**3GPP TSG RAN WG1 #100bis-e R1-2002457**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on NR UE features for others

Agenda Item: 7.2.11.13

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

# **Introduction**

This contribution summarizes the discussions and proposals in AI 7.2.11.13 regarding UE features for others.

In R1-2001484 [1] which is the version after [100e-NR-Rel-16-UEFeatures] email discussion, there are following feature groups proposed to be updated/added for Rel-16.

* 8-1 Dynamic power sharing for LTE-NR DC
* [5-11c] Up to 3 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 1
* [5-12c] Up to 3 unicast PUSCHs per slot per CC for different TBs for UE processing time Capability 1
* [5-13g] Up to 3 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 2
* [5-13h] Up to 3 unicast PUSCHs per slot per CC for different TBs for UE processing time Capability 2
* [5-35] Simultaneously enable CBG and multiple PDSCHs per slot

In addition, following points are discussed in contributions [2-9] in AI 7.2.11.13.

* Approaches for “basic feature group(s)” according to [10]
* Approaches for “mandatory with capability signaling” according to [10]
* Interpretation for mixture of XDD/FRX
* Some other issues such as cross-WI aspects

Based on the discussions summarized in Section 2-7, following is the suggested list of issues to be discussed and priority order considering RAN2 impact especially for capability signaling design as well as general aspects that have impact on on-going RAN1 UE feature discussion.

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

**1st priority issues (such as a certain FG is necessary or not, and general aspects having signaling impact):**

* **Confirm the updated FG8-1**
* **Whether the FGs [5-11c]/[5-12c]/[5-13g]/[5-13h] for up to 3 unicast PDSCHs (PUSCHs) per slot per CC for different TBs are introduced or removed**
* **Whether the FG [5-35] for simultaneously enabling CBG and multiple PDSCHs per slot is introduced or removed**
* **Whether “Need of FDD/TDD differentiation” and “Need of FR1/FR2 differentiation” are applicable only to “per UE” feature group or also applicable to other types**
* **Whether all the UE feature groups shall fall into one of the “type” categories uniquely or there can be some exceptional cases that multiple “type” categories are selected for a UE feature group**

**2nd priority issues (general aspects without signaling impact):**

* **Whether/how to specify “basic feature group(s)” for the feature (WI) or for a purpose**
	+ **If Alt.2 approach in RP-200502 is adopted for some features (WIs), whether consistent way should be used or not**
* **Whether/how to define the default values including Rel-15 NR features for Rel-16**
	+ **Whether it should be discussed for each FG which is mandatory with capability signaling or a common approach should be applied to all FGs that are mandatory with capability signaling**
* **Clarify how to describe “Capability interpretation for mixture of FDD/TDD and/or FR1/FR2” column as below.**
	+ **For a UE capability with FRX and/or XDD differentiation, it should be described how to interpret the UE capability in case of cross-carrier operation**
	+ **For a UE capability that the FRX (or XDD) differentiation applies to both the cell receiving the corresponding indication and the cell applying the indication, the UE shall support the cross FR (or XDD) operation associated with the capability if the UE indicates support of the capability for both FRs (or, FDD & TDD) and support for FR1-FR2 (or FDD-TDD) CA**
	+ **For a UE capability that allows both FRX and XDD differentiations, a rationale why it is needed should be described**

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

|  |  |
| --- | --- |
| Company | Comment |
| Intel | We propose to update 2nd priority as following:* **Clarify how to describe “Capability interpretation for mixture of FDD/TDD and/or FR1/FR2” column as below.**
	+ **For a UE capability with FRX and/or XDD differentiation, the generic principle on how to interpret all the combinations of signaling should be decided.**
	+ **For a UE capability with FRX and/or XDD differentiation, it should be described how to interpret the UE capability in case of cross-carrier operation**
	+ **For a UE capability that the FRX (or XDD) differentiation applies to both the cell receiving the corresponding indication and the cell applying the indication, the UE shall support the cross FR (or XDD) operation associated with the capability if the UE indicates support of the capability for both FRs (or, FDD & TDD) and support for FR1-FR2 (or FDD-TDD) CA**
	+ **For a UE capability that allows both FRX and XDD differentiations, a rationale why it is needed should be described**
 |
| Huawei, HiSilicon | * We are generally fine with FL’s original assessment, with a minor suggestion that the below may not need to be listed as 1st priority as it may in the end depend on the discussion of each WI’s feature list while the RAN2 LS is already there anyway. That is also the reason that we discussed this but does not propose anything specific.
	+ **Whether all the UE feature groups shall fall into one of the “type” categories uniquely or there can be some exceptional cases that multiple “type” categories are selected for a UE feature group**
* Additionally, we are not in support of the adding proposed from Intel in the above row. Reasons as also given in R1-2002674 ([8]) include that the proposal seems motivated with misunderstanding of RAN2 LSs and an issue identified by RAN1. Since a similar issue for Rel-15 is ongoing in RAN2 we do not think we need reopen the discussion for Rel-16 in RAN1 which may potentially lead to a different signalling approach/framework between releases. It does not either seem to be an urgent issue to be fixed within this meeting.
 |
| ZTE | From the current list, one issue related to xDD/FRx differentiation is put under the first priority but the others are put under the second priority. However, we think these issues are related. For example, whether xDD/FRx differentiation is needed for all types of capability depends on how to interpret the capability for cross-carrier operation without xDD/FRx differentiation. So we think all xDD/FRx differentiation should be discussed together in one email thread with the same priority. |
| Nokia, Nokia Shanghai Bell | We are generally fine with the categorization of issues given by the FL’s assessment. As for planning the upcoming email discussions, we would like to note that while the update to 8-1 has been discussed over a few rounds of email discussions already, the new FG proposals [5-X] listed above have been proposed rather recently and they may require more discussions before they can be eventually agreed.  |
| Qualcomm | In general, we agree with the categorization. We have some proposed additions / clarifications as follows: An important additional 1st priority issue is to discuss the applicability of all Rel-15 and Rel-16 features to NR-U. For example, whether mTRP is supported in NR-U, etc. In order to avoid an extended debate, we suggest agreeing that all features should be applicable to NR-U as a default, and possibly discuss only some exception cases. At the same time, this does give rise to IODT concern, since all the Rel-15 and Rel-16 features will not be introduced at the same time in licensed and unlicensed. Therefore, even though as default all features should apply to unlicensed, a UE capability differentiation is still needed. In order to introduce the capability differentiation with the smallest possible change in the structure of the capability signaling, we propose to convert most per-UE capability to per-band capability. It would need further discussion how to do the same for Rel-15 features. Regarding XDD/FRX differentiation, we think that a description will be need for each impacted FG that has some cross-carrier element. This is not to explain the rationale for the differentiation but rather to explain whether the differentiation is from the perspective of the cell delivering the control or the cell to which the control is applied, or some other interpretation. We don’t think that the topic of how to signal capability in FR1 TDD and incapability in both FR1 FDD and FR2 TDD at the same time needs further discussion in RAN1. As an additional topic, we would like to clarify whether or not FR1 and FR2 serving cells can be in the same TAG in UL CA. This clarification may impact Rel-15.  |
|  |  |

