**3GPP TSG-RAN** **WG2 Meeting #110-e R2-200xxxx**

**Electronic, June 1 – 12, 2020**

**Source: Qualcomm Incorporated**

**Title: Summary of email discussion [Post109bis-e][064][NR15] XDD FRX differentiation (Qualcomm)**

**Document for: Decision**

**Agenda Item: 5.4.3**

# Introduction

This document provides a summary of the following email discussion.

* [Post109bis-e][064][NR15] XDD FRX differentiation (Qualcomm)

      Scope: First priority, clarify the behaviour of the current UE capability signalling for xDD FRx differentiation, including identification of the problematic case that the current signalling does not allow the UE to signal. Second priority, if progress is good/fast, can discuss which actions should be taken, ways forward.   
Intended outcome: Report.  
Deadline: Next meeting

# Discussion

## UE setting of xDD FRx split capabilities

Three possible interpretations for the UE setting of xDD FRx split capabilities were identified so far. This section summarizes the setting of UE capability signalling in the following interpretations.

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

**Interpretation 1-b** (e.g. [R2-2003454](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_109bis-e/Docs/R2-2003454.zip), Huawei)

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

NOTE:

* “**Unable to signal**” indicates that the set of UE capabilities is allowed according to the UE capability differentiation rules in the standard, i.e. ‘yes’ or ‘no’ indications in the “FDD-TDD DIFF” and “FR1-FR2 DIFF” in TS38.306. But the UE capability signalling is not capable of expressing the set of UE capabilities.
* “**Not allowed**” indicates the set of UE capabilities is NOT allowed according to the UE capability differentiation rules in the standard, i.e. ‘yes’ or ‘no’ indications in the “FDD-TDD DIFF” and “FR1-FR2 DIFF” in TS38.306.

In both cases, the UE can choose to fallback to an allowed UE capability setting.

## UE capabilities with both xDD and FRx differentiations

**Interpretation 1-a**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Support for the feature | | UE capability containers | | | | | |
| xDD-Diff in common | FRX-diff in common | fdd-Add | tdd-Add | fr1-Add | fr2-Add |
| **Case 1** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | Supported | Supported | Not included | Not included | Not included | Not included |
| **Case 2** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | Not supported | Not supported | Not included | Not included | Not included | Not included |
| **Case 3** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | Not supported | Supported | Not included | Supported | Not included | Not included |
| **Case 4** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | Not supported | Not supported | Not included | Supported | Not included | Supported |
| **Case 5** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | Not supported | Not supported | Not included | Supported | Supported | Not included |
| **Case 6** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | Unable to signal | | | | | |
| **Case 7** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | Not supported | Not supported | Supported | Not included | Supported | Not included |
| **Case 8** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | Supported | Not supported | Not included | Not included | Supported | Not included |

**Interpretation 1-b**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Support for the feature | | UE capability containers | | | | | |
| xDD-Diff in common | FRX-diff in common | fdd-Add | tdd-Add | fr1-Add | fr2-Add |
| **Case 1** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | Supported | Supported | Not included | Not included | Not included | Not included |
| **Case 2** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | Not supported | Not supported | Not included | Not included | Not included | Not included |
| **Case 3** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | Not supported | Not supported | Not included | Supported | Not included | Not included |
| **Case 4** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | Not supported | Not supported | Not included | Supported | Not included | Supported |
| **Case 5** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | Not supported | Not supported | Not included | Supported | Supported | Not included |
| **Case 6** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | Unable to signal | | | | | |
| **Case 7** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | Not supported | Not supported | Supported | Not included | Supported | Not included |
| **Case 8** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | Not supported | Not supported | Not included | Not included | Supported | Not included |

**Interpretation 2**

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 (xDD-diff and FRx-diff) for features that do not require FR1/FR2 or FDD/TDD differentiation

