**3GPP TSG RAN WG2 Meeting #117-e**   **R2-220xxxx**

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

**Agenda Item:** **8.20.3**

**Source:**  **Intel Corporation**

**Title:** **Summary report of [Pre117-e][210][71G] UE capabilities**

**Document for:** **Discussion/Decision**

# Introduction

This is to kick-off the following offline discussion:

[Pre117-e][210][71G] Summary of UE capabilities (Intel)

This document aims to summarize the papers that have been submitted to agenda item 8.20.3 of RAN2#117-e related to the open issues on UE capabilities identified as follow:

**Issue C1: RAN feature lists for 71 Ghz**

RAN1 sent the feature list in an LS to RAN2 in R1-2200781. These should be captured in 38.306 and 38.331. Some discussion is likely needed in RAN2#117bis-e.

**Issue C2: UE capability for L2 buffer size**

RAN2#116-e agreed on the following:

* *Keep the L2 buffer size definition as it reflects the upper bound of the L2 buffer size requirement.*
* *FFS whether UE capability is needed to address concern on too high L2 buffer size requirement. Companies should bring analysis on this to next meeting*

RAN2 needs to make a decision on whether a UE capability is needed for UEs which can not support the high L2 bffer size needed with the increased data rates for FR2-2

**Issue C3: FRx differentiation (including FR2-1 and FR2-2 differentiation)**

The main session in RAN2#116bis-e has agreed to the following:

* *From Rel-17 onwards, at least for new capabilities, if a UE capability requires at least FRx or at least xDD differentiation, it is defined with both FRx and xDD differentiation in per band signaling, i.e. no new UE capabilities will be defined in the FRX and XDD capability signaling branches.*

RAN2 need to confirm that all new Rel-17 UE capabilities that requires FRx differentiation, including between FR2-1 and FR2-2, will have to be per-band signalling. RAN2 need to confirm that: 1) for a UE capability which can be differentiated between FR2-1 and FR2-2 with per-band signalling, ‘FR2 TDD’ in Table B-1 in Annex B of TS 38.306 only means ‘FR2-1 TDD’; 2) for UE capabilities which are not differentiated between FR2-1 and FR2-2, ‘FR2 TDD’ in Table B-1 includes both FR2-1 TDD and FR2-2 TDD.

# Issue C2: UE capability for L2 buffer size

There are 5 companies contributed to this issue. The proposals are as follow:

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| **Tdoc** | **Proposals** |
| [1] | Proposal#3: To accommodate the UE total L2 buffer size requirement, it is left to the UE implementation to limit the maximum UL/DL data rate of the FR2-2 CC. No new UE capability is introduced for this release |
| [3] | Proposal 1: RAN2 to introduce a new UE capability to allow scaling L2 buffer size only for band combinations including FR2-2 band and consider the TP attached in Annex as baseline. |
| [4] | Proposal 6: No new capability is needed for UE indicating L2 buffer size limitation. |
| [5] | Proposal 2: Some smaller values may be introduced for the existing UE capability scaling factor to lessen high L2 buffer requirement. |
| [6] | Proposal 1 For NR operation in 71 GHz, no new UE capability and scaling factor is needed for indicating L2 buffer size requirement of the UE. |

4 companies [1,4-6] thinks that there is no new capability and scaling factor needed for indicating L2 buffer size requirement of the UE. 3 companies think that the existing scaling factor for both PDSCH and PUSCH can already be used to indicate limitation of maximum data rate calculation and thus limit L2 buffer size. One company thinks that it can be left tot the UE implementation to limit the max UL/DL rate of the FR2-2 CC (e.g. limiting the MIMO layer, bandwidth, scaling factor etc) and hence limit the L2 buffer size. One company further think that smaller values for the existing scaling factor can be introduced.

On the other hand, 1 company think there is a need for a new UE capability to allow scaling L2 buffer size only for band combinations including FR2-2 band. The justification is that the required total L2 buffer size can be up to about 12.9Gbytes in some extreme case with the use of asymmetric SCS.