# **Updated FL Proposals**

The moderator recommends following email discussions for FL Proposals 1, 2 and 3 (only if following condition is met).

* High priority items are recommended for discussion starting Monday, April 20th, 2020. Ideally, discussions on high priority items can be concluded by Friday, April 24, 2020.
* Medium priority items are recommended for discussion starting at the time that high priority items are (almost) converged before Monday, April 27th, 2020, otherwise starting at Monday, April 27th, 2020.
* Low priority items are recommended for discussion starting at Monday, April 27th, 2020 only if high and medium priority items are converged before Monday, April 27th, 2020. Otherwise, discussion on low priority items will be postponed to next RAN1 meeting.

**FL Proposal 1 (high priority): Email discussion/approval on updates for Rel-15 capabilities (20th-24th April)**

* **Confirm the updated FG8-1**
* **Discuss whether the FGs [5-11c]/[5-12c]/[5-13g]/[5-13h] for up to 3 unicast PDSCHs (PUSCHs) per slot per CC for different TBs are introduced or removed. If there is no consensus to add a new feature group at the end of this email discussion, the new feature group is not introduced in Rel-16.**
* **Discuss whether the FG [5-35] for simultaneously enabling CBG and multiple PDSCHs per slot is introduced or removed. If there is no consensus to add a new feature group at the end of this email discussion, the new feature group is not introduced in Rel-16.**

**FL Proposal 2 (medium priority): Email discussion/approval on general issues having capability signaling impact (TBD)**

* **Whether “Need of FDD/TDD differentiation” and “Need of FR1/FR2 differentiation” are applicable only to “per UE” feature group or also applicable to other types**
* **Clarify how to describe “Capability interpretation for mixture of FDD/TDD and/or FR1/FR2” column as below.**
	+ **For a UE capability with FRX and/or XDD differentiation, the generic principle on how to interpret all the combinations of signaling should be decided**
	+ **For a UE capability with FRX and/or XDD differentiation, it should be described how to interpret the UE capability in case of cross-carrier operation**
		- **Even for UE capability not per-UE and related to cross-carrier operation, it should be described how to interpret the UE capability in case of cross-carrier operation**
	+ **For a UE capability that the FRX (or XDD) differentiation applies to both the cell receiving the corresponding indication and the cell applying the indication, the UE shall support the cross FR (or XDD) operation associated with the capability if the UE indicates support of the capability for both FRs (or, FDD & TDD) and support for FR1-FR2 (or FDD-TDD) CA**
	+ **For a UE capability that allows both FRX and XDD differentiations, a rationale why it is needed should be described**

**FL Proposal 3 (low priority): Email discussion/approval on general issues without having capability signaling impact (TBD)**

* **Whether/how to specify “basic feature group(s)” for the feature (WI) or for a purpose**
	+ **If Alt.2 approach in RP-200502 is adopted for some features (WIs), whether consistent way should be used or not**
* **Whether/how to define the default values including Rel-15 NR features for Rel-16**
	+ **Whether it should be discussed for each FG which is mandatory with capability signaling or a common approach should be applied to all FGs that are mandatory with capability signaling**

# **Update for 8-1: Dynamic power sharing for LTE-NR DC**

In [1], the updated FG8-1 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **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 | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 8. UL TPC | 8-1 | Dynamic power sharing for LTE-NR DC | When total transmission power exceeds Pcmax, UE scales NR transmission power.  | EN-DC | No | N/A |  | Per UE | N/A | N/A |  |  | Mandatory with capability signalling set to 1 |

Following feedback is provided in a contribution for the RAN1#100bis-e meeting.