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | | | |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | 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 | | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FR1+FR2 | | | |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  | FDD | TDD |
| FR1 | 1 | 0 |  | FR1 | 1 | x |  | FR1 | 0 | 0 |
| FR2 | x | 0 |  | FR2 | x | 0 |  | FR2 | x | 1 |
| Case 7: fdd | | |  | fr1+fdd | | |  | Case 4: 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 |
| Case 8: fr1+fdd | | |  | Case 3: fr2+tdd | | |  | Case 6: 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 |
| Case 1: common | | |  | common | | |  | fr2+tdd | | |
|  |  |  |  |  |  |  |  |  |  |  |
|  | FDD | TDD |  |  | FDD | TDD |  |  |  |  |
| FR1 | 1 | x |  | FR1 | 0 | 1 |  |  |  |  |
| FR2 | x | 0 |  | FR2 | x | 0 |  |  |  |  |
| fr1+fdd | | |  |  | Case 5: Unable to signal |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |

## UE capabilities with xDD differentiation only

Rapproteur’s note: It is rapporteur’s understanding that there is no difference in UE capability bit setting among different interpretations.

**Interpretation 1-a, 1-b and 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Support for the feature | | UE capability containers | | | | | |
| xDD-Diff in common | FRX-diff in common | fdd-Add | tdd-Add | fr1-Add | fr2-Add |
| **Case 1** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | Supported | N/A | Not included | Not included | N/A | N/A |
| **Case 2** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | Not supported | N/A | Not included | Not included | N/A | N/A |
| **Case 3** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | Not supported | N/A | Not included | Supported | N/A | N/A |
| **Case 4** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | Not allowed | | | | | |
| **Case 5** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | Not allowed | | | | | |
| **Case 6** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | Not allowed | | | | | |
| **Case 7** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | Not supported | N/A | Supported | Not included | N/A | N/A |
| **Case 8** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | Not allowed | | | | | |

## UE capabilities with FRx differentiation only

Rapproteur’s note: It is rapporteur’s understanding that there is no difference in UE capability bit setting among different interpretations.

**Interpretation 1-a, 1-b and 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Support for the feature | | UE capability containers | | | | | |
| xDD-Diff in common | FRX-diff in common | fdd-Add | tdd-Add | fr1-Add | fr2-Add |
| **Case 1** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | N/A | Supported | N/A | N/A | Not included | Not included |
| **Case 2** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | N/A | Not supported | N/A | N/A | Not included | Not included |
| **Case 3** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘supported | Not allowed | | | | | |
| **Case 4** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | N/A | Not supported | N/A | N/A | Not included | Supported |
| **Case 5** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | Not allowed | | | | | |
| **Case 6** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported | Not allowed | | | | | |
| **Case 7** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘not supported | Not allowed | | | | | |
| **Case 8** | * FR1 FDD: ‘supported’ * FR1 TDD: ‘supported’ * FR2 TDD: ‘not supported | N/A | Not supported | N/A | N/A | Supported | Not included |

