**3GPP TSG RAN Meeting #106 RP-243295**

**Madrid, Spain, December 9-12, 2024**

**Source: Apple, TELUS, Bell Mobility, BT plc, Skyworks Solutions Inc.**, **Anterix, Southern Linc, AT&T, Boost Mobile Network, Murata, Ericsson, Samsung, Qorvo, Nokia, Huawei, HiSilicon, vivo, OPPO, Qualcomm, Google, Sony, ZTE, Intel Corporation**

**Title: New WID on low band carrier aggregation via switching**

**Document for: Approval**

**Agenda Item: 9.1.4**

3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>
See also the [3GPP Working Procedures](http://www.3gpp.org/specifications-groups/working-procedures), article 39 and the TSG Working Methods in [3GPP TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm)

Title: New WID on low band carrier aggregation via switching

Acronym: NR\_LBCA\_Sw

Unique identifier: TBD

NOTE: For new WIs/SIs leave the Unique identifier empty and make a proposal for an Acronym.

 For a revised WI/SI: Take Unique identifier and acronym as shown in 3GPP workplan.

 If this is a RAN WID including Core and Perf. part, then Title, Acronym and Unique identifier refer to the feature WI.

 Please tick (X) the applicable box(es) in the table below:

 Either:

|  |  |
| --- | --- |
| **This WID includes a Core part** | **X** |
| **This WID includes a Performance part** | **X** |

 or:

|  |  |
| --- | --- |
| **This WID includes a Testing part** |  |
| **and it addresses the following 3GPP work area:** | **Radio Access** |  |
| **Core Network** |  |
| **Services** |  |

Potential target Release: *{Rel-19}*

NOTE: In case of contradiction with the target dates of clause 5, clause 5 determines the target release.

# 1 Impacts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Affects:** | UICC apps | ME | AN | CN | Others (specify) |
| **Yes** |  | X |  |  |  |
| **No** | X |  | X | X |  |
| **Don't know** |  |  |  |  |  |

# 2 Classification of the Work Item and linked work items

### 2.1 Primary classification

This description is either a …

|  |  |
| --- | --- |
|  | Study Item |

or a

|  |
| --- |
| Normative Work Item:*tick applicable boxes below* |
|  | Stage 1 |
| x | Stage 2 |
| x | Stage 3 |
|  | Other (e.g. testing) |

### 2.2 Parent Work Item

For a brand-new topic, use “N/A” in the table below. Otherwise indicate the parent Work Item.

|  |
| --- |
| Parent Work / Study Items  |
| Acronym | Working Group | Unique ID | Title (as in 3GPP Work Plan) |
| N/A |  |  |  |

NOTE: RAN agreed some time ago, that it describes the feature WI + Core/Perf. part WI or Testing part WI in one WID. Therefore the table above should include the feature WI data (In case the feature covers Core and Perf. part, please list under Working Group the leading WG of the Core part).

### 2.3 Other related Work Items and dependencies

|  |
| --- |
| Other related Work/Study Items (if any) |
| **Acronym** | Unique ID | Title | Nature of relationship |
| NR\_MC\_enh | RAN1 | 940094 | Multi-carrier enhancements for NR |

NOTE: Also related or dependent WIs/SIs in other TSGs shall be indicated here.

**Dependency on non-3GPP (draft) specification**:

# 3 Justification

Operator interest for aggregating low band spectrum has always been high during the entire history of the carrier aggregation feature, spanning LTE and NR specifications. Considering the practicalities of handset RF front end architectures available in the market today, the operators have requested 3GPP to consider specifying a solution based on a switching scheme which can potentially accommodate the related limitations.

A group of operators have submitted a contribution motivating this proposal previously in RP-241537 with the following problem statement:

- We are rich in mid-band spectrum (~300 MHz) which is effective closer to sites, however we have limited low-band spectrum (15 MHz) which propagates farther

- As our customers move between sites (urban and rural), they’re spending more time in low-band coverage.