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| [6] | Ericsson | 8-1 is in Release 15 mandatory with capability signalling. The proposal is to require Release 16 UEs to set the capability signalling to 1(supported). Ericsson is supportive of this proposal.1. Release 16 UEs are required to set the capability bit for FG 8-1 Dynamic power sharing for LTE-NR DC(8-1) to 1, i.e. supported.
 |

**Based on above, the updated FG8-1 as in R1-2001484 would be acceptable.**

* **Whether/how to specify “basic feature group(s)” for the feature (WI) or for a purpose**
	+ **If Alt.2 approach in RP-200502 is adopted for some features (WIs), whether consistent way should be used or not**

# **New FGs [5-11c]/[5-12c]/[5-13g]/[5-13h] and [5-35]**

In [1], [5-11c]/[5-12c]/[5-13g]/[5-13h] and [5-35] are captured with bracket as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **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 | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
|  | [5-11c] | Up to 3 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 1 | Up to 3 unicast PDSCHs per slot per CC only in TDM is supported for Capability 11) PDSCH(s) for Msg. 4 is included |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS. | Optional with capability signalling |
|  | [5-12c] | Up to 3 unicast PUSCHs per slot per CC for different TBs for UE processing time Capability 1 | Up to 3 unicast PUSCHs per slot per CC only in TDM is supported for Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS. | Optional with capability signalling |
|  | [5-13g] | Up to 3 unicast PDSCHs per slot per CC for different TBs for UE processing time Capability 2 | Up to 3 unicast PDSCHs per slot per CC only in TDM is supported for Capability 2UE can report values ‘X’ and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology* When configured with less than or equal to X DL CCs, the UE may expect to be scheduled with up to 3 PDSCHs per slot with Capability #2 on all of the configured serving cells for which processingType2Enabled is configured and set to enabled

2) No scheduling limitation3) N1 based on Table 5.3-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | 5-5a or 5-5b | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCSMore than one set of per SCS per band reports can be signalled for a given band combination | Optional with capability signalling |
|  | [5-13h] | Up to 3 unicast PUSCHs per slot per CC for different TBs for UE processing time Capability 2 | Up to 3 unicast PUSCHs per slot per CC only in TDM is supported for Capability 2UE can report values ‘X’ and supports the following operation, only when all carriers are self-scheduled and all Capability #2 carriers in a band are of the same numerology• When configured with less than or equal to X UL CCs, the UE may expect to be scheduled with up to 3 PUSCHs per slot with Capability #2 on all of the configured serving cells for which processingType2Enabled is configured and set to enabled2) N2 based on Table 6.4-2 of TS 38.214 for given SCS from {15, 30, 60} kHz | 5-5c | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCSMore than one set of per SCS per band reports can be signalled for a given band combination | Optional with capability signalling |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | [5-35] | Simultaneously enable CBG and multiple PDSCHs per slot | Simultaneously enable CBG and multiple PDSCHs per slot | 5-11,5-11a, 5-11b, 5-13. 5-13a. 5-13c, 5-22, 5-23, 5-24 | Yes | N/A | gNB is not expected to configure CBG operation and multiple PDSCHs per slot simultaneously. | Per UE | No | Yes | N/A | There is conclusion in Rel-15 that the scenario described in the draft CR (R1-1907505) can happen but can be handled via implementation in which case the UE performance may not be optimal. To ensure the NR data rate performance while maximizing the respective benefits of CBG based operations and multiple PDSCHs per slot, an explicit UE capability of support simultaneous operation is preferable. | Optional with capability signaling |

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

|  |  |  |
| --- | --- | --- |
| [5] | Samsung | For FGs 5-11c/5-12c/5-13g/5-13h above, there are already capabilities for UE to receive up to 2 or 4 PDSCH/PUSCH, respectively, while the proposed FGs are for UE to receive up to 3 PDSCH/PUSCH. This would bring UE fragmentation with no clear benefits. Also for FG 5-35, this seems a signaling to indicate less capability than Rel-15. It is also not clear to have this signaling.Observation 1. There is no clear benefit to introduce new FGs 5-11c/5-12c/5-13g/5-13h, and 5-35. |
| [6] | Ericsson | Proposals 5-11c/5-12c//5-13g/5-13h all add additional granularity in the number of unicast PUSCH/PDSCH per slot per CC for different TBs that can be configured. Additional discussion is needed before introducing these.Our understanding is that the intention with the introduction of this signalling is to allow a UE that indicates support for both CBG and multiple PDSCH per slot, to indicate no support for being configured with CBG and multiple PDSCHs per at the same time. This means relaxed behaviour compared to Release 15 and is problematic for several reasons. First of all, even though phrased as indicating support, this in practice is a “incapability bit” as stated by RAN2 in their LS in [R1-2001513](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001513.zip)[2]. Secondly, a Rel-15 network will not receive this signalling from a Rel-16 UE and will assume that the UE supports the combination.1. Do not introduce new capability for simultaneously enabling of CBG and multiple PDSCHs per slot.
 |
| [8] | Huawei, HiSilicon | In the worst case if the number of CBGs is 8, then UE needs to increase its capability 7 times than CBG is disabled if all unsuccessfully decoded CBGs are retransmitted in one slot assuming the maximum number of DL TB per slot is 7. On the other hand, if peak rate performance is sacrificed as concluded in RAN1, significant data rate degrade (more than 10%) can be expected due to e.g. dropping one or more successfully decoded TBs, which further leads to more potential retransmissions consequently and is highly undesirable. Figure 1. One CBG based retransmission exampleIn order to maintain the NR designated peak rate performance, it is desired to solve this problem in Rel-16 and beyond. Several approaches can be considered:* ***Option 1****: Change* $C'$ *to* $C$ *in* $V\_{j,m}$*for DataRate calculation and DataRateCC calculation in subcluase 5.1.3 and 6.1.4 of TS 38.214 as described in R1-1907505.*