**Q1: Companies are requested to indicate which interpretation they support.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Interpretation 1-a/1-b/2** | **Comment** |
| Nokia | 1-a/1-b | We are aligned to 1-a table (offline we understood that proponent of 1-b is also aligned to 1-a but chose a different way to represent the information). |
| vivo | 1-a | The difference between 1-a and 1-b is for only for case 3 and case 8 XDD/FRX common parts.  Due to the sentence “set all fields of UE-NR/MRDC-Capability except fdd-Add-UE-NR/MRDC-Capabilities, tdd-Add-UE-NR/MRDC-Capabilities, fr1-Add-UE-NR/MRDC-Capabilities and fr2-Add-UE-NR/MRDC-Capabilities, to include the values applicable for all duplex mode(s) and frequency range(s) that the UE supports” in 38.306, We prefer 1-a interpretation. |
| Huawei | 1-b | Proponent.  We are a bit confused on vivo’s comments, the highlighted sentence exactly reflects the reality that only when the values are applicable for all duplex modes or frequency ranges supported by the UE, the UE should set the common containers. This means in case 3, the UE does not have the same value for the capability applicable for the 3 modes and thus should not be set in the common container. |
| CATT | 1-b | It is true that the key point it to align understanding on  ‘**include the values applicable for all duplex mode(s) and frequency range(s) that the UE supports’**  We tend to agree with Huawei’s interpretation to the text. ‘All’ here covers both duplex and FR. |
| ZTE | 1-a | We are aligned to 1-a.  For 1-b, seems there is no need to separate “XDD-Diff” and “FRX-Diff” in common branch, only 1 bit would be sufficient for a given feature.  Since we already defined separate XDD-Diff and FRX-Diff in the common branch, we think they should indicate the support for XDD and FRX respectively. |
| OPPO | 1-a or 1-b | We also think the spirit of the interpretation 1-a and 1-b is the same i.e. UE indicates the support of UE capability of one specific type of band e.g. FR1FDD by signaling support both for FR1 and FDD in corresponding IEs. The difference mainly is signaling aspect in case 3 and case 8 where only one kind of band type is not supported. Because current text procedure show common IE will be set “include the values applicable for all duplex mode(s) and frequency range(s) that the UE supports”. In this aspect interpretation 1-b is correct. But in case 3 the support of FR1 and FR2 is not signaled explicitly in 1-b, from our perspective this is not correct because in the table “not supported” is equivalent to “not included” logically. Unfortunately current text procedure hint such kind of contradict UE behavior. So in short we think current text need be improved for both interpretations.  For both 1-a and 1-b, the sentence to set common IE should be changed to be “include the values applicable for all duplex mode(s) and/or frequency range(s) that the UE supports”. Then different value between FRX and XDD of the common IE is allowed and consequently tables of 1-a and 1-b will be the same. |
| Huawei2 |  | To respond to ZTE’s comment on “Since we already defined separate XDD-Diff and FRX-Diff in the common branch, we think they should indicate the support for XDD and FRX respectively.”, we think this is fully correct. Actually one motivation to introduce XDD-Diff and FRX-Diff is because there are parameters differed only in XDD or FRX. So for these parameters, we would have only XDD-Diff or FRX-Diff.  For the suggestion from OPPO, we actually have thought a similar way to make a smooth change. However we then realized that this might have inter-operability problem for e.g. case 3. If the UE sets the common container as 1-a, the NW based on the current 38306 text would assume this applies to all duplex modes and frequency ranges while it actually doesn’t. we don’t think not signaled means not supported, as the XDD-add/FRX-add branch needs to fulfill the text I highlighted in red.   1. if UE supports both FDD and TDD and if (some of) the UE capability fields have a different value for FDD and TDD   2> if for FDD, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:  3> include field fdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FDD;  2> if for TDD, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:  3> include field tdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for TDD; |
| Ericsson | 2 | We think this option reflects the procedures captured in 38.306, since such procedures were designed based on “values applicable for all duplex mode(s) and frequency range(s) that the UE supports”. This implies that how those capabilities are included in the common and diff branches depend on not only if the feature is supported for a particular duplex mode or FR, but also whether the UE supports other duplex mode or FR.  Another aspect is that the procedures in 38.306 require the UE to indicate in the dedicated diff branches (i.e. fr1-Add-UE-NR, fr2-Add-UE-NR…) additional functionality it supports. Such additional functionality cannot be cherry picked by considering only one specific FR or duplex mode. For instance, in case 4 (in section 2.1.1) described in interpretation 1a and 1b, it is stated that the UE would include the supported feature in tdd-Add-UE-NR/MRDC-Capabilities. However, the support of the feature in FR1 and FR2 is not the same. This UE supports the feature in all FR2 bands that it supports. Hence, it could set the bit in the FR2 branch. But because it does not support the feature in FR1 TDD, it cannot set the bit in the TDD branch. |
| MediaTek | 1-a (and 1-b is acceptable) | We basically have very similar view as OPPO. We understand that the current text seems saying the UE includes the capability for common filed only if it supports **all** XDD and FRX combination. However, purely look at the ASN.1 define, there are 2 “common” fields in this scenario. If the UE supports all combination, it include both fields. It is somehow strange that UE supports both FDD and TDD but could not include the common field for FDD and TDD. Thus, we slightly prefer 1-a than 1-b. |
| Qualcomm Incorporated | 1-a | This is based on the assumption that the network can consider the UE supports the feature in a given combination of duplex mode and frequency range, when the UE indicates the support in both the corresponding duplex mode and frequency range in the UE capability signaling.  Interpretation 1-b seems to follow the specification text literally. But it results in unfortunate signalling that the UE does not indicate “support” in any of bits available for FRx (case 3) or xDD (case 8), and the network still needs to infer UE support for the feature. |
| Samsung | 1-b | We have same view with Huawei and CATT. According to the current specification, interpretation 1-b is aligned.  ‘**include the values applicable for all duplex mode(s) and frequency range(s) that the UE supports’**  In addition, we have additional FRx/xDD containers which are used for the additional functionality having some different values. It would be better that RAN2 stick to the current operation though it has some cases not to signaling.  In addition, there are no implementation issues for the case 3/8 to be separately signaled. |
| Apple | Either 1-a or 1-b is acceptable | We also feel that 1-a and 1-b do not have fundamental differences. Current spec 38.306, as pointed out by Huawei, supports 1-b as the common field is only indicated when UE supports it in all duplex modes and frequency ranges.  If majority of companies prefer 1-a, we can also accept the change suggested by OPPO. |
| Intel | Either of 1a/1b interpretations by themselves work and 1b goes by the spec in strict verbal sense. | Regarding “‘include the values applicable for all duplex mode(s) and frequency range(s) that the UE supports”, our understanding is aligned with Ericsson that “all” means based on UE supporting. For example, if the UE supports FDD only, the UE use only common branch instead of fdd-Add.  Our understanding is close to 1-b interpretation that common branch is used when the UE supports the same capability for both FDD/TDD and/or FR1/FR2 assuming the UE supports both FDD/TDD and/or FR1/FR2. |

