to support 16-QAM (e.g. in terms of transmit / receive EVM). Additionally, the signaling of “per band” capability prevents potential issues in the field in the case there is lack of IODT opportunities with multiple infrastructure vendors when initially deploying the feature: a second vendor with which the UE has not been tested against may think the feature is tested, which may lead to malfunctioning in the field.**Proposal 1: The capability for 16-QAM for NPUSCH and NPDSCH (FG1-1 and 1-2) is “per band”.** |
| [7] | Ericsson | 1. During RAN1# 107-e, it was discussed whether the “Type” of the Rel-17 features should be defined “Per UE” or “Per Band”.
2. In our view, as for legacy features, the Type of Rel-17 features built under a L1 Terrestrial context should in principle be defined “Per UE”.
3. The motivation for defining the “Type” as “Per Band” has been around “NTN” and an “RF impact (Tx and Rx EVM)”. However, such a motivation is outside the RAN1 expertise.
* Moreover, not even “NTN IoT” has defined the “Type” as “Per Band”, since in [R1-2112900](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Docs/R1-2112900.zip) there seems to be an FFS on it: “[per UE/per band]”
1. RAN1 that designed the Rel-17 features under a “L1 Terrestrial” context does not have the expertise to acknowledge or reject motivations around “NTN” and “RF impacts”, thus we can follow the Moderator’s suggestion of defining the “Type of FGs 1-3 and 1-4 (i.e., LTE-MTC features) “per UE” and leaving the Type of FGs 1-1 and 1-2 (i.e., NB-IoT features) up to RAN2/RAN4”.
2. For 16-QAM for unicast in UL and DL (i.e., FGs 1-1 and 1-2 in the “UE Feature list” respectively), whether the “Type” is to be defined “Per UE” or “Per Band” is up to RAN2/RAN4.
3. For the “Need of FDD/TDD differentiation,” the support of 16-QAM has been developed under the context of FDD. Supporting 16-QAM for TDD has been found to result in specification impacts (See [R1-2112363](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Docs/R1-2112363.zip)), and therefore 16-QAM should only be supported for FDD operation.
4. For 16-QAM for unicast in UL and DL: The column “Need of FDD/TDD differentiation” is filled-in as “FDD only”, whereas the column “Capability interpretation for mixture of FDD/TDD” is filled-in as non-applicable, that is “N/A”.
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## **Discussion**

**[FL1] Proposal 2-1:**

* **For FGs 1-1 and 1-2, select one of the following options:**
	+ **Option 1: type of FGs 1-1 and 1-2 are per UE**
		- **Option 1-1: FDD/TDD differentiation is not needed**
		- **Option 1-2: FDD/TDD differentiation is needed**
		- **Option 1-3: FDD/TDD differentiation needs to be further discussed**
		- **Option 1-4: FGs 1-1 and 1-2 are supported for FDD only**
	+ **Option 2: type of FGs 1-1 and 1-2 are per band**
	+ **Option 3: Ask RAN2/RAN4 to decide the type of FGs 1-1 and 1-2**

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| Company | Comment |
| Moderator | Summary of companies view* Option 1: HW/HiSi, ZTE, Nokia/NSB, DOCOMO
	+ Option 1-1: HW/HiSi
	+ Option 1-2: DOCOMO
	+ Option 1-3: ZTE
	+ Option 1-4: E///
* Option 2: QC
* Option 3: DOCOMO, E///