However, this requires specification changes and needs to consider impact on Rel-15 implementations.* ***Option 2****: When CBG based retransmission is enabled, only one unicast PDSCH is scheduled per slot.*

However, this restricts the network scheduling and applicable scenarios for CBG based operation especially for traffic heavy/data rate oriented cases.* ***Option 3:*** *UE reports newtork that whether UE supports more than one unicast PDSCH reception per slot on this cell, when CBG based retransmission is configured for a cell.*

This has benefits of no specification impact and actually relying on UE implementation evolution with sufficient flexibility, if the device has the capability to work under the enhanced operation.***Proposal 1****: Agree on FG 5-35 as an optional per-UE reported capability for Rel-16 to indicate whether UE supports more than one unicast PDSCH reception per slot on a carrier when CBG based (re)transmission is configured for that carrier.**~*Firstly, it is not clear if we need additional UE capabilities for the above except for 5-11c, 5-12c, 5-13g, 5-13h as they are already in Rel-15. It seems just some copy-paste from Rel-15 UE feature list thus should be removed from Rel-16 UE feature list for further discussion. Secondly, for 5-11c, 5-12c, 5-13g, 5-13h where *N*=3, the gap between the existing related Rel-15 UE features 5-11/11b, 5-12/12b, 5-13/13c and 5-13d/13f where *N*=2/4 seems small. It is not clear about the motivation from proponents.Lastly, since msgB is introduced from 2-step RACH WI in response to successfully decoding of msgA, which can similar to msg4 when carrying successRAR, further discussion would be needed for relevant UE capabilities in DL. This may be either handled in specific 2-step RACH WI, or as enhanced UE capabilities of DL of FG 5-11 ~ 5-13h.***Proposal 2****: UE capabilities for multiple PDSCHs reception should take msgB into account. Clarify the motivation of up to N PDSCHs/PUSCHs where N=3.* |
| [9] | Qualcomm Incorporated | The proposed changes in 5-11c, 5-12c, 5-13d and 5-13g are to allow for scheduling 3 TBs in both UL and DL. Considering the (4,3) span pattern of FG 3-5b, these additions would allow for matching the number of TBs and the spans in each slot. |

**Based on above, following point should be discussed.**

* **Whether the FGs [5-11c]/[5-12c]/[5-13g]/[5-13h] for up to 3 unicast PDSCHs (PUSCHs) per slot per CC for different TBs are introduced or removed**
* **Whether the FG [5-35] for simultaneously enabling CBG and multiple PDSCHs per slot is introduced or removed**

# **Approaches for “basic feature group(s)”**

In [10], the informational summary on RAN#87e discussion on Rel-16 UE features including “basic feature group” aspects is shown as below.

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| * Terminology definitions based on Rel-15 (TR38.822)
	+ “Feature(s)”: It is a highest level grouping. In Rel-16, it is per-WI grouping.
	+ “Feature group(s)”: It is a kind of “subfeature(s)” within a “feature”, and is defined by each row in the UE features list.
	+ “Component(s)”: One feature group contains one or multiple components. When UE reports support of the feature group, basically it is applied to all components in the feature group.
* In case that a set of feature groups/components is necessary to be supported by UE (and NW) for a certain purpose,
	+ There are at least two possible approaches below to define the set of feature groups for a purpose.
		- Approach 1: A basic feature group(s), which is a set of components that are viewed necessary to provide a minimum level of support for the feature. Defining a basic feature group(s) is not always possible or necessary for a given feature.
		- Approach 2: A set(s) of feature groups necessary to be supported for the purpose is defined somewhere in specification(s).
	+ Each WG is responsible on whether/how to define the basic feature group(s) or the set(s) of feature groups, and it is possible to take different decision on approaches (including possibility to not define any basic feature group or set) for different purposes/features. It is preferable to take common approach across WGs for same feature/purpose.
		- The Plenary guidance may be requested, if needed after WG discussions, on whether defining a set of feature groups based on Approach 2 for some feature, either in addition or instead of approach 1. There has been no conclusion in previous discussions, including RAN 87e, that it would be necessary.
	+ Irrespective of defining a set of feature groups for a purpose, capability bit(s) should be defined for each of feature groups independently.
* For each feature group (capability bit(s)) defined as “mandatory with capability signaling”, each WG should take either one of following approaches.
	+ Approach 1: default value should be defined in each WG for the case where UE does not report or the case before UE reports.
	+ Approach 2: the capability signaling is mandatory present so that UE must report.
 |

Regarding the “basic feature group aspects, following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

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| --- | --- | --- |
| [2] | ZTE | As shown above, two approaches have been identified to group feature groups/components together. Approach 1 is the ordinary way as we adopted in Rel-15 and Approach 2 is more like the ‘UE feature profile’.* Approach 1: A basic feature group(s), which is a set of components that are viewed necessary to provide a minimum level of support for the feature. Defining a basic feature group(s) is not always possible or necessary for a given feature.
* Approach 2: A set(s) of feature groups necessary to be supported for the purpose is defined somewhere in specification(s).

