**3GPP TSG-RAN** **WG2 Meeting #109bis-e R2-200xxxx**

**Electronic, April 20 – 30, 2020**

**Source: Qualcomm Incorporated**

**Title: Summary of email discussion [AT109bis-e][014][NR15] UE Cap Miscellaneous II**

**Document for: Decision**

**Agenda Item: 6.19**

# Introduction

This document summarizes the following email discussion.

* [AT109bis-e][064][NR15] XDD FRX differentiation (Qualcomm)

Scope: Reply LS to R1, In this context, clarify the meaning of/how current signaling works. Determine whether clarifications to current TS is needed. Can discuss how to extend if/when needed.

Intended outcome: Approved LS, Report and/or clarification CR (if agreed).

Deadline: April 29 0700 UTC

# Discussion

## UE setting of xDD FRx split capabilities

During the online discussion the following two interpretations were identified on how the UE sets xDD FRx split capabilities when the feature is supported only in one of duplex modes or frequency range.

(The following description is difficult to understand. It is recommended to look at example scenarios further down).

**Interpretation 1** (e.g. [R2-2002573](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_109bis-e/Docs/R2-2002573.zip))

* The UE indicates the feature support for a duplex mode (e.g. TDD), regardless of whether the UE supports the feature in all supported combination(s) of the duplex mode and frequency range(s) (e.g. FR1-TDD, FR2-TDD) according to the reported frequency band capability.
* The UE indicates the feature support for a frequency range (e.g. FR1), regardless of whether the UE supports the feature in all supported combination(s) of the frequency range and duplex mode(s) (e.g. FR1-FDD, FR1-TDD) according to the reported frequency band capability.

**Interpretation 2** (e.g. [R2-2003269](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_109bis-e/Docs/R2-2003269.zip)):

* The UE indicates the feature support for a duplex mode (e.g. TDD), only when the UE supports the feature in all supported combination(s) of the duplex mode and frequency range(s) (e.g. FR1-TDD, FR2-TDD) according to the reported frequency band capability.
* The UE indicates the feature support for a frequency range (e.g. FR1), only when the UE supports the feature in all supported combinations of the frequency range and duplex mode(s) (e.g. FR1-FDD, FR1-TDD) according to the reported frequency band capability.

Let’s look at some scenarios for easier understanding of the two different interpretations above.

**Scenario 1:**

* The UE reports the support for FR1 FDD band, FR1 TDD band, and FR2 TDD band.
* The UE supports the feature only for FR2 TDD
* **With interpretation 1:**
  + The UE includes the capability in tdd-Add-UE-NR/MRDC-Capabilities.
  + The UE includes the capability in fr2-Add-UE-NR/MRDC-Capabilities.
* **With interpretation 2:**
  + The UE does **NOT** include the capability in tdd-Add-UE-NR/MRDC-Capabilities.

(because the UE does not support the feature for TDD with all applicable frequency ranges according to the supported frequency bands; in this case FR1 TDD and FR2 TDD.

* + The UE includes the capability in fr2-Add-UE-NR/MRDC-Capabilities.

(because the UE supports the feature for FR2 with all applicable duplex mode according to the supported frequency bands; in this case FR2 TDD.

**Scenario 2:**

* The UE reports the support for FR1 FDD band and FR2 TDD band.
* The UE supports the feature only for FR2 TDD (same as scenario 1)
* **With interpretation 1:**
  + The UE includes the capability in tdd-Add-UE-NR/MRDC-Capabilities.
  + The UE includes the capability in fr2-Add-UE-NR/MRDC-Capabilities.
* **With interpretation 2:**
  + The UE includes the capability in tdd-Add-UE-NR/MRDC-Capabilities.

(because the UE support the feature for TDD with all applicable frequency range according to the supported frequency bands; in this case only FR2-TDD)

* + The UE includes the capability in fr2-Add-UE-NR/MRDC-Capabilities.

(because the UE support the feature for FR2 with all applicable duplex mode according to the supported frequency bands; in this case only FR2-TDD)

As can be observed, the key difference in interpretation 2 is that the setting of xdd/frx-Add-UE-NR/MRDC-Capabilities is dependent on the supported frequency bands that the UE reports in the UE radio capability.