At RAN1#107-e, this issue was discussed together with other FGs 1-3 and 1-4 but no consensus was achieved. During the discussion, most companies showed their flexibility to accept Option 3 for FGs 1-1 and 1-2, and it seemed stable that type of FGs 1-3 and 1-4 are per UE. Companies are invited to provide view whether you can live with Option 3 for FGs 1-1 and 1-2.Also, Companies are invited to provide view whether to support FGs 1-1 and 1-2 for TDD bands. |
| Ericsson | We think it would be better to decouple the open issue on the “Type” from the open issue on the “TDD support”. The reason is that even if the type were per band, for supporting TDD operation there are other technical aspects (rate matching design, UE demodulation requirements, BS conformance test) that would need to be addressed for supporting FGs 1-1 and 1-2 in TDD operation.Having said that:On the “TDD support”, our first preference is “**Option 1-4: FGs 1-1 and 1-2 are supported for FDD only**”On the “Type” our first preference is to define the “Type: Per UE,” and *iff* there were reasons outside the terrestrial L1 expertise to do it otherwise we would be open to let working groups with the right expertise to decide (as per option 3). |
| ZTE, Sanechips | We agree with the suggestion from Ericsson that the issue on the “Type” and issue on the “TDD support” can be decoupled.For type of FGs 1-1 and 1-2, we support Per UE.For TDD support issue, actually, if TDD is supported, we are failed to find the Rel-17 16-QAM specific RAN1 aspects. |
| Ericsson v004 | To ZTE: On the comment “*actually, if TDD is supported, we are failed to find the Rel-17 16-QAM specific RAN1 aspects*”. To make it clear, the RAN1 impact from supporting 16-QAM for TDD NB-IoT is:* In legacy TDD NB-IoT, NPDSCH can be transmitted on DwPTS.
* For NPDSCH without repetition, rate matching is used for the Resource Element (RE) mapping into the special subframe.
* The RE mapping on special subframes including rate matching aspects would have to be discussed for supporting 16-QAM in TDD NB-IoT.

On top of that, we have pointed out the impacts in RAN4 (UE demodulation requirements and BS conformance test). |
| NTT DOCOMO | We are also fine to decouple the issue on the type and the issue on the TDD support.Regarding the type, our first preference is Option 1 i.e., per-UE, but given some concern from RF impact perspective, we are also fine with Option 3 i.e., Ask RAN2/RAN4 to decide the type of FGs 1-1 and 1-2.Regarding the TDD support, based on comments/contributions from Ericsson and ZTE, we understand the issue to support this feature for TDD and hence we would be fine to support this feature for FDD only (Option 1-4), but it would be appropriate that such decision is made in the maintenance agenda. |
| Qualcomm | Our first preference is per-band. We would also be OK with not supporting the feature for TDD (but still the feature would be per band). |
| Huawei, HiSilicon | By decoupling the questions, for reporting type, we prefer per-UE. For TDD/FDD differentiation, we didn’t see any problem to support TDD with those listed by Ericsson. The three aspects are identical for NPUSCH with or without 16-QAM. On the RAN4 impact, anyway Ran4 would need to specify the performance test, we don’t see any problem to support both TDD and FDD. |
| Ericsson v008 | To Huawei: In relation with the TDD operation and the identified RAN1 impact you commented “*The three aspects are identical for NPUSCH with or without 16-QAM*”. On that matter, what is not identical are the TBS/MCS tables for 16-QAM, therefore we need to make the rate-matching analysis/design on each of the applicable special subframe configurations in Table 4.2-1 of TS 36.211 for all ITBS, ISF indices, and for the different deployment modes. This will allow us to identify which transport block sizes are suitable to be transmitted on DwPTS as a function of the achievable code rates obtained in each case. |

# **1-3: 14 HARQ processes for PDSCH for HD-FDD Cat. M1 UEs**

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

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| 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 |
| 1. NB\_IOTenh4\_LTE\_eMTC6 | 1-3 | 14 HARQ processes for PDSCH for HD-FDD Cat. M1 Ues | 1. Support of 14 DL HARQ processes for unicast in HD-FDD in CE mode A in RRC\_CONNECTED2. PDSCH scheduling delay3. HARQ-ACK delay solution with Alt-1 and Alt-2e | 1. Category M12. HD-FDD | Yes | N/A | The network cannot enable 14 HARQ processes for the UE | Per UE | FDD only | N/A | * PDSCH scheduling delay:
	+ 2 BL/CE DL subframes.
	+ 1 BL/CE DL subframe + 1 subframe + 3 BL/CE UL subframes + 1 subframe + 1 BL/CE DL subframe.
	+ 1 subframe + 3 BL/CE UL subframes + 1 subframe + 2 BL/CE DL subframes.
* HARQ-ACK 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).
	+ 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”.
	+ For component 3, UE reports one of {Alt-1, Alt-1 and Alt-2e}
 | Optional with capability signaling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