- Low-band carries significant traffic volumes in urban and rural

- Our customers spend 15% of their day on average in urban low-bands, and 50% in rural low-bands

- Low-band capacity challenge has a huge impact on customer experience. Users will experience poor data speeds due to low-band congestion.

- Low-Low band CA is one way of solving this problem, however OEM’s have challenges to support low-low band CA and this ecosystem does not exist

- B29 is widely deployed in our network and is underutilized

- Bell and TELUS together has nationwide access to 10 MHz of MBS – DL only (n29) in 700MHz spectrum.

- Band 29 reaches 83% of Canada’s pop.

An operator-suggested scenario involves the aggregation of n5 with n29. From the duplexer design perspective, the frequency separation between the bands does not pose a feasibility challenge in general. However, the large fractional bandwidth carries additional implementation challenges for smartphones from the antenna design perspective. If the OEM chooses to implement a single antenna to aggregate these bands, then some tuning solution might become necessary to optimize performance. Optimization for both bands simultaneously can be challenging due to their separation in frequency. A potential design choice to implement additional antenna elements to support these combinations may carry cost and RF architecture complexity impacts in terms of additional components and volume in the form factor. Although the band combination is already specified in TS38.101-1, this practical implementation challenge may pose a barrier for the combination’s adoption in a wide range of devices.

The motivation paper accompanying this new work item proposal provides further details on the frequency arrangements of the considered band combinations and the proposed switching scenarios.

An enhancement of the 3GPP specification is needed to enable the following solution:

- Device needs to support switching: when the SCell operation istriggered, UE needs to switch to the SCell, and during the operation period there is no simultaneous Tx/Rx between the PCell and the SCell

- Device switches back to the PCell after the SCell operation is finished

Recognizing that this work item has impact on the RAN1 working group, the proposed objectives strive to minimize the impact on the physical layer procedures and are intended to implement the minimum useful functionality, from the operators’ perspective. Additionally, the operators have prioritized the suggested effort on the proposed band combinations with one example band combination to be completed as part of the proposed work item and the remaining combinations to be handled via the band combination basket work item approach.

# 4 Objective

### 4.1 Objective of SI or Core part WI or Testing part WI

Introduce physical layer procedures and requirements to enable low band carrier aggregation via switching according to the following objectives:

- Specify UE requirements, including at least switching gap (if needed), and corresponding physical layer procedures to allow switching between {case 1, case 2} [RAN4, RAN1]

- Case 1: Tx/Rx on FDD carrier 1 and no Rx on SDL carrier 2

- Case 2: Rx on SDL carrier 2 and no Tx/Rx on FDD carrier 1

- RAN1 to specify only a semi-static switching pattern based on RRC configuration, liaising with RAN2 and RAN4 as necessary

- Specify the switching delay and time mask for carrier switching [RAN4]

- Specify necessary RRM requirements [RAN4]

- Define the corresponding UE capabilities [RAN4, RAN2, RAN1]

- Consider the following deployment constraints:

- The carrier frequency for all cases is <1 GHz

- Co-located and synchronized network deployment for both carriers

- Both carriers are in a single TAG

- SCS 15KHz on both carriers

Note 1: Specify requirements for the feature with the following example band combination: CA\_n5A-n29A in this WI, with additional band combinations to be handled via the basket work item approach

Note 2: Strive to minimize the RAN1 impact

### 4.2 Objective of Performance part WI

- Specify RRM test cases

### 4.3 RAN time budget request (not applicable to RAN5 WIs/SIs)

NOTE: For all new RAN related WIs/SIs which are not led by RAN WG5 the WI/SI rapporteur has to fill out the attached Excel table to request time budgets for corresponding RAN WG meetings.
The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI.
One time unit (TU) corresponds to ~ 2 hours in the meeting.
If no TU is needed, then leave the field empty otherwise enter a number >0 in the field.