## The specification text in TS38.306

The current procedural text in TS38.306 is as follows. According to the company inputs during RAN2#109bis-e meeting, the parts highlighted are subject to discussion.

|  |
| --- |
| The UE may support different functionalities between FDD and TDD, and/or between FR1 and FR2. The UE shall indicate the UE capabilities as follows. […]   1. set all fields of UE-NR/MRDC-Capability except fdd-Add-UE-NR/MRDC-Capabilities, tdd-Add-UE-NR/MRDC-Capabilities, fr1-Add-UE-NR/MRDC-Capabilities and fr2-Add-UE-NR/MRDC-Capabilities, to include the values applicable for all duplex mode(s) and frequency range(s) that the UE supports; 2. if UE supports both FDD and TDD and if (some of) the UE capability fields have a different value for FDD and TDD   2> if for FDD, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:  3> include field fdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FDD;  2> if for TDD, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:  3> include field tdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for TDD;   1. if UE supports both FR1 and FR2 and if (some of) the UE capability fields have a different value for FR1 and FR2:   2> if for FR1, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:  3> include field fr1-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FR1;  2> if for FR2, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:  3> include field fr2-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FR2; |

## Discussion point 1: “include the values applicable for all duplex mode(s) and frequency range(s)”

There seems to be different interpretations regarding this sentence.

**Interpretation 1-a** assumes that “XDD-diff” and “FRX-diff” in common branch can be set separately and included when the UE supports the feature for all duplex mode(s) and all frequency ranges, respectively, i.e. “XDD-diff” and “FRX-diff” can include different values.

**Interpretation 1-b** and **interpretation 2** assumes that the “XDD-diff” and “FRX-diff” in common branch is included when the UE supports the feature for all duplex mode(s) and all frequency ranges, i.e. “XDD-diff” and “FRX-diff” cannot include different values.