Based on the majority view, rapporteur suggests the following proposal:

**Proposal 2-1 [4/5]: [To agree] To accommodate the UE total L2 buffer size requirement, it is left to the UE implementation to limit the maximum UL/DL data rate of the FR2-2 CC. No new UE capability is introduced** **for UE indicating L2 buffer size limitation for this release**

# Issue C3: FRx differentiation (including FR2-1 and FR2-2 differentiation)

There are 2 companies contributing to this issue. The proposals are as follow:

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| **Tdoc** | **Proposals** |
| [1] | **Proposal#1:** For existing UE capabilities that are with consistency check (’ UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands and all TDD-FR2 bands respectively.’) in the field description, update it to:UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands ~~and~~ all TDD-FR2-1 bands and all TDD-FR2-2 respectively.**Proposal#2:** For new Rel-17 UE capabilities that are per UE capability signalling with FRx diff and/or xDD diff, include the following to the field description:UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands, all TDD-FR2-1 bands and all TDD-FR2-2 respectively. |
| [2] | Proposal 1: Clarify in Annex B of TS 38.306 that for a UE capability which cannot be differentiated between FR2-1 and FR2-2, ‘FR2 TDD’ in Table B-1 includes both FR2-1 TDD and FR2-2 TDD.Proposal 2: Clarify in Annex B of TS 38.306 that for a UE capability which can be differentiated between FR2-1 and FR2-2, ‘FR2 TDD’ in Table B-1 only means ‘FR2-1 TDD’. |

For [1], since it is agreed that new Rel-17 UE capabilities that requires FRx differentiation will be set per band signalling with the new agreement, the consistency check that is added to those per band capability may need to be updated for existing UE capabilities and also new Rel-17 capabilities.

For [2], it proposes to update the Annex B in TS38.306 to clarify that for feature that is not FRx differentiation, the TDD-FR2 is for both FR2-1 and FR2-2, this allows the UE which support FR2-2 bands can still use the existing common UE capability. For feature that is FRx differentiation, the TDD-FR2 is for only FR2-1 capability and not for FR2-2 capability. New capability is already introduced/agreed for FR2-2 capability for this feature.

Based on the above, rapporteur suggests that the proposals from [1] and [2] can be discussed and agreed:

**Proposal#3-0: All new Rel-17 UE capabilities that requires FRx differentiation, including between FR2-1 and FR2-2, will have to be per-band signalling (as already agreed in the main session)**

**Proposal#3-1: For existing UE capabilities that are with consistency check (’ UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands and all TDD-FR2 bands respectively.’) in the field description, update it to:**

**UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands ~~and~~ all TDD-FR2-1 bands and all TDD-FR2-2 respectively.**

**Proposal#3-2: For new Rel-17 UE capabilities that are per UE capability signalling with FRx diff and/or xDD diff, include the following to the field description:**

**UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands, all TDD-FR2-1 bands and all TDD-FR2-2 respectively.**

**Proposal#3-3: Clarify in Annex B of TS 38.306 that for a UE capability which cannot be differentiated between FR2-1 and FR2-2, ‘FR2 TDD’ in Table B-1 includes both FR2-1 TDD and FR2-2 TDD.**

**Proposal#3-4: Clarify in Annex B of TS 38.306 that for a UE capability which can be differentiated between FR2-1 and FR2-2, ‘FR2 TDD’ in Table B-1 only means ‘FR2-1 TDD’.**

# Other issues

## Intra-NR handover to/from FR2-2

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| **Tdoc** | **Proposals** |
| [2] | Proposal 7: RAN2 to clarify the intra-NR handover capabilities in FR2-2 should be defined with separate IOT capability bit, even when the corresponding FR2-2 band is supported.  |

Currently, in the baseline running CR for TS38.306, the newly agreed for handoverFR1-FR2-2 and handoverFR2-1-FR2-2 are mandatory support for UE supporting both FR1 and FR2-2 and FR2-1 and FR2-2, respectively. This is basically aligned with existing handoverFR1-FR2. [2] thinks that it should not be mandated for the UE to support it since the coverage of FR2-2 is limited and the capability is made optional. [2] has made the following TP update:

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| ***handoverFR1-FR2-2***Indicates whether the UE supports HO between FR1 and FR2-2. This field only applies to NR SA/NR-DC/NE-DC (e.g. PCell handover), and PSCell change when (NG)EN-DC/NR-DC is configured. UEs supporting this shall indicate support of *handoverInterF* for both FR1 and FR2-2. | UE | No | No | No |
| ***handoverFR2-1-FR2-2***Indicates whether the UE supports HO between FR2-1 and FR2-2. This field only applies to NR SA/NR-DC/NE-DC (e.g. PCell handover), and PSCell change when (NG)EN-DC/NR-DC is configured. UEs supporting this shall indicate support of *handoverInterF* for both FR2-1 and FR2-2. | UE | No | No | No |

Rapporteur suggest to discuss the proposal and the TP:

**Proposal 4.1-1: RAN2 to clarify the intra-NR handover capabilities in FR2-2 should be defined with separate IOT capability bit, even when the corresponding FR2-2 band is supported.**

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| ***handoverFR1-FR2-2***Indicates whether the UE supports HO between FR1 and FR2-2. This field only applies to NR SA/NR-DC/NE-DC (e.g. PCell handover), and PSCell change when (NG)EN-DC/NR-DC is configured. UEs supporting this shall indicate support of *handoverInterF* for both FR1 and FR2-2. | UE | No | No | No |
| ***handoverFR2-1-FR2-2***Indicates whether the UE supports HO between FR2-1 and FR2-2. This field only applies to NR SA/NR-DC/NE-DC (e.g. PCell handover), and PSCell change when (NG)EN-DC/NR-DC is configured. UEs supporting this shall indicate support of *handoverInterF* for both FR2-1 and FR2-2. | UE | No | No | No |

## EUTRAN to NR handover capabilities

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| **Tdoc** | **Proposals** |
| [2] | **Proposal 4: RAN2 to clarify that ‘*eutra-5GC-HO-ToNR-TDD-FR2-r15*’ and ‘*eutra-EPC-HO-ToNR-TDD-FR2-r15*’ in LTE indicates whether the UE supports handover from E-UTRA/5GC and E-UTRA/EPC to NR TDD FR2-1, respectively.****Proposal 5: RAN2 to introduce new UE capabilities ‘*eutra-5GC-HO-ToNR-TDD-FR2-r17*’ and ‘*eutra-EPC-HO-ToNR-TDD-FR2-r17*’ in LTE to indicate whether the UE supports handover from E-UTRA/5GC and E-UTRA/EPC to NR TDD FR2-2, respectively.****Proposal 6: RAN2 to clarify that ‘*ims-VoiceOverNR-FR2-r15*’ in LTE indicates whether the UE supports IMS voice over NR FR2-1, and RAN2 introduce a new UE capability ‘*ims-VoiceOverNR-FR2-r17*’ in LTE to indicate whether the UE supports IMS voice over NR FR2-2.****Proposal 7: RAN2 to clarify ‘*ce-EUTRA-5GC-HO-ToNR-TDD-FR2-r16*’ in LTE indicates whether the UE supports handover from E-UTRA/5GC in coverage enhancement mode A or B to NR TDD FR2-1, and RAN2 add ‘*ce-EUTRA-5GC-HO-ToNR-TDD-FR2-r17*’ in LTE to indicate whether the UE supports handover from E-UTRA/5GC in coverage enhancement mode A or B to NR TDD FR2-2.** |

[2] also identified that the following LTE to NR handover capability in LTE specification TS36.306 needs to be updated since RAN2 agreed the equivalent UE capabilities, i.e. ‘*handoverLTE-5GC*’ and ‘*handoverLTE-EPC*’ can be differentiated for FR2-1 and FR2-2. For ‘*handoverLTE-5GC*’ or ‘*handoverLTE-EPC*’, they are inter-system HO capabilities from a NR cell to a EUTRA cell connected to 5GC or EPC, respectively:

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| 1. 4.3.34.4 *eutra-5GC-HO-ToNR-FDD-FR1-r15*

This field indicates whether the UE supports handover from E-UTRA/5GC to NR FDD FR1. It is mandatory for UEs of this release of the specification if the UE supports the associated RATs and if the UE supports *eutra-5GC-r15*.1. 4.3.34.5 *eutra-5GC-HO-ToNR-TDD-FR1-r15*

This field indicates whether the UE supports handover from E-UTRA/5GC to NR TDD FR1. It is mandatory for UEs of this release of the specification if the UE supports the associated RATs and if the UE supports *eutra-5GC-r15*.1. 4.3.34.6 *eutra-5GC-HO-ToNR-FDD-FR2-r15*

This field indicates whether the UE supports handover from E-UTRA/5GC to NR FDD FR2. It is mandatory for UEs of this release of the specification if the UE supports the associated RATs and if the UE supports *eutra-5GC-r15*.1. 4.3.34.7 *eutra-5GC-HO-ToNR-TDD-FR2-r15*

This field indicates whether the UE supports handover from E-UTRA/5GC to NR TDD FR2. It is mandatory for UEs of this release of the specification if the UE supports the associated RATs and if the UE supports *eutra-5GC-r15*.1. 4.3.34.8 *eutra-EPC-HO-ToNR-FDD-FR1-r15*