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| [2] | Huawei, HiSilicon | One remaining issue is whether reporting types of FGs 1-1, 1-2, 1-3 and 1-4 are per UE or per band. As from RAN1 point of view, there’s no problem in supporting the reporting types as per UE. In addition, regarding the large ignalling overhead, reporting type of per UE is preferred.**Proposal 2: The reporting type of FGs 1-1, 1-2, 1-3 and 1-4 is per UE.** |
| [3] | ZTE, Sanechips | **Per UE or Per band**For type of FGs 1-1, 1-2, 1-3 and 1-4, whether they are per UE reported or per band reported has been initially discussed in last meeting. For 16-QAM (FGs 1-1 and 1-2), some contributions mentioned 1-1 and 1-2 have RF impact (Tx and Rx EVM), so it makes sense to have these per band. However, in practice, 1) MTC 64QAM is per UE. Similarly, we do not see any issue to adopt the similar method.2) The EVM in LTE or NR is the same across all bands [2]. We do not see the necessity to set16-QAM as per band.Therefore, at least for 16-QAM, it should not be per band. Regarding 14-HARQ processes (FG 1-3) and 1736bits (FG 1-4), these two features would not have impact on the RF and also there would not exist the IODT issues. Therefore, we do not see any reason to set it as per band. ***Proposal 1: The type of FGs 1-1, 1-2, 1-3 and 1-4 should be Per UE.*****Need of FDD/TDD differentiation**For 14-HARQ processes, it is only for FDD which has been agreed. As for 1736bits, it is only used for HD-FDD according to the WID. Therefore, these two features need FDD/TDD differentiation.***Proposal 3: For FG 1-3 and FG 1-4, FDD/TDD differentiation is needed and both of them are used for FDD only.*****14-HARQ processes compatible with legacy feature**For dynamic HARQ-ACK delay, it is overlapped with the current design of 14-HARQ feature. Even though the HARQ delay value may be compatible, the DCI fields for UE reading HARQ delay are quite different. When both of features are enabled, it is confused whether the HARQ delay is determined by HARQ-ACK delay field or PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ processes field. Therefore, it doesn’t need to support any of them at the same time.For uplink HARQ-ACK feedback, we think it is beneficial to support it for the large repetition case. However, for 14-HARQ process feature, it is mainly used for small repetition, e.g., one repetition. However, according to the latest agreement, repetition may be not precluded for DL 14-HARQ processes. Therefore, in some case, uplink HARQ-ACK feedback can also be used for uplink transmission.For PUR, it is for idle mode, it is nature to assume to not support it for 14-HARQ processes, since such large data rate requirement is not needed for PUR. Moreover, PUR is mainly used for uplink transmission, while 14-HARQ feature is used for downlink. Therefore, there is no need to support 14-HARQ processes in PUR.Additionally, MTB for 14-HARQ process is not supported according to the conclusion.***Proposal 4: It is RAN1 assumption that except for Rel-16 Multi-TB scheduling and Rel-14 dynamic HARQ-ACK delay, the 14 HARQ processes feature is compatible with all other eMTC features in connected-mode applicable for HD-FDD Cat.*** ***Proposal 5: 14-HARQ processes is not supported for PUR.*** |
| [4] | Nokia, NSB | **FGs 1-1, 1-2, 1-3, 1-4**: per UE |
| [5] | DOCOMO | * 1-3: 14 HARQ processes for PDSCH for HD-FDD Cat. M1 Ues
	+ We think the type of FGs 1-3 should be per UE and FDD-only, same as Rel-16 eMTC/NB-IoT FGs.
	+ At the RAN1#107-e meeting, it was proposed to add a note “*It is RAN1 assumption the 14 HARQ processes feature is compatible with all other eMTC features in connected-mode applicable for HD-FDD Cat. M1 Ues in CE mode A, except for the simultaneous configuration with Rel-16 Multi-TB scheduling*” for FG1-3, but it was not agreed [2]. Some companies commented that Rel-14 dynamic HARQ-ACK delay should also be excluded.
	+ We think that Rel-14 dynamic HARQ-ACK delay should not be mixed with FG 1-3 as new HARQ-ACK delay is designed for this FG 1-3, and it seems obvious. Therefore, we are fine with either having the note with also excluding Rel-14 dynamic HARQ-ACK delay or having no additional note/conclusion on this issue.
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| [6] | Qualcomm | One of the most contentious issues in the last meeting was whether the features for eMTC and NB-IoT were “per UE” or “per band”.In our view, the newly introduced features should be “per band” for the following reason: with the introduction of NTN IOT, there should be a way to differentiate the capability of using 16-QAM or 14 HARQ processes for terrestrial and non-terrestrial cases. “Per band” capability indication allows for this indication.**Observation 1: All the IOT features should be “per band” to allow differentiation of support of a feature in terrestrial and non-terrestrial networks.**Similar to the points above, the eMTC features 1-3 and 1-4 shall be indicated “per band” due to NTN/TN differentiation and robustness against lack of IODT opportunities.**Proposal 2: FG 1-3 and 1-4 are “per band”.** |
| [7] | Ericsson | For the above UE feature list on the support of 14 HARQ processes in DL for HD-FDD Ues in CE Mode A, we have the following observation and proposals:1. To define the “Type” of the Rel-17 features built under a L1 Terrestrial context, we can follow the Moderator’s suggestion of defining the “Type of FGs 1-3 and 1-4 (i.e., LTE-MTC features) “per UE” and leaving the Type of FGs 1-1 and 1-2 (i.e., NB-IoT features) up to RAN2/RAN4”.
2. For 14 HARQ processes in DL for HD-FDD Ues (i.e., FG 1-3 in the “UE Feature list”), the column “Type” is defined “Per UE”.