Companies are requested to provide their comment on the two interpretations as described above.

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| **Company name** | **Comments** |
| Qualcomm Incorporated | Our understanding is in line with the interpretation 1. We also see a few technical drawbacks for the interpretation 2.  With the interpretation 1, the network considers that the UE supports the feature in duplex mode + frequency range combination, only if the UE signals the support of the feature for both the duplex mode and the frequency range. With interpretation 2 however, the network needs to look into the xDD FRx split capabilities AND frequency band capability of the UE to derive the true UE capability.  Furthermore, with the interpretation 2, the UE needs to change the setting of xDD FRx split capabilities according to the frequency bands the UE reports. It should be noted that the frequency bands the UE reports is subject to UE capability filter. |
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## “Problematic case”

The problematic case which the UE would not be able to signal true UE capability depends on the interpretation on how the UE sets xDD FRx split capabilities.

* **With interpretation 1 (see Annex 1):**
  + FR1 FDD: Supported
  + FR1 TDD: Not supported
  + FR2 TDD: Supported
* **With interpretation 2 (see Annex 2):**
  + FR1 FDD: Not supported
  + FR1 TDD: Supported
  + FR2 TDD: Not supported
  + The UE supports FR1 FDD, FR1 TDD, and FR2 TDD

Companies are requested to state if they agree to the above or not.

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| --- | --- | --- |
| **Company name** | **Agree / Disagree** | **Comments** |
| Qualcomm Incorporated | Agree |  |
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## Need of specification clarification

Companies are requested to provide their comment on whether any clarification of the standard is necessary. If so, how.

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| **Company name** | **Interpretation 1 or 2** | **Comments** |
| Qualcomm Incorporated | Interpretation 1 | We can consider adding expected network behaviour, which will also serve as UE implementation guidance, e.g.   * NOTE: In case the UE signals its capability in fdd-Add-UE-NR/MRDC-Capabilities, tdd-Add-UE-NR/MRDC-Capabilities, fr1-Add-UE-NR/MRDC-Capabilities and/or fr2-Add-UE-NR/MRDC-Capabilities, the network considers that the UE supports the feature in a given combination of duplex mode and frequency range, only if the UE signals the support of the feature for both the duplex mode and the frequency range. |
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## LS response to RAN1

RAN2 response to RAN1 LS [R2-2003269](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_109bis-e/Docs/R2-2003269.zip), is going to be slightly different between the two interpretations.

* **With interpretation 1:**
  + RAN2 confirms the current UE capability signaling does not allow the UE to signal support for a feature in the case identified by RAN1.
  + No consensus in RAN2 whether the problematic case should be addressed or not.
  + RAN2 asks RAN1 whether they see the need of a solution where the UE can indicate the support of a feature in the problematic case.
* **With interpretation 2:**
  + RAN2 confirms the current UE capability signaling does not allow the UE to signal support for a feature in a specific case, but such case is different from the one identified by RAN1.
  + No consensus in RAN2 whether the problematic case should be addressed or not ???
  + RAN2 asks RAN1 whether they see the need of a solution where the UE can indicate the support of a feature in the problematic case ???

## Solution to address the “problematic case”

**Proposal 1: xxxx**

# Summary

xxxxxxxxxx

# Conclusion

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# Annex 1

**Table-1:** Current UE capability bit setting

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| True UE capability | | UE capability bits | | UE capability container |
| **Case 1** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | FDD | Yes | Common |
| TDD |
| FR1 |
| FR2 |
| **Case 2** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | FDD | No |  |
| TDD |
| FR1 |
| FR2 |
| **Case 3** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | FDD | No |  |
| TDD | Yes | tdd-Add |
| FR1 | Yes | Common |
| FR2 |
| **Case 4** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | FDD | No |  |
| TDD | Yes | tdd-Add |
| FR1 | No |  |
| FR2 | Yes | fr2-Add |
| **Case 5** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | FDD | No |  |
| TDD | Yes | tdd-Add |
| FR1 | Yes | fr1-Add |
| FR2 | No |  |
| **Case 6** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | FDD | **Not possible to express** |  |
| TDD |
| FR1 |
| FR2 |
| **Case 7** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | FDD | Yes | fdd-Add |
| TDD | No |  |
| FR1 | Yes | fr1-Add |
| FR2 | No |  |
| **Case 8** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | FDD | Yes | Common |
| TDD |
| FR1 | Yes | fr1-Add |
| FR2 | No |  |