During Rel-16 initial UE feature discussion, Approach 1 is preferred. If companies couldn’t converge on the basic UE feature for certain WI, then companies could further discuss it via Approach 2 later.***Proposal 1****: During Rel-16 initial UE feature discussion, Approach 1 is adopted to define basic UE feature group(s) for WIs with consensus.*  |
| [5] | Samsung | The features introduced in Rel-16 are basically optional for NR UEs, because those features are additional ones upon Rel-15 NR features. Which features are implemented by the UEs are determined by commercial market needs, then Approach 2 seems not proper. As Approach 1 describes, basic feature group consisting of essential components in order to support a give feature can be decided for some features. One possibility is that, the defined basic feature group can be pre-requisite for other components of the feature. RAN1 needs to further discuss whether/how the basic feature group is determined per WI basis.Proposal 1: Adopt Approach 1 for basic feature group. |
| [7] | Futurewei | Basic feature groups in Rel-15 were used to indicate sets of components that are mandatory for the NR system. For Rel-16, as discussed in RAN, for some features (e.g., NRU, V2X, IAB, 2-step RACH, DC/CA, [URLLC],…) it may be desired to identify a basic set of subfeatures/components that a UE should support if a feature is supported, which can help the adoption or the performance of a the feature as a whole. A difference is that since essentially all features in Rel-16 are “optional” on top of Rel-15, the basic feature groups in Rel-16 would in the end have a recommendation such as “Optional with capability signaling. The FG must be supported for XXX”. (similar to the current handling of IAB/V2X)The Appendix contains an analysis of the current NR feature list for the Rel-16 WIs in [4]. There, basic features are indicated in three main ways: 1. NR-U and 5G-V2X use the Notes field to indicate the Basic FGs
2. 2-step RACH, MR-DC/CA name a highest level-feature “Basic..”
3. IAB/V2X state in the Mandatory/Optional column that the FG must be supported for IAB/V2X.

Other observations:* 2-step RACH uses the term “conditionally mandatory” for a dependent basic FG
* NR-MIMO has FGs with basic and optional components (likely needs to be revised)
* Positioning has a structure similar to basic FGs for each of the various positioning methods
* Other WIs either are relatively simple/independent or not clear if can/will label as basic
* [NR-U has a lot of FGs]

It would be best if the recommendation column and basic features be handled in a uniform way across the WIs. One proposal is to use the IAB/V2X style, with NR-U, 2-step and MR-DC/CA adding an indication in the Mandatory/Optional column. If a FG is proposed to be basic but not yet agreed it can be listed as a “possible basic feature group” and discussion continued later.**Proposal: For uniform handling of rel-16 UE features*** **A basic or possibly basic FG is designated as such in the “Mandatory/Optional” column**
	+ **If agreed, “Optional with capability signalling. The FG must be supported for XXX”.**
	+ **If proposed but not yet agreed, “Optional with capability signalling. This is possibly a basic feature group for XXX.”**
* **It is acceptable but not required to additionally have “This is a basic feature group” text in the Mandatory/Optional column or the Notes column**
* **It is acceptable but not required to additionally name a feature group as “Basic…”**
* **Dependent basic FGs are handled the same way as high-level basic FGs**
	+ **The term “conditionally mandatory” is not used**
	+ **The pre-requisite column should not be left blank**
 |

**Based on above, following points should be discussed in each sub-agenda (for corresponding WI).**

* **Whether/how to specify “basic feature group(s)” for the feature (WI) or for a purpose**
	+ **If Alt.2 approach in RP-200502 is adopted for some features (WIs), whether consistent way should be used or not**

Note that it is moderator’s understanding that some feature (WI) already takes Alt.1 approach (e.g., FG9-1 in 2 step RACH) while some other feature (WI) already takes Alt.2 approach (e.g., description in mandatory/optional column in IAB).

# **Approaches for “mandatory with capability signaling”**

In [10], the informational summary on RAN#87e discussion on Rel-16 UE features including “mandatory with capability signaling” aspects is shown as in section 4.

Regarding “mandatory with capability signaling” aspects, following feedback is provided in a contribution for the RAN1#100bis-e meeting.

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| [5] | Samsung | In many cases, UE can report one of the candidate values as its capability. In Rel-16 features as well as Rel-15 existing features, a default value may be needed in case that the UE does not report the value. If the UE does not report the value, then an ambiguity may occur. For example, there is an ambiguity in calculation of TBSLBRM for limited buffer rate matching before the UE reports its maximum supported layers. In Rel-15, RAN1 decided not to define the default value for backward compatibility. Including this feature, RAN1 needs to discuss whether/how to define the default values.Proposal 2. RAN1 needs to discuss whether/how to define the default values including Rel-15 NR features for Rel-16. |

**Based on above, following points should be discussed.**

* **Whether/how to define the default values including Rel-15 NR features for Rel-16**
	+ **Whether it should be discussed for each FG which is mandatory with capability signaling or a common approach should be applied to all FGs that are mandatory with capability signaling**

# **Interpretation for mixture of XDD/FRX differentiation**

Following views on interpretation for mixture of XDD/FRX differentiation are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | ZTE | According to the discussion in [2], the rapporteur also made the following proposal.* + “Need of FDD/TDD differentiation” and “Need of FR1/FR2 differentiation” are applicable only to “per UE” feature group, and hence those should be “N/A” for all feature groups other than per UE feature group.

