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| 3GPP TR 38.839 V0.4.0 (2022-05) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Networks;  Simultaneous Rx/Tx band combinations  (Release 17) | |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions “shall” and “shall not” are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions “must” and “must not” are not used as substitutes for “shall” and “shall not”. Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction “may not” is ambiguous and is not used in normative elements. The unambiguous constructions “might not” or “shall not” are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions “can” and “cannot” are not substitutes for “may” and “need not”.

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions “is” and “is not” do not indicate requirements.

# 1 Scope

The present document is a technical report for simultaneous Rx/Tx band combinations. The TR includes principles to decide mandatory/optional capability for FDD-TDD, TDD-TDD band combinations in different cases, identify case by case issues and align the specification treatment for CA/DC/SUL band combinations.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: “Vocabulary for 3GPP Specifications”.

[2] RP-210890, “New WID on New WID on simultaneous Rx/Tx band combinations for CA, SUL, MR-DC and NR-DC”.

[3] 3GPP TS 38.101-1: “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”.

[4] 3GPP TS 38.101-2: “NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone”.

[5] 3GPP TS 38.101-3: “NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios”.

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

ACLR Adjacent Channel Leakage Ratio

ACS Adjacent Channel Selectivity

A-MPR Additional Maximum Power Reduction

BCS Bandwidth Combination Set

CA Carrier Aggregation

CC Component Carrier

DC Dual Connectivity

EIRP Equivalent Isotropically Radiated Power

EN-DC E-UTRA/NR DC

EVM Error Vector Magnitude

FDM Frequency Division Multiplexing

FR Frequency Range

ENBW The aggregated bandwidth of an E-UTRA sub-block and an adjacent NR sub-block

ITS Intelligent Transportation System

ITU-R Radiocommunication Sector of the International Telecommunication Union

MBW Measurement bandwidth defined for the protected band

MPR Allowed maximum power reduction

MSD Maximum Sensitivity Degradation

MCG Master Cell Group

NR New Radio

NS Network Signalling

NSA Non-Standalone, a mode of operation where operation of an other radio is assisted with an other radio

OOB Out-of-band

OOBE Out-of-band emission

OTA Over The Air

PRB Physical Resource Block

PSCCH Physical Sidelink Control Channel

PSSCH Physical Sidelink Shared Channel

RE Resource Element

REFSENS Reference Sensitivity

RF Radio Frequency

Rx Receiver

SCG Secondary Cell Group

SCS Subcarrier spacing

SEM Spectrum Emission Mask

SL Sidelink

SUL Supplementary uplink

TDM Time Division Multiplex

Tx Transmitter

UE User Equipment

UL MIMO Up Link Multiple Antenna transmission

ULSUP Uplink sharing from UE perspective

# 4 Background

## 4.1 Justification

Simultaneous Rx/Tx capability for inter-band CA, SUL and EN-DC band combinations were introduced from Rel-15. Specifically, for inter-band CA and EN-DC combination, the capability is used for TDD-TDD and TDD-FDD band combinations. According to the description of the capability, it is conditional mandatory and the condition is described in the field, i.e. indicated in the RAN4 spec which combinations should mandatorily support simultaneous Rx/Tx. For the combinations which have no such indication, the capability is optional, i.e. for UE supporting simultaneous Rx/Tx, the capability should be reported, otherwise, the capability is absent or not reported. Since the capability is important for network scheduling, it should be reported accurately.

However, there are no clear principles to judge whether a band combination can mandatorily support simultaneous Rx/Tx capability, especially for FDD-TDD band combinations. It is noted that in Rel-15, whether a FDD-TDD band combination shall support simultaneous Rx/Tx is based on operators’ request. But afterwards, most FDD-TDD band combinations are not indicated mandatorily in RAN4 specification. With increasing number of band combinations introduced after Rel-15, the applicability of simultaneous Rx/Tx capability for a band combination becomes more ambiguous in the specification, which is not helpful for both network scheduling and use of the capability for UE side. It is worth noting that if the capability is not indicated accurately by UE, unexpected performance loss may happen due to scheduling limitation.