# Annex 2

Table indicating support of a feature with FR1/FR2, TDD/FDD differentiation:

Label

1 UE supports the feature for the given FRX/XDD mode

0 UE does not support the feature for the given FRX/XDD

x UE does not support the given FRX/XDD mode

fdd UE includes the feature in fdd-Add-UE-NR/MRDC-Capabilities

tdd UE includes the feature in tdd-Add-UE-NR/MRDC-Capabilities

fr1 UE includes the feature in fr1-Add-UE-NR/MRDC-Capabilities

fr2 UE includes the feature in fr2-Add-UE-NR/MRDC-Capabilities

common UE includes the feature in the common branch for features that do not require FR1/FR2 or FDD/TDD differentiation

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|  | FR1 only | | | |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  | FDD | TDD |
| FR1 | 1 | 0 |  | FR1 | 0 | 1 |  | FR1 | 1 | 1 |
| FR2 | x | x |  | FR2 | x | x |  | FR2 | x | x |
| fdd | | |  | tdd | | |  | common | | |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  |  |  |
| FR1 | 1 | x |  | FR1 | x | 1 |  |  |  |  |
| FR2 | x | x |  | FR2 | x | x |  |  |  |  |
| common | | |  | common | | |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | TDD only | | | |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  | FDD | TDD |
| FR1 | x | 1 |  | FR1 | x | x |  | FR1 | x | 1 |
| FR2 | x | 1 |  | FR2 | x | 1 |  | FR2 | x | 0 |
| common | | |  | common | | |  | fr1 | | |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  |  |  |  |  |  |  |
| FR1 | x | 0 |  |  |  |  |  |  |  |  |
| FR2 | x | 1 |  |  |  |  |  |  |  |  |
| fr2 | | |  |  |  |  |  |  |  |  |
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|  | FR1+FR2 | | | |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  | FDD | TDD |
| FR1 | 1 | 0 |  | FR1 | 0 | 1 |  | FR1 | 0 | 0 |
| FR2 | x | 0 |  | FR2 | x | 0 |  | FR2 | x | 1 |
| fdd | | |  | new signaling | | |  | fr2 | | |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  | FDD | TDD |
| FR1 | 1 | 1 |  | FR1 | 0 | 1 |  | FR1 | 1 | 0 |
| FR2 | x | 0 |  | FR2 | x | 1 |  | FR2 | x | 1 |
| fr1+fdd | | |  | fr2+tdd | | |  | fr2+fdd | | |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  | FDD | TDD |
| FR1 | 1 | 1 |  | FR1 | 1 | x |  | FR1 | 0 | x |
| FR2 | x | 1 |  | FR2 | x | 1 |  | FR2 | x | 1 |
| common | | |  | common | | |  | fr2+tdd | | |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  |  |  |  |  |  |  |
| FR1 | 1 | x |  |  |  |  |  |  |  |  |
| FR2 | x | 0 |  |  |  |  |  |  |  |  |
| fr1+fdd | | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | Irrelevant cases | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  | FDD | TDD |
| FR1 | 0 | x |  | FR1 | x | 0 |  | FR1 | x | x |
| FR2 | x | x |  | FR2 | x | x |  | FR2 | x | 0 |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  | FDD | TDD |
| FR1 | 0 | 0 |  | FR1 | x | 0 |  | FR1 | 0 | x |
| FR2 | x | x |  | FR2 | x | 0 |  | FR2 | x | 0 |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  |  |  |
| FR1 | 0 | 0 |  | FR1 | x | x |  |  |  |  |
| FR2 | x | 0 |  | FR2 | x | x |  |  |  |  |