Based on our understanding, in addition to “per UE” feature group, “Need of FDD/TDD differentiation” and “Need of FR1/FR2 differentiation” may also be applicable to other types of feature group in case of cross-carrier operation, e.g., “per band”, “per band of band combination” or “per CC per band per band combination”. Take the Rel-15 UE capability *aperiodicTRS* as an example. UE capability *aperiodicTRS* is a “per Band” signaling, which is to indicate the network whether the UE supports DCI triggering aperiodic TRS associated with periodic TRS. Without XDD/FRX differentiation, it is not clear how to interpret the UE capability. For example, if UE indicates support of *aperiodicTRS* for Band A and not support of *aperiodicTRS* for Band B. If UE needs to trigger A-TRS for Band B from Band A, it is not clear whether UE supports this kind of operation. XDD/FRX differentiation may be one way to clarify the UE behavior with these capabilities in case of cross-carrier operation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Definitions for parameters | Per | M | FDD-TDDDIFF | FR1-FR2DIFF |
| ***aperiodicTRS***Indicates whether the UE supports DCI triggering aperiodic TRS associated with periodic TRS. | Band | No | No | Yes |

Another way to handle this issue is to clarify in the field description. For example, for *aperiodicTRS,* we could add one clarification in the field description like “In case of cross-carrier triggering, UE supports DCI triggering aperiodic TRS associated with periodic TRS as long as the UE supports it in the triggering cell”.***Proposal 3****: To clarify the interpretation of Rel-16 UE feature in case of cross-carrier operation, the following approaches can be considered:**1. In addition to “per UE” feature group, “Need of FDD/TDD differentiation” and “Need of FR1/FR2 differentiation” may also be applicable to other types of feature group in case of cross-carrier operation, e.g., “per band”, “per band of band combination” or “per CC per band per band combination”.**2. Add clarification in the field description to make it clear how to interpret the UE capability in case of cross-carrier operation.* |
| [4] | Intel Corporation | RAN2 LS [2] provided guidance to RAN1 UE capability definition. One input was to provide rationale for necessity of both xDD and FRx differentiations for per-UE capability.

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| --- |
| **7 Rationale for necessity of both xDD and FRx differentiations for per-UE capability**RAN2 did not discuss the RAN1 LS on XDD-FRX Differentiation (R1-1913579/R2-2000013) at the RAN2#109-e meeting, but RAN2 would anyway appreciate to be provided with rationale in case Per-UE capability with both FDD/TDD and FR1/FR2 differentiations is deemed as necessary for a feature.  |

**Proposal 1: When both xDD and FRx differentiations are allowed, the proponents provide rationale why it is needed.**Also, there was a discussion in Rel-15 UE feature on how to interpret the combination of xDD and FRx differentiation bits. For instance, in case that both capability signalling is allowed, when UE reports TDD=NotSupport and FR2=Support, it is self-contradictory as FR2 has TDD only. During the discussion in Rel-15, there was also different interpretation whether such case is allowed or not. RAN1 left it out to further clarify and thus we think this is a good timing to restart the discussion.One option could be to clarify what is the correct interpretation on each capability signaling when signalling both. On the other hand, we think it would be better to define a common interpretation for possible combinations, and, if needed, some exceptions can be explained to each UE feature.Some proposals to allow both signalling according to the latest discussion in [1] can be found. As one example,~Therefore, we propose to define interpretation on combination of xDD and FRx differentiations. The proposal is not limited to the case of both signalling since no signalling also implies the feature is supported once signalled. As a general form for the discussion, we reuse what we discussed in Rel-15 (as shown in proposal 2).**Proposal 2: RAN1 to define interpretation on combination of xDD and FRx differentiations by using the following table.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FDD-TDD Diff** | **FR1-FR2 Diff** | **Capability per UE** | **Capability setting in FDD** | **Capability setting in TDD** | **Capability setting in FR1** | **Capability setting in FR2** | **Implied capability in FR1-FDD** | **Implied capability in FR1-TDD** | **Implied capability in FR2** |
| N | N | N | N/A | N/A | N/A | N/A | [N] | [N] | [N] |
| Y | [Y] | [Y] | [Y] |
| N | Y | N/A | N/A | N/A | N | N | [N] | [N] | [N] |
| N | Y | [N] | [N] | [Y] |
| Y | N | [Y] | [Y] | [N] |
| Y | Y | [Y] | [Y] | [Y] |
| Y | N | N | N | N/A | N/A | [N] | [N] | [N] |
| N | Y | [N] | [Y] | [Y] |
| Y | N | [Y] | [N] | [N] |
| Y | Y | [Y] | [Y] | [Y] |
| Y | Y | N | N | N | N | [N] | [N] | [N] |
| N | Y | [N/A] | [N/A] | [N/A] |
| Y | N | [N/A] | [N/A] | [N/A] |
| Y | Y | [N/A] | [N/A] | [N/A] |
| N | Y | N | N | [N/A] | [N/A] | [N/A] |
| N | Y | [N] | [N] | [Y] |
| Y | N | [N] | [Y] | [N] |
| Y | Y | [N] | [Y] | [Y] |
| Y | N | N | N | [N/A] | [N/A] | [N/A] |
| N | Y | [N/A] | [N/A] | [N/A] |
| Y | N | [Y] | [N] | [N] |
| Y | Y | [N/A] | [N/A] | [N/A] |
| Y | Y | N | N | [N/A] | [N/A] | [N/A] |
| N | Y | [N/A] | [N/A] | [N/A] |
| Y | N | [Y] | [Y] | [N] |
| Y | Y | [Y] | [Y] | [Y] |