On the other hand, during RAN1#107 the following conclusion remained stable for endorsement until a last-minute comment was received which made the Chairman to decide proceeding as follows: “*Seems that we need to comeback to proposal 3-3 in Q1*”.

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| **Proposed conclusion 3-3:*** **It is RAN1 assumption the 14 HARQ processes feature is compatible with all other eMTC features in connected-mode applicable for HD-FDD Cat. M1 Ues in CE mode A, except for the simultaneous configuration with Rel-16 Multi-TB scheduling, to be captured in the note column in FG 1-3**
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The last-minute comment was related with having deleted the following text in red: “except for the simultaneous configuration with … and Rel-14 dynamic HARQ-ACK delay”. On this matter, the main reason for having deleted “Rel-14 dynamic HARQ-ACK delay” had to do with the fact that it was unclear what is really meant by “dynamic HARQ-ACK delay”, since it may encompass for example the scheduling possibility to delay HARQ-ACK > 4 which is obviously not incompatible, and other functionalities that are not incompatible either. The misunderstanding that led to the concern seems to be connected with having interpreted that “Rel-14 dynamic HARQ-ACK delay” equals to “HARQ-ACK delay field” but it is not the same, since as we expressed it before the wording “Rel-14 dynamic HARQ-ACK delay” can be seen as encompassing more than just what is provided by a DCI field. Moreover, it should be clear from the agreements on the “HARQ-ACK delay” (and from TS 36.212) that in Rel-17 for the 14 HARQ processes feature, the HARQ-ACK delays are only provided through the “*PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ*” DCI field”.1. The last-minute comment on “Proposed conclusion 3-3” had to do with having deleted the following text in red: “*except for the simultaneous configuration with … and Rel-14 dynamic HARQ-ACK delay*”.
2. The reason for having deleted “Rel-14 dynamic HARQ-ACK delay” is the broadness of the term in red which encompasses functionalities that are not incompatible with the 14 HARQ processes feature, for example the scheduling possibility to delay HARQ-ACK > 4 which is obviously not incompatible.
3. It seems that the last-minute concern had to do with having interpreted that “Rel-14 dynamic HARQ-ACK delay” equals to “HARQ-ACK delay field” but it is not the same, since the wording “Rel-14 dynamic HARQ-ACK delay” can be seen as encompassing more than just what is provided by a DCI field.
4. By having deleted “Rel-14 dynamic HARQ-ACK delay”, there is no intention of performing a dynamic switching between legacy “HARQ-ACK delays” and “Rel-17 HARQ-ACK delays”. Indeed, from TS 36.212, for the 14 HARQ processes feature the HARQ-ACK delays are only possible to be provided through the “PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ” DCI field.
5. Based on the clarification provided in the previous observations, it should be clear that we can proceed with “Proposed conclusion 3-3” from RAN1# 107-e.
6. Conclusion: It is RAN1 assumption the 14 HARQ processes feature is compatible with all other eMTC features in connected-mode applicable for HD-FDD Cat. M1 Ues in CE mode A, except for the simultaneous configuration with Rel-16 Multi-TB scheduling, to be captured in the note column in FG 1-3.
7. If after the provided explanations there were a request to make explicit that there is no intention of performing a dynamic switching between legacy “HARQ-ACK delays” and “Rel-17 HARQ-ACK delays”, then we can write a second conclusion as below (although it seems unnecessary based on what is already captured in TS 36.212):
	* + In Rel-17 for the 14 HARQ processes feature, the HARQ-ACK delays are only provided through the “PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ” DCI field.
 |

## **Discussion**

**[FL1] Proposal 3-1:**

* **For FG 1-3, select one of the following options:**
	+ **Option 1: type of FG 1-3 is per UE**
	+ **Option 2: type of FG 1-3 is per band**

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| --- | --- |
| Company | Comment |
| Moderator | Summary of companies view* Option 1: HW/HiSi, ZTE, Nokia/NSB, DOCOMO, E///
* Option 2: QC

At RAN1#107-e, this issue was discussed together with other FGs but no consensus was achieved. During the discussion, most companies showed their flexibility to accept Option 3 for FGs 1-1 and 1-2, and it seemed stable that type of FGs 1-3 and 1-4 are per UE. Companies are invited to provide view whether you can live with Option 1 for FG 1-3. |
| Ericsson | Option 1 |
| ZTE, Sanechips | Per UE. |
| Nokia, NSB | Option 1 (Per UE) |
| NTT DOCOMO | We support Option 1 i.e., per-UE. |
| Qualcomm | One of the objectives of “per band” is to differentiate the feature when deployed in different scenarios, e.g. for NTN IOT. |
| Huawei, HiSilicon | Option 1. |

**[FL1] Proposed conclusion 3-2:**

* **It is RAN1 assumption the 14 HARQ processes feature is compatible with all other eMTC features in connected-mode applicable for HD-FDD Cat. M1 UEs in CE mode A, except for the simultaneous configuration with Rel-16 Multi-TB scheduling,** **to be captured in the note column in FG 1-3**