This field indicates whether the UE supports handover from E-UTRA/EPC to NR FDD FR1. It is mandatory for UEs of this release of the specification if the UE supports the associated RATs.1. 4.3.34.9 *eutra-EPC-HO-ToNR-TDD-FR1-r15*

This field indicates whether the UE supports handover from E-UTRA/EPC to NR TDD FR1. It is mandatory for UEs of this release of the specification if the UE supports the associated RATs.1. 4.3.34.10 *eutra-EPC-HO-ToNR-FDD-FR2-r15*

This field indicates whether the UE supports handover from E-UTRA/EPC to NR FDD FR2. It is mandatory for UEs of this release of the specification if the UE supports the associated RATs.1. 4.3.34.11 *eutra-EPC-HO-ToNR-TDD-FR2-r15*

This field indicates whether the UE supports handover from E-UTRA/EPC to NR TDD FR2. It is mandatory for UEs of this release of the specification if the UE supports the associated RATs. |

Rapporteur suggests to discuss the proposals and adopt the TP in [2]:

**Proposal 4.2-1: RAN2 to clarify that ‘*eutra-5GC-HO-ToNR-TDD-FR2-r15*’ and ‘*eutra-EPC-HO-ToNR-TDD-FR2-r15*’ in LTE indicates whether the UE supports handover from E-UTRA/5GC and E-UTRA/EPC to NR TDD FR2-1, respectively.**

**Proposal 4.2-2: RAN2 to introduce new UE capabilities ‘*eutra-5GC-HO-ToNR-TDD-FR2-r17*’ and ‘*eutra-EPC-HO-ToNR-TDD-FR2-r17*’ in LTE to indicate whether the UE supports handover from E-UTRA/5GC and E-UTRA/EPC to NR TDD FR2-2, respectively.**

**Proposal 4.2-3: RAN2 to clarify that ‘*ims-VoiceOverNR-FR2-r15*’ in LTE indicates whether the UE supports IMS voice over NR FR2-1, and RAN2 introduce a new UE capability ‘*ims-VoiceOverNR-FR2-r17*’ in LTE to indicate whether the UE supports IMS voice over NR FR2-2.**

**Proposal 4.2-4: RAN2 to clarify ‘*ce-EUTRA-5GC-HO-ToNR-TDD-FR2-r16*’ in LTE indicates whether the UE supports handover from E-UTRA/5GC in coverage enhancement mode A or B to NR TDD FR2-1, and RAN2 add ‘*ce-EUTRA-5GC-HO-ToNR-TDD-FR2-r17*’ in LTE to indicate whether the UE supports handover from E-UTRA/5GC in coverage enhancement mode A or B to NR TDD FR2-2.**

## Applicability of FR2-2 to other Rel-17 features

RAN2#116bis-e has agreed on the following:

*RAN2 to discuss (starting in the next meeting) the interaction of FR2-2 with upper layer features introduced by other Rel-17 WIs*

[1] did a quick analysis and think that FR2-2 is applicable to all the other Rel-17 features except for NTN which applies to FR1 and thus proposed the following:

**Proposal#4:** From RAN2 point of view, FR2-2 are assumed to be also applicable to other Rel-17 features, unless otherwise specified (e.g. if the feature is only for FR1). No impact to the specification

Rapporteur suggests to discuss and agree the above proposal:

**Proposal 4.3-1:** From RAN2 point of view, FR2-2 are assumed to be also applicable to other Rel-17 features, unless otherwise specified (e.g. if the feature is only for FR1). No impact to the specification

# Conclusion

RAN2 is requested to discuss the following proposals:

**Issue C2: UE capability for L2 buffer size**

**Proposal 2-1 [4/5]: [To agree] To accommodate the UE total L2 buffer size requirement, it is left to the UE implementation to limit the maximum UL/DL data rate of the FR2-2 CC. No new UE capability is introduced for UE indicating L2 buffer size limitation for this release**

**Issue C3: FRx differentiation (including FR2-1 and FR2-2 differentiation)**

**Proposal#3-0: [To agree] All new Rel-17 UE capabilities that requires FRx differentiation, including between FR2-1 and FR2-2, will have to be per-band signalling (as already agreed in the main session)**

**Proposal#3-1: [To agree] For existing UE capabilities that are with consistency check (’ UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands and all TDD-FR2 bands respectively.’) in the field description, update it to:**

**UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands ~~and~~ all TDD-FR2-1 bands and all TDD-FR2-2 respectively.**

**Proposal#3-2: [To agree] For new Rel-17 UE capabilities that are per UE capability signalling with FRx diff and/or xDD diff, include the following to the field description:**

**UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands, all TDD-FR2-1 bands and all TDD-FR2-2 respectively.**

**Proposal#3-3: [To agree] Clarify in Annex B of TS 38.306 that for a UE capability which cannot be differentiated between FR2-1 and FR2-2, ‘FR2 TDD’ in Table B-1 includes both FR2-1 TDD and FR2-2 TDD.**

**Proposal#3-4: [To agree] Clarify in Annex B of TS 38.306 that for a UE capability which can be differentiated between FR2-1 and FR2-2, ‘FR2 TDD’ in Table B-1 only means ‘FR2-1 TDD’.**

**Intra-NR handover to/from FR2-2**

**Proposal 4.1-1: [To agree] RAN2 to clarify the intra-NR handover capabilities in FR2-2 should be defined with separate IOT capability bit, even when the corresponding FR2-2 band is supported.**

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| ***handoverFR1-FR2-2***Indicates whether the UE supports HO between FR1 and FR2-2. This field only applies to NR SA/NR-DC/NE-DC (e.g. PCell handover), and PSCell change when (NG)EN-DC/NR-DC is configured. UEs supporting this shall indicate support of *handoverInterF* for both FR1 and FR2-2. | UE | No | No | No |
| ***handoverFR2-1-FR2-2***Indicates whether the UE supports HO between FR2-1 and FR2-2. This field only applies to NR SA/NR-DC/NE-DC (e.g. PCell handover), and PSCell change when (NG)EN-DC/NR-DC is configured. UEs supporting this shall indicate support of *handoverInterF* for both FR2-1 and FR2-2. | UE | No | No | No |

**EUTRAN to NR handover capabilities**

**Proposal 4.2-1: [To agree] RAN2 to clarify that ‘*eutra-5GC-HO-ToNR-TDD-FR2-r15*’ and ‘*eutra-EPC-HO-ToNR-TDD-FR2-r15*’ in LTE indicates whether the UE supports handover from E-UTRA/5GC and E-UTRA/EPC to NR TDD FR2-1, respectively.**

**Proposal 4.2-2: [To agree] RAN2 to introduce new UE capabilities ‘*eutra-5GC-HO-ToNR-TDD-FR2-r17*’ and ‘*eutra-EPC-HO-ToNR-TDD-FR2-r17*’ in LTE to indicate whether the UE supports handover from E-UTRA/5GC and E-UTRA/EPC to NR TDD FR2-2, respectively.**

**Proposal 4.2-3: [To agree] RAN2 to clarify that ‘*ims-VoiceOverNR-FR2-r15*’ in LTE indicates whether the UE supports IMS voice over NR FR2-1, and RAN2 introduce a new UE capability ‘*ims-VoiceOverNR-FR2-r17*’ in LTE to indicate whether the UE supports IMS voice over NR FR2-2.**

**Proposal 4.2-4: [To agree] RAN2 to clarify ‘*ce-EUTRA-5GC-HO-ToNR-TDD-FR2-r16*’ in LTE indicates whether the UE supports handover from E-UTRA/5GC in coverage enhancement mode A or B to NR TDD FR2-1, and RAN2 add ‘*ce-EUTRA-5GC-HO-ToNR-TDD-FR2-r17*’ in LTE to indicate whether the UE supports handover from E-UTRA/5GC in coverage enhancement mode A or B to NR TDD FR2-2.**

**Applicability of FR2-2 to other Rel-17 features**

**Proposal 4.3-1:** **[To agree]** From RAN2 point of view, FR2-2 are assumed to be also applicable to other Rel-17 features, unless otherwise specified (e.g. if the feature is only for FR1). No impact to the specification

# References

[1] R2-2202661 Remaining UE capability issues on NR operation for upto 71GHz Intel Corporation discussion Rel-17 NR\_ext\_to\_71GHz-Core

[2] R2-2202711 Discussion about UE capabilities on Ext 52-71GHz Huawei, HiSilicon discussion Rel-17 NR\_ext\_to\_71GHz-Core

[3] R2-2202921 Discussion on L2 buffer size Samsung discussion Rel-17 NR\_ext\_to\_71GHz-Core

[4] R2-2202710 Discussion about RAN2 impacts of Ext 52-71GHz Huawei, HiSilicon discussion Rel-17 NR\_ext\_to\_71GHz-Core

[5] R2-2203419 Remaining UP issues for extending to 71GHz ZTE Corporation, Sanechips discussion

[6] R2-2202433 Remaining protocol aspects Ericsson discussion Rel-17 NR\_ext\_to\_71GHz-Core