**Q2: Companies are requested to provide their comment on the observation above, if any.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Comment on interpretation 1-a/1-b/2** | **Comment** |
| Nokia | 1-b | Our understanding is that irrespective of the UE supporting FR1/FR2 or both or FDD/TDD or both, the common bit has to be set. However, if the UE supports both FR1+FR2 and FDD+TDD and it has different capabilities for a given feature in FR1/FR2 and FDD/TDD it will use the specific parts. |
| Vivo | 1-a | We prefer 1-a interpretation. |
| Huawei | 1-b | At least in the current 38.306 text “to include the values applicable for all duplex mode(s) and frequency range(s) that the UE supports” this seems quite clear to us this means the common branch can only be set when all the capabilities are the same for all supported duplex modes and frequency ranges. We actually think Nokia’s interpretation is 1-b. |
| CATT | 1-b | See comments to previous comment. |
| ZTE | 1-a | We are aligned to 1-a.  Similar to our response in Q1, interpretation 1-b only needs 1 bit, using two bits is wasted. |
| OPPO | 1-b | Literally interpretation is 1-b. |
| Ericsson | 2 | The procedures simply mention “for all duplex mode(s) and all frequency ranges” without pointing to any particular handling in that case, so we think the sentence is clear in this aspect. Interpretation 1-b and 2 may differ on the interpretation of the sentence “the UE supports” (which is discussed more below), but in general we think the description above is aligned to both 1-b and 2. |
| MediaTek |  | Literally interpretation is more like 1-b. But since there are two common fields, we think that 1-a is also fine. |
| Qualcomm Incorporated | 1-a |  |
| Samsung | 1-b | This interpretation is quite aligned with the current text. |
| Apple | 1-b | Literal interpretation is 1-b. |
| Intel | 1-b/2 | We agree with Ericsson. |

## Discussion point 2: “the UE supports”

The current specification text assumes that the UE includes the xDD FRx split capabilities based on the duplex mode(s) and frequency range(s) the UE supports. For interpretation 1-a and 1-b, it is not clarified in the tables of section 2.1 how the UE would change the UE capability setting when the UE does not support a given combination of duplex mode + frequency range. For example, in the case 4 below, the UE capability setting should be different when the UE does not support an FR2-TDD band.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Support for the feature | | UE capability containers | | | | | |
| xDD-Diff in common | FRX-diff in common | fdd-Add | tdd-Add | fr1-Add | fr2-Add |
| **Case 4** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported’ | Not supported | Not supported | Not included | Supported | Not included | Supported |

**Interpretation 2** is indeed based on the assumption that the UE includes the xDD FRx split capabilities based on the duplex mode(s) and frequency range(s) the UE supports. Therefore the case where the UE does not support the feature for a given combination of duplex mode + frequency range, and the case where the UE does not support a given combination of duplex mode + frequency range are clearly distinguished, as in the example below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| UE does not support the feature in FR1 TDD | | |  | UE does not support FR1 TDD band | | |
|  | FDD | TDD |  |  | FDD | TDD |
| FR1 | 1 | **0** |  | FR1 | 1 | **x** |
| FR2 | x | 0 |  | FR2 | x | 0 |
| fdd | | |  | fr1+fdd | | |

It should be noted however that the true UE capability for duplex mode and frequency range may not be fully visible from the network point of view, due to the UE capability filter. This poses the question whether the UE is required to include the xDD FRx split capabilities based on the duplex mode(s) and frequency range(s) the UE “reports”, as opposed what the UE “supports”.