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| --- | --- |
| Company | Comment |
| Moderator | Summary of companies view* Support (Alt1): E///
	+ Alt2: Alt1 + excluding Rel-14 HARQ delay:
		- ZTE, DOCOMO
* Not support (i.e., having no note/conclusion): DOCOMO
* Others
	+ Alt3 (as a conclusion): In Rel-17 for the 14 HARQ processes feature, the HARQ-ACK delays are only provided through the “PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ” DCI field.
		- E///
 |
| Ericsson | Ok with “Proposed conclusion 3-2”.In our paper we have explained why the term “Rel-14 dynamic HARQ-ACK delay” can not be part of the conclusion, and that if (still) there were a request to make explicit that there is no intention of performing a dynamic switching between legacy “HARQ-ACK delays” and “Rel-17 HARQ-ACK delays”, then we can write a second conclusion as below (although it seems unnecessary based on what is already captured in TS 36.212):In Rel-17 for the 14 HARQ processes feature, the HARQ-ACK delays are only provided through the “PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ” DCI field. |
| ZTE, Sanechips | Our concern would be the real HARQ ACK delay is determined by HARQ-ACK delay field or PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ field, if both of these two features are enabled at the same time. |
| Ericsson v004 | To ZTE: Your concern only touches upon DCI fields, while the term “Rel-14 dynamic HARQ-ACK delay” is broader than that. There is no intention of performing a dynamic switching between legacy “HARQ-ACK delays” and “Rel-17 HARQ-ACK delays”. Indeed, from TS 36.212, for the 14 HARQ processes feature the HARQ-ACK delays are only possible to be provided through the “PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ” DCI field. Thus, although it seems unnecessary, if there were still a concern, perhaps to move forward we could on top of the “Conclusion” add a “Note” explicitly stating e.g., “In Rel-17 for the 14 HARQ processes feature, the HARQ-ACK delays are only provided through the “PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ” DCI field.” |
| NTT DOCOMO | Based on the explanation provided by Ericsson, we are fine with suggested note as below.* **It is RAN1 assumption the 14 HARQ processes feature is compatible with all other eMTC features in connected-mode applicable for HD-FDD Cat. M1 Ues in CE mode A, except for the simultaneous configuration with Rel-16 Multi-TB scheduling,** **to be captured in the note column in FG 1-3. In Rel-17 for the 14 HARQ processes feature, the HARQ-ACK delays are only provided through the “PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ” DCI field.**
 |