 For revisions of already approved WI/SI descriptions: Please remove the Excel table from the WID/SID's zip file. The time budgets are already recorded. If you want to modify them, then this has to be done via the status report and not via a revised WID/SID.

 If this WID is covering Core and Performance part, then please fill out one line for each part in the attached Excel table.

**additional comments to the time budget request in the attached Excel table:**

# 5 Expected Output and Time scale

*{If this WID covers both stage 2 and stage 3, clearly indicate the different completion dates.}*

|  |
| --- |
| **New specifications** *{One line per specification. Create/delete lines as needed}* |
| Type  | TS/TR number | Title | For info at TSG#  | For approval at TSG# | Remarks |
| Internal TR | 38.xxx | Low band carrier aggregation via switching | RAN #108 | RAN #109 | Rapporteur: TBD |

NOTE: If this is a RAN WI including Core and Perf. part, then all new Core part specs have to be listed first and then all new Perf. part specs. Indicate "Core part" or "Perf. part" under Remarks for each spec.
By default a new specs can only be new for one of both parts.

|  |
| --- |
| **Impacted existing TS/TR** *{One line per specification. Create/delete lines as needed}* |
| TS/TR No. | Description of change  | Target completion plenary# | Remarks |
| 38.213 | NR; Physical layer procedures for control | RAN #108 | Core part |
| 38.214 | NR; Physical layer procedures for data | RAN #108 | Core part |
| 38.300 | NR; NR and NG-RAN Overall description; Stage-2 | RAN #109 | Core part |
| 38.306 | NR; User Equipment (UE) radio access capabilities | RAN #109 | Core part |
|  |  |  |  |
|  |  |  |  |
| 38.331 | NR; Radio Resource Control (RRC); Protocol specification | RAN #109 | Core part |
| 38.101-1 | NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone NR;  | RAN #109 | Core part |
| 38.133 | NR; Requirements for support of radio resource management | RAN #109 | Core part |
| 38.133 | NR; Requirements for support of radio resource management | RAN #111 | Performance part |

NOTE: If this is a RAN WI including Core and Perf. part, then all new Core part specs have to be listed first and then all new Perf. part specs. Indicate "Core part" or "Perf. part" under Remarks for each spec.
If an existing spec is affected by both (Core part and Perf. part), then it has to be listed twice with appropriate approval dates.

# 6 Work item Rapporteur(s)

*{Mandatory: <FamilyName>, <GivenName>, <Company>, <email address>}*

*{Optional: <FamilyName>, <GivenName>, <Company>, <email address>: Secondary task(s).}*

*{The first listed Rapporteur is the work item primary Rapporteur. The role of a Rapporteur is further described in* [*www.3gpp.org/specifications-groups/delegates-corner/writing-a-new-spec*](http://www.3gpp.org/specifications-groups/delegates-corner/writing-a-new-spec)*.
Secondary co-Rapporteur(s) are possible for specific secondary task(s)}*.

NOTE: The first listed Rapporteur has the overall responsibility for this WI (incl all secondary tasks).

# 7 Work item leadership

RAN WG4

RAN WG1 secondary

# 8 Aspects that involve other WGs

NOTE: For RAN WIs: Section 8 applies only toWGs outside of TSG RAN because all RAN WG aspects have to be covered in section 4.

# 9 Supporting Individual Members

|  |
| --- |
| Supporting IM name |
| Anterix |
| Apple |
| AT&T |
| Bell Mobility |
| Boost Mobile Network |
| BT plc |
| Ericsson |
| Google |
| HiSilicon |
| Huawei |
| Intel Corporation |
| Murata |
| Nokia |
| OPPO |
| Qorvo |
| Qualcomm |
| Samsung |
| Skyworks Solutions Inc. |
| Sony |
| Southern Linc |
| TELUS |
| vivo |
| ZTE |
|  |