 |
| [8] | Huawei, HiSilicon | There is company preference on discussion on‘Capability interpretation for mixture of FDD/TDD and/or FR1/FR2’, by coupling this entry of UE feature list to the RAN2 inquiry of ‘rationale for necessity of both xDD and FRx differentiations for per-UE capability’.Our view is that the above coupling is incorrect. The feature list entry of mixture of xDD/FRx was set from RAN2 LS in [5] in Reno meeting, even before the issue raised about support of possible combinations of XDD/FRX. As a matter of fact, the interpretation of mixture of xDD/FRx was motivated by the discussion of CA with cross-carrier operation, and there had been clear conclusion in RAN1. To inherit from that concluded for Rel-15 as request by RAN2, the following is therefore proposed***Proposal 3****: Clarify that “Capability interpretation for mixture of FDD/TDD and/or FR1/FR2” is interpreted as below:** *For a UE capability that the FRX (or XDD) differentiation applies to both the cell receiving the corresponding indication and the cell applying the indication, the UE shall support the cross FR (or XDD) operation associated with the capability if the UE indicates support of the capability for both FRs (or, FDD & TDD) and support for FR1-FR2 (or FDD-TDD) CA.*

Further, the issue of ‘rationale for necessity of both xDD and FRx differentiations for per-UE capability’ may or may not be due to the concern of the support of all 8 possible combinations of xDD/FRx by the current Rel-15 UE capability signalling framework [7], as RAN2 in [6] has indicated that they has not discussed the issue. In our view, issue raised in [7] could be solely resolved in RAN2 and does not seem to require any further discussion in RAN1 for Rel-16, unless further required by RAN2. Thus,***Observation 1****: RAN1 does not seem to have a need to further work on the issue raised in R1-1913579, unless further requested by RAN2.* |

**Based on above, following points should be discussed.**

* **Clarify how to describe “Capability interpretation for mixture of FDD/TDD and/or FR1/FR2” column as below.**
	+ **For a UE capability with FRX and/or XDD differentiation, it should be described how to interpret the UE capability in case of cross-carrier operation**
	+ **For a UE capability that the FRX (or XDD) differentiation applies to both the cell receiving the corresponding indication and the cell applying the indication, the UE shall support the cross FR (or XDD) operation associated with the capability if the UE indicates support of the capability for both FRs (or, FDD & TDD) and support for FR1-FR2 (or FDD-TDD) CA**
	+ **For a UE capability that allows both FRX and XDD differentiations, a rationale why it is needed should be described**
* **Whether “Need of FDD/TDD differentiation” and “Need of FR1/FR2 differentiation” are applicable only to “per UE” feature group or also applicable to other types**

# **Other issues**

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

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| --- | --- | --- | --- |
| [2] | ZTE | In the WI for NR mobility enhancements, it has been agreed that the power control schemes of DAPS HO follow that of NR-DC by replacing the MCG with target MCG and SCG with source MCG as shown below.

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| --- |
| Agreement:If a UE is configured with DAPS HO operation, the UE performs transmission power control based on Section 7.6.2 of 38.213 replacing the MCG with target MCG and SCG with source MCG. |

From UE complexity perspective, there is no difference on the power control operation between NR-DC and DAPS HO. However, two separate UE capabilities are defined for NR-DC (FG 18-1/1a/1b) and DAPS HO (FG 21-2) according to the latest UE feature in [2]. Given the power control schemes are first defined in NR-DC, we suggest deleting FG 12-2 defined for DAPS HO. Note that, intra-frequency NR-DC is not supported while intra-frequency DAPS HO is supported. But, RAN2 will find a way to further specify the signaling structure if only one capability is agreed in RAN1. ***Proposal 5****: Delete feature group 21-2 due to the duplication with 18-1/1a/1b.* |
| [3] | OPPO | In the NR unlicensed session, it was agreed to support SRS transmission whose starting position can be at any symbol of a slot, and the UE feature is captured as follows

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 10-11 | SRS starting position at any OFDM symbol in a slot |  |  | Yes | N/A |  | Per band or per UE | N/A | N/A |  | Support transmitting SRS starting in all symbols (0,…,13) of a slot | Optional with capability signalling |