# **1-4: A maximum DL TBS of 1736 bits for HD-FDD Cat. M1 Ues in CE mode A only**

In [1], FG 1-4 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 |
| 1. NB\_IOTenh4\_LTE\_eMTC6 | 1-4 | A maximum DL TBS of 1736 bits for HD-FDD Cat. M1 Ues in CE mode A only | 1. Support of 1736 bits max DL TBS for unicast in HD-FDD in CE mode A in RRC\_CONNECTED | 1. Category M12. HD-FDD | Yes | N/A | The network cannot schedule a PDSCH with TBS larger than 1000 bits for Cat. M1 Ues | Per UE | FDD only | N/A |  | Optional with capability signaling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | Huawei, HiSilicon | One remaining issue is whether reporting types of FGs 1-1, 1-2, 1-3 and 1-4 are per UE or per band. As from RAN1 point of view, there’s no problem in supporting the reporting types as per UE. In addition, regarding the large ignalling overhead, reporting type of per UE is preferred.**Proposal 2: The reporting type of FGs 1-1, 1-2, 1-3 and 1-4 is per UE.** |
| [3] | ZTE, Sanechips | **Per UE or Per band**For type of FGs 1-1, 1-2, 1-3 and 1-4, whether they are per UE reported or per band reported has been initially discussed in last meeting. For 16-QAM (FGs 1-1 and 1-2), some contributions mentioned 1-1 and 1-2 have RF impact (Tx and Rx EVM), so it makes sense to have these per band. However, in practice, 1) MTC 64QAM is per UE. Similarly, we do not see any issue to adopt the similar method.2) The EVM in LTE or NR is the same across all bands [2]. We do not see the necessity to set16-QAM as per band.Therefore, at least for 16-QAM, it should not be per band. Regarding 14-HARQ processes (FG 1-3) and 1736bits (FG 1-4), these two features would not have impact on the RF and also there would not exist the IODT issues. Therefore, we do not see any reason to set it as per band. ***Proposal 1: The type of FGs 1-1, 1-2, 1-3 and 1-4 should be Per UE.*****Need of FDD/TDD differentiation**For 14-HARQ processes, it is only for FDD which has been agreed. As for 1736bits, it is only used for HD-FDD according to the WID. Therefore, these two features need FDD/TDD differentiation.***Proposal 3: For FG 1-3 and FG 1-4, FDD/TDD differentiation is needed and both of them are used for FDD only.*** |
| [4] | Nokia, NSB | **FGs 1-1, 1-2, 1-3, 1-4**: per UE |
| [5] | DOCOMO | * 1-4: A maximum DL TBS of 1736 bits for HD-FDD Cat. M1 Ues in CE mode A only
	+ We think the type of FGs 1-4 should be per UE and FDD-only, same as Rel-16 eMTC/NB-IoT FGs.
 |