**Q3: Companies are requested to confirm that the UE to include the xDD FRx split capabilities based on the duplex mode(s) and frequency range(s) the UE supports.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Yes / No** | **Comment on interpretation 1-a/1-b/2** | **Comment** |
| Nokia | Yes | - | Taking the Case 4 example here: As the xADD fields were set to (0,1) and (0,1) for xDD and FRx respectively this implies the UE supports both FR1 and FR2 as well as FDD and TDD but just wants to indicate that it supports a given feature only on TDD and FR2. |
| Vivo | Yes |  | This question confuses me. We assume that anyway the XDD/FRX\_common and XDD/FRX\_add should be reported based on the duplex mode(s) and frequency range(s) the UE supports.  Does rapporteur mean that the UE should set XDD/FRX\_common feature based on the duplex mode(s) and frequency range(s) the UE supports? |
| Huawei |  |  | We are also confused about this question. If a UE does not support any FR2 TDD band, why the UE would report something as case 4? |
| CATT | Yes |  | From the existing spec it is clear UE sets these singling based on the feature it supports. Maybe this question can be made clearer. |
| ZTE | Yes |  | We have the same question with Huawei.  If the question is whether UE should set the XDD-FRX parameters irrespective of “filtered bands/BCs”. Our understanding is “Yes”. |
| OPPO | Yes |  |  |
| Huawei2 | Yes |  | After the moderator’s clarification, we understand the question now. We understand the filter is only to filter the band list, not to filter the whole duplex modes or frequency range. So to include what UE supports makes sense. Actually it might not matter that much whether the UE reports sth. support or requested to be reported, because the UE in this case would not report any FR2 TDD band and thus the network would not use this capability part anyway. |
| Ericsson | Yes |  | From one perspective it could have had a use to apply the procedures from 38.306 for FRX/XDD differentiation according to what the UE reports since the network should derive what the UE supports from what it reports. However, since current procedures are stated according to what the UE *supports*, we think we should keep the procedures as they are. |
| MediaTek | Yes |  | We also understand that UE should set the XDD-FRX parameters irrespective of “filtered bands/BCs”. |
| Qualcomm Incorporated | Yes |  | The UE will change the UE capability setting based on the supported duplex mode and frequency range bands.  In case of interpretation 1-a, the network can simply assume the UE supports bands of all duplex modes and frequency ranges in determining the xDD and FRx capabilities as follows.   * The UE supports the feature in a given combination of duplex mode and frequency range, when the UE indicates the support in both the corresponding duplex mode and frequency range in the UE capability signaling. |
| Samsung | Yes |  | We share the view of CATT that the existing spec it is clear UE sets these singling based on the feature it supports. |
| Apple | Yes |  |  |
| Intel | Yes? |  | Basically, the common branch  is used if the UE supports the same capability in both FDD/TDD and/or both FR1 and FR2.  However, in addition, the UE could also use in the following cases.   * Case 1:  the UE supports either FDD or TDD only for xDD differentiate capapilities (no FRx differentiation) * Case 2: the UE supports either FR1 or FR2 only for FRx differentiate capabilties (no FRx differentiation)   In case 1 and case 2, the UE doesn’t need to differentiate whether a certain capability supports in FDD or TDD (FR1 or FR2). So, it can just use common branch.  Regarding MTK’s comment “UE should set the XDD-FRX parameters irrespective of “filtered bands/BCs”, we understand there is no filtering of bands in UE capability enquiry. So, UE capability won’t be changed upon UE capability enquiry within UE capability signalling framework unless the UE’s supported frequency bands are changed by UE implementation which doesn’t cover in the specification. |

**Q4: Is the UE required to include the xDD FRx split capabilities based on the duplex mode(s) and frequency range(s) the UE reports?**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Yes / No** | **Comment on interpretation 1-a/1-b/2** | **Comment** |
| Nokia | No | - | Based on Q3 that was the idea of differentiation across xDD and FRx from the beginning. In our understanding, the common part is used ONLYwhen the UE supports the given feature for both FR1+FR2/FDD+TDD or it supports the feature for FR1/FR2 AND it is capable of only FR1/FR2 and so on. |
| Vivo |  |  | For case1, we assume that UE sets XDD/FRX\_common feature based on the duplex mode(s) and frequency range(s) the UE supports, because the UE sets “support” for both XDD/FRX\_common feature, however there is no FR2 FDD case.  For other cases, the UE does not change XDD/FRX\_common feature setting based on the duplex mode(s) and frequency range(s) the UE supports. |
| Huawei | No |  | We have the same understanding as Nokia. To be more specific, we think that the common part should only be set only when:   1. The capability is applicable for both XDD and FRX and the value is the same for XDD and FRX supported by the UE; 2. The capability is only applicable for XDD and the value is the same as FDD/TDD supported by the UE; 3. The capability is only applicable for FRX and the value is the same as FR1/FR2 supported by the UE   We are then a bit confused then why in Q1&Q2 Nokia’s understanding is aligning with 1-a, this seems indeed the interpretation of 1-b. |
| CATT | No |  | See previous comment. |
| ZTE | No |  | In addition to case1~8 of interpretation 1-a, we understand the common part can also be set in following cases:  1）UE supports the feature for TDD, and the UE only supports TDD bands. In this case, XDD-Diff in common will be set to “supported”.  2）UE supports the feature for FR1, the UE only supports FR1 bands. In this case, FRX-Diff in common will be set to “supported”.  And so on. |
| OPPO | No |  |  |
| Ericsson | No |  | See above. |
| MediaTek | No |  |  |
| Qualcomm Incorporated | No | Interpretation 1-a | The network can simply assume the UE supports bands of all duplex modes and frequency ranges in determining the xDD and FRx capabilities as follows.   * The UE supports the feature in a given combination of duplex mode and frequency range, when the UE indicates the support in both the corresponding duplex mode and frequency range in the UE capability signaling. |
| Samsung | No |  | Same view with Nokia and Huawei. |
| Apple | No |  | Same as above. |
| Intel |  |  | Same view with Nokia and Huawei. |