~***Observation 1: Support of SRS starting position at any symbol in a slot will alleviate the shortage of SRS capacity and is beneficial for licensed bands as well.******Observation 2: Support of SRS starting position at any symbol in a slot for licensed bands will lead to NO additional standardization efforts.******Proposal 1: Support SRS resource starting at any symbol in a slot for licensed bands in Rel-16, i.e., UE feature 10-11 is also applicable to licensed bands.*** |
| [7] | Futurewei | NR is much more complex than LTE in terms of both feature groups and configurability. We seem to have gone a bit far in feature fragmentation, where an excessive number of optional sub-features are included for a feature. This is often done in the name of "testing" or "letting the market decide", but is often about a company preference in making some sub-features available before others. However, if each company tries to delay or suppress a single sub-feature it will be difficult for any feature to gain traction in the marketplace. The “spirit” of the RAN#87 discussion was to ensure, at least for some features, that more sub-features can be counted on as available whenever the feature is supported by a UE. This could help wide adoption and/or performance of features in the market as a whole. “Basic” feature groups are discussed in the next section, but here it is worth pointing out that as part of this effort we should try to reduce unnecessary or excessive feature fragmentation. To this end, we observe:**Observation 1: We do not have to turn all of the testing protocol into over the air signaling**Multiple components can be grouped and tested together (with a single IODT bit), and not every component that will be tested needs to be listed in the feature list (c.f., the two alternatives for 2-step RACH 9-1 in [4]). Grouping components means that they will be available for deployment together, which is a positive as long as efforts are spent on testing to ensure deployments are not delayed.**Observation 2: We do not have to have an independent IODT bit for every feature that can conceivably (but perhaps not usefully) be deployed without another feature**Requiring an IODT bit in every case where a feature could *conceivably* be deployed (whether or not that is a typical or useful deployment) contributes to "excessive fragmentation", and can also greatly increase signaling overhead (c.f. RAN2 request related to FR1/FR2/TDD/FDD differentiation). With ten optional feature groups there are likely not 1000 different deployment timelines that need to be supported. Reductions in fragmentation by recognizing both competence in testing and the most likely useful deployments is beneficial given the RAN level discussion.~Based on feedback from RAN2 and RAN, a feature group should not have multiple components each with support / not support capability signaling. Rather, these components should have their own row in the feature group table. However, these components may all be expected to be supported if the feature is supported. These additional rows of the table are dependent basic FGs. The Mandatory/Optional and “pre-requisite” column should be filled out to indicate the hierarchical relationship. NOTE: Pre-requisites can indicate *any* dependency requirement, not only a functional necessity. So if basic feature group relationships are defined they should be captured in a consistent way using the pre-requisite and other columns in the table.There was a comment in the RAN discussion that all features need not be dependent on a (high level) basic feature, and in RAN1 (for NR-U) to remove pre-requisites and to only include a pre-requisite if it they are functionally necessary. As discussed above, pre-requisites may be included for any reason. The comments may have been made as an unlicensed feature group with a pre-requisite would be difficult to use on a licensed band. This is a separate issue and discussed more in the next subsection. ~Some features are very clearly developed and defined within their WI scope. For example, sidelink features should not be used on the uplink or downlink, and unlicensed features should not be used on licensed spectrum. As this is the default case, a proposal is not necessary, and a simple observation made:**Observation 3: All unlicensed features were developed for unlicensed use in that WID, and by default are only available for use in shared spectrum unless we make a specific decision otherwise.**Going beyond the scope of the NR-U WID can be discussed … but doing so should be a lower priority than completing the other features and TEI in Rel-16. The UE feature discussion on NR-U (including possible basic features and feature group dependencies) should proceed within the scope of the WID without assuming those features will be used on licensed spectrum. |
| [8] | Huawei, HiSilicon | In addition to the issues above, in [5], RAN2 has requested RAN1 for input of UE feature list for Type (i.e. 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)) as below* *Following the above granularity, RAN2 requests that all the UE features fall into one of the above categories uniquely, for example, some UE features which are categorized as ‘Per FSPC’ are not defined to be applicable across all CCs*

This has been the usual case for most of the UE features that are being discussed. However, there may be some cases unclear whether the above request has to be met, as can be found in Rel-15 that the capability of *csi-ReportFramework* is per ‘band or UE’ reported. In our view, whenever possible, the above shall be met in RAN1 UE feature list discussion. It would be then understood that also for Rel-16 eMIMO feature, division of a single large FG into separate ones that each has uniquely reported UE type may be preferable.  |
| [9] | Qualcomm Incorporated | In addition, the proposed FG 11-3a-e would allow for capability signalling for the simultaneous use of CBG-based UL transmission and minimum processing capability 2.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-3a | CBG based transmission for UL with 1 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with 1 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | 5-5a or 5-5b | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |
| 11-3b | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | 5-13 | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |
| 11-3c | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | 5-13a | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |
| 11-3d | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | 5-13c | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |
| 11-3e | CBG based transmission for UL with up to 3 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 3 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | 5-13d | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |

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**Basically, some of above proposals can be discussed in other sub-agenda related to the proposal, and only the following point should be discussed in this sub-agenda.**

* **Whether all the UE feature groups shall fall into one of the “type” categories uniquely or there can be some exceptional cases that multiple “type” categories are selected for a UE feature group**

# **References**

[1] R1-2001484 RAN1 UE features list for Rel-16 NR after RAN1#100-E Moderator (AT&T, NTT DOCOMO, INC.)

[2] R1-2001634 Remaining issues on Rel-16 NR UE features ZTE

[3] R1-2001742 Discussion on the support of SRS transmission in all symbols of a slot OPPO

[4] R1-2002026 On UE feature list Intel Corporation

[5] R1-2002159 UE features for other aspects Samsung

[6] R1-2002281 Potential change/update on existing UE features for Rel-16 UE Ericsson

[7] R1-2002656 High-level discussion on Rel-16 UE features Futurewei

[8] R1-2002674 Other aspects of Rel-16 UE features Huawei, HiSilicon

[9] R1-2002687 Discussion on UE features Qualcomm Incorporated

[10] RP-200502 Informational summary on email discussion: [Rel16\_UE\_capabilities] Exchange of views NTT DOCOMO, INC.