| [6] | Qualcomm | One of the most contentious issues in the last meeting was whether the features for eMTC and NB-IoT were “per UE” or “per band”.In our view, the newly introduced features should be “per band” for the following reason: with the introduction of NTN IOT, there should be a way to differentiate the capability of using 16-QAM or 14 HARQ processes for terrestrial and non-terrestrial cases. “Per band” capability indication allows for this indication.**Observation 1: All the IOT features should be “per band” to allow differentiation of support of a feature in terrestrial and non-terrestrial networks.**Similar to the points above, the eMTC features 1-3 and 1-4 shall be indicated “per band” due to NTN/TN differentiation and robustness against lack of IODT opportunities.**Proposal 2: FG 1-3 and 1-4 are “per band”.** |
| [7] | Ericsson | For the above UE feature list on the support of a maximum DL TBS of 1736 bits for HD-FDD Ues in CE Mode A, we have the following proposal:1. To define the “Type” of the Rel-17 features built under a L1 Terrestrial context, we can follow the Moderator’s suggestion of defining the “Type of FGs 1-3 and 1-4 (i.e., LTE-MTC features) “per UE” and leaving the Type of FGs 1-1 and 1-2 (i.e., NB-IoT features) up to RAN2/RAN4”.
2. For the max DL TBS of 1736 bits for HD-FDD Ues (i.e., FG 1-4 in the “UE Feature list”), the column “Type” is defined “Per UE”.
 |

## **Discussion**

**[FL1] Proposal 4-1:**

* **For FG 1-4, select one of the following options:**
	+ **Option 1: type of FG 1-4 is per UE**
	+ **Option 2: type of FG 1-4 is per band**

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | Summary of companies view* Option 1: HW/HiSi, ZTE, Nokia/NSB, DOCOMO, E///
* Option 2: QC

At RAN1#107-e, this issue was discussed together with other FGs but no consensus was achieved. During the discussion, most companies showed their flexibility to accept Option 3 for FGs 1-1 and 1-2, and it seemed stable that type of FGs 1-3 and 1-4 are per UE. Companies are invited to provide view whether you can live with Option 1 for FG 1-4. |
| Ericsson | Option 1 |
| ZTE, Sanechips | Option 1 |
| Nokia, NSB | Option 1 |
| NTT DOCOMO | We support Option 1 i.e., per-UE. |
| Qualcomm | If we make this feature “per UE”, we would like to have a differentiation between TN and NTN. |
| Huawei, HiSilicon | Option 1. |

# **Conclusions**

TBD

# **References**

[1] R1-2112900 Updated RAN1 UE features list for Rel-17 LTE after RAN1 #107-e Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2200978 Rel-17 UE features for NB-IoT and LTE-MTC enhancements Huawei, HiSilicon

[3] R1-2201140 Discussion on LTE-M and NB-IoT UE features ZTE, Sanechips

[4] R1-2201416 On UE features for NB-IoT and LTE-MTC enhancements Nokia, Nokia Shanghai Bell

[5] R1-2201509 Discussion on UE features for NB-IoT and LTE-MTC enhancements NTT DOCOMO, INC.

[6] R1-2202173 UE features for NB-IoT and LTE-MTC enhancements Qualcomm Incorporated

[7] R1-2202279 On UE features for NB-IoT and LTE-MTC enhancements Ericsson