## Discussion point 3: “the additional functionality applicable for FDD/TDD/FR1/FR2”

It was clarified for the **interpretation 2** that “the additional functionality applicable for TDD” means additional functionality that applies for TDD in all the FR modes the UE supports, and this applies similarly to other cases. So the corresponding specification text needs to be read as follows when the UE supports FR1 FDD, FR1 TDD and FR2 TDD.

3> include field fdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FDD FR1;

3> include field fdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for TDD FR1 and TDD FR2;

3> include field fdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FR1 FDD and FR1 TDD;

3> include field fdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FR2 TDD;

**Interpretation 1-a** and **Interpretation 1-b** however do not follow such interpretation, e.g. in case 4.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Support for the feature | | UE capability containers | | | | | |
| xDD-Diff in common | FRX-diff in common | fdd-Add | tdd-Add | fr1-Add | fr2-Add |
| **Case 4** | * FR1 FDD: ‘not supported’ * FR1 TDD: ‘not supported’ * FR2 TDD: ‘supported’ | Not supported | Not supported | Not included | Supported | Not included | Supported |

**Q5: Companies are requested to provide their comment on the observation above, if any.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Comment on interpretation 1-a/1-b/2** | **Comment** |
| Nokia | 1-a/1-b | Taking the Case 4 example here: As the xADD fields were set to (0,1) and (0,1) for xDD and FRx respectively this implies the UE supports both FR1 and FR2 as well as FDD and TDD but just wants to indicate that it supports a given feature only on TDD and FR2.  In fact, for interpretation 2 example from section 2.1.1 1-a table the corresponding case is Case 1 where xADD fields are not required to be used. |
| vivo |  | Same answer in Q4. |
| Huawei | 1-a/1-b | We think the capability is seen feature by feature. So as Nokia explained for a certain feature, this can be deduced accordingly. If the UE does not support any FR2 TDD band, then no capability shall be indicated “support” for FR2 TDD. |
| CATT | 1-a/1-b | Interpretation 2 seems not obvious from the existing spec. |
| ZTE |  | We understand the wording “additional functionality applicable for….” means the feature was set to “not supported” in common branch, but UE do support it for a specific case (FR1 or FR2 or TDD or FDD), thereby xdd-add-, frx-add is signaled. |
| OPPO | 1-a/1-b | We think that is the essential difference between interpretation 2 and 1-a/1-b and we think 1-a/1-b is correct. |
| Ericsson | 2 | See our comments in Q1. On top of that, we would like to highlight that there is no particular handling of e.g. “additional functionality applicable for FR1” – it should thus be a functionality applicable to all duplex modes the UE supports in FR1. Otherwise one would have to change the current procedures to make it applicable to e.g. FR1 FDD only, in some scenarios, FR1 TDD only, in some scenarios, and both FR1 FDD and TDD, in some scenarios. |
| MediaTek |  | We think that 1-a/1-b is more correct interpretation. |
| Qualcomm Incorporated | 2 / 1-a / 1-b | The interpretation 2 is unnecessarily complicated.  In interpretation 1-a, the network can simply apply “AND” operation in determining the UE capability as follows   * The UE supports the feature in a given combination of duplex mode and frequency range, when the UE indicates the support in both the corresponding duplex mode and frequency range in the UE capability signaling.   Interpretation 1-b requires additional handling in case 3 and case 8. |
| Samsung |  | We also think that 1-a/1-b is more correct interpretation |
| Apple | 1-a/1-b |  |
| Intel |  | This is reasonable interpretation if we assume that xdd/frx differentiate capabilities are considered for xdd/frx that UE supports. |

# Summary

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# Conclusion

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