Previously, the simultaneous Rx/Tx capability is focused on FR1 or FR1 and FR2, since now inter-band CA is also supported for FR2, the capability should also be considered for band combinations in FR2.

On the other hand, as the capability is defined for CA, SUL, MR-DC and NR-DC band combinations, and applicability of the corresponding requirements cover different specifications, e.g. TS 38.101-1 and TS 38.101-3, the way to treat simultaneous Rx/Tx capability as well as the requirements should be aligned among the specifications.

## 4.2 Objective

### 4.1.1 Objective and scope

The objectives of the WI are as follows:

1. Define clear principles for FDD-TDD or TDD-TDD band combinations for which can support or not support simultaneous Rx/Tx for FR1, FR2 and FR1+FR2.
   1. The principles should be studied firstly before detailed analysis carried out for specific band combinations
2. Identify for each FDD-TDD and TDD-TDD band combinations for CA, SUL, MR-DC and simultaneous Rx/Tx capability NR-DC based on technical analysis in parallel with the basket WI intending to introduce the band combination.
3. Align the specification treatment of simultaneous Rx/Tx capability for CA, SUL, MR-DC and NR-DC band combinations.

### 4.1.2 Way of working

The new request adding CA, SUL, MR-DC and NR-DC band combinations for evaluation of supporting simultaneous Rx/Tx capability should be submitted on RAN4 reflector before tdoc submission deadline to the next RAN4 meeting (1 week before the meeting). The basket WI will then be updated with the new requests and submitted to next RAN4 meeting for endorsement, before submission to RAN meeting for approval.

When the work is completed, all draft CRs related to one request will be submitted in the same RAN4 meeting to check consistency. If they are endorsed, the basket WI Rapporteur will merge all draft CRs from all requests in big CRs (one per TS specification). After the RAN4 meeting preceding a RAN meeting, those big CRs will be sent on RAN4 reflector for email approval (1 week) and, if agreed, they will be submitted to following RAN meeting.

# 5 Principles for simultaneous Rx/Tx UE capability

## 5.1 Applicability of simultaneous Rx/Tx capability

The following consensus was reached in RAN4 on applicability of simultaneous Rx/Tx capability.

* Simultaneous Rx/Tx capability for LTE CA band combination can be applied for the corresponding inter-band NR CA band combination.
* Same simultaneous Rx/Tx capability can be applied for the corresponding band combination among NR CA, NR DC and NR EN-DC
* If the mandatory simultaneous Rx/Tx capability applies for a band combination, the mandatory simultaneous Rx/Tx capability also applies for the band combination when the applicable band combination is a subset of a higher order band combination.

## 5.2 Rules to decide simultaneous Rx/Tx capability for a band combination

### 5.2.1 FR1+FR1 FDD-TDD band combination

*Editor note: This band combination category also includes SUL band combination where SUL band is derived from FDD band.*

For FR1+FR1 FDD-TDD band combination,

* Simultaneous Rx/Tx is the default capability in FDD-TDD FR1 band combinations
* For TDD-FDD combinations, the capability is mandatory without checking if there are no MSD issues and frequency range is not adjacent to each other for the band combinations
* For TDD-FDD combinations with REFSENS degradation due to self-interference, MSD caused by harmonics/IMD, etc. should be defined. For some band combinations that are close in frequency, e.g. bands n7 and n38, other methods to mitigate interference can be considered as well. Simultaneous Rx/Tx capability for this kind of special cases could be handled separately from those having MSD issues.
* Case by case analysis is considered for FR1 FDD-TDD band combination which may have difficulty to support simultaneous Rx/Tx operation, e.g. with large MSD. If a FR1 FDD-TDD band combination is identified which cannot support simultaneous Rx/Tx operation, a note similar to FR1 TDD-TDD band combination shall be indicated in the specification, and for such operation the minimum requirements are not applicable for this band combination. Otherwise, the FR1 FDD-TDD band combination with MSD can support simultaneous Rx/Tx operation.

### 5.2.2 FR1+FR1 TDD-TDD band combination

*Editor note: This band combination category also includes SUL band combination where SUL band is derived from TDD band.*

For FR1+FR1 TDD-TDD band combination, the simultaneous Rx/Tx capability should be studied case by case.

### 5.2.3 FR1+FR2 FDD-TDD band combination

For FR1+FR2 FDD-TDD band combination, the simultaneous Rx/Tx capability shall be mandatory if FR1 FDD band (<4GHz) is aggregated with FR2 TDD bands.

### 5.2.4 FR1+FR2 TDD-TDD band combination

For FR1+FR2 TDD-TDD band combination, the simultaneous Rx/Tx capability is mandatory for band combination with FR1 bands up to 5GHz and FR2 bands above 24GHz. Whether the FR1 bands can be extended to 7.125GHz is FFS until there are such FR1+FR2 band combinations available in RAN4.

### 5.2.5 FR2+FR2 TDD-TDD band combination

For FR2+FR2 TDD-TDD band combination, the simultaneous Rx/Tx capability should be studied case by case.

## 5.3 Release independent for simultaneous Rx/Tx

The following consensus was reached in RAN4 on release independent for simultaneous Rx/Tx capability.

* At least in the Rel-15 RAN4 specifications, the indication of mandatory/optional simultaneous Rx/Tx capability support for each combination should remain unchanged.
* For the FDD-TDD and TDD-TDD band combination introduced in Rel-17 38.101-1, 38.101-2, 38.101-3, the simultaneous Rx/Tx capability affiliated to the band combination is considered as release independent from Rel-15 if the band combination is mandatory to support simultaneous Rx/Tx in Rel-17.
  + For example: A band combination is specified as mandatory support of simultaneous Rx/Tx in Rel-17. If Rel-15 or Rel-16 UE wants to support this band combination with release independent manner, it shall support simultaneous Rx/Tx.

# 6 Specific cases for TDD-TDD band combinations

## 6.1 FR2+FR2 TDD-TDD band combination

For FR2+FR2 TDD-TDD band combinations introduced in Rel-17, it is clarified that the minimum requirements apply only when there is non-simultaneous Rx/Tx operation between inter-band NR carriers.

Table 6.1-1: Inter-band CA operating bands in FR2

|  |  |
| --- | --- |
| NR CA Band | NR Band |
| CA\_n257-n2591 | n257, n259 |
| CA\_n258-n2601 | n258, n260 |
| CA\_n258-n2611 | n258, n261 |
| CA\_n260-n2611,2 | n260, n261 |
| NOTE 1: The minimum requirements apply only when there is non-simultaneous Rx/Tx operation between inter-band NR carriers in the current version of this specification.  NOTE 2: The band combination was introduced in Rel-16. | |

# 7 Specific cases for FDD-TDD band combinations

*<To be added>*

# Annex A (informative): Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **Tdoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2021-04 | RAN4 #98-bis-e | R4-2107311 |  |  |  | TR skeleton for TR38.xxx Simultaneous RxTx band combinations | 0.01 |
| 2021-11 | RAN4  #101-e | R4-2119528 |  |  |  | R4-2114516, TP for TR 38.839: Principles for simultaneous Rx/Tx capability | 0.1.0 |
| 2022.01 | RAN4  #102-e | R4-2205579 |  |  |  | R4-2201955, TP for TR 38.839: Principles for simultaneous Rx/Tx capability | 0.2.0 |
| 2022.05 | RAN4  #103-e | R4-2209251 |  |  |  | R4-2206489, TP for TR 38.839: Update for simultaneous Rx/Tx capability | 0.3.0 |
| 2022.05 | RAN4  #103-e | R4-22XXXXX |  |  |  | R4-229740, TP for TR 38.839: Update for simultaneous Rx/Tx capability | 0.4.0 |