**3GPP TSG-RAN WG4 Meeting # 109 R4-2318168**

**Chicago, US, November 13 – November 17, 2023**

**Agenda item:** 8.10.3

**Source:** Moderator (vivo)

**Title:** Topic summary for [109][212] NR\_BWP\_wor

**Document for:** Information

# Introduction

This topic summary covers following agenda for WI of completion of specification support for bandwidth part operation without restriction.

8.10 Completion of specification support for bandwidth part operation without restriction in NR [NR\_BWP\_wor]

8.10.1 General and work plan

8.10.2 RRM core requirements

# Topic #1: General

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318482 | Vodafone | ***Proposal 1:*** ***Adopt the following WF for Issue 1-4:*****Issue 1-4: Requirements/UE behaviour for UE supporting both option B-1-1 and A*** For UE supporting both option B-1-1 and option A, UE shall perform L1 measurement according to network configuration, there is no need to define requirements/ UE behaviour.

***Proposal 2:*** ***Adopt the following WF for Issue 1-5:*****Issue 1-5: Requirements/UE behaviour for UE supporting both option C and A*** For UE supporting both option C and option A, UE shall perform L1 measurement according to network configuration, there is no need to define requirements/ UE behaviour.

***Proposal 3:*** ***A UE supporting both Option B-1-1 and Option B-1-2 shall NOT indicate support of option B-1-1 if interruptions occur due to supporting option B-1-2 in the other band(s) in the same band combination.***  |
| R4-2318930 | CMCC | **Proposal 1: For UE supporting both option B-1-1 and option A, UE shall perform L1 measurement according to network configuration, there is no need to define requirements/ UE behaviour.** **Proposal 2: For UE supporting both option C and option A, UE shall perform L1 measurement according to network configuration, there is no need to define requirements/ UE behaviour.** **Proposal 3: A UE shall not indicate support of both option B-1-1 and option B-1-2 per BC.**  |
| R4-2319036 | vivo | **Observation 1: there is no obvious gain if option A and option B-1-1 are supported simultaneously.** **Proposal 1:** **For UE supporting both option B-1-1 and A, if CSI-RS is configured within the active BWP for L1 measurements, then UE is NOT expected to perform RLM/BFD/BM based on CD-SSB outside active BWP.****Proposal 2:** **It is clarified in the SSB based L1 measurement requirements that if UE supports both option B-1-1 and option A then the UE is not required to measure the SSB if it is outside active BWP.****Proposal 3:** **For UE supporting both option C and A, both CSI-RS and NCD-SSB within the active BWP can be configured for L1 measurements. No additional requirements/UE behaviour is needed.****Proposal 4:** **A UE shall not indicate support of both option B-1-1 and option B-1-2 per BC.****Proposal 5:** **If option 4 is agreeable, LS to RAN2 on the RAN4 agreements that a UE shall not indicate support of both option B-1-1 and option B-1-2 per BC as it would impact RAN2 spec.** |
| R4-2319037 | vivo | **LS on further conclusion on BWP operation without restriction** |
| R4-2320009 | Huawei, HiSilicon | **Proposal 1: For UE supporting both option B-1-1 and A, if configured by NW, UE should perform L1 measurement on both CD-SSB outside active BWP and CSI-RS within active BWP. No additional requirements will be defined for such scenario.****Proposal 2: For UE supporting both option C and A, if configured by NW, UE should perform L1 measurement on both NCD-SSB within active BWP and CSI-RS within active BWP. No additional requirements will be defined for such scenario.****Proposal 3: RAN4 not to discuss reporting behaviour for UE supporting both option B-1-1 and B-1-2.** |
| R4-2320289 | Nokia, Nokia Shanghai Bell | 1. A UE supporting both option B-1-1 and A shall perform RLM/BFD/BM measurements according to network configuration.
2. A UE supporting both option C and A shall perform RLM/BFD/BM measurements according to network configuration.
3. UE shall not indicate support of B-1-1 in a band if interruptions occur in the band due to support of B-1-2 in another band.
 |
| R4-2320694 | Ericsson | **UE behaviour when supporting options B-1-1 and A:*** **Observation #1**: SSB based BM/RLM/BFD and CSI-RS based BM/RLM/BFD exist since Rel-15. Based on the general principle since Rel-15 if the UE supports option B-1-1 and if the CSI-RS is within the active BWP then the UE should perform the BM/RLM/BFD according to both option B-1-1 and option A.
* **Proposal #1**: RAN4 does not need to define additional requirements or clarify UE behaviour for the UE supporting options B-1-1 and A.

**UE behaviour when supporting options C and A:*** **Observation #2**: This scenario is somewhat analogous to the UE supporting option B-1-1 (i.e. BM/RLM/BFD based on SSB) and option A.
* **Proposal #2**: RAN4 does not need to define additional requirements or clarify UE behaviour for the UE supporting options C and A.

**UE behaviour when supporting options B-1-1 and B-1-2:*** **Observation #3**: Option B-1-1 and option B-1-2 are mutually exclusive since the former shall not cause any interruption while the latter is allowed to cause interruptions.
* **Proposal #3**: No clarification is needed regarding UE behaviour regarding UE supporting both option B-1-1 and option B-1-2 per BC.
 |
| R4-2318597 | Apple | **Proposal 1: For UE supporting both option B-1-1 and option A, UE shall perform L1 measurement according to network configuration, there is no need to define requirements/ UE behaviour.****Proposal 2: For UE supporting both option C and option A, UE shall perform L1 measurement according to network configuration, there is no need to define requirements/ UE behaviour.****Proposal 3: UE shall not indicate support of both option B-1-1 and option B-1-2 per BC.****Observation 1: for UE supporting both option B-1-1 and C, it is unclear which SSB UE shall measure when active BWP does NOT contain neither CD-SSB nor NCD-SSB. Technically, UE shall be able to measure any of them as long as both CD-SSB and NCD-SSB are within CBW.****Proposal 4: for UE supporting both option B-1-1 and C, RAN4 shall discuss which SSB UE shall measure when active BWP does NOT contain neither CD-SSB nor NCD-SSB. Candidate solutions:*** **Option 1: Leave it to network control.**
* **Option 2: UE always measures CD-SSB unless the active BWP contains NCD-SSB.**
 |
| R4-2318334 | CATT | **Proposal 2:** **No need to define requirements for supporting multiple options.**  |
| R4-2320931 | MediaTek inc. | **Proposal 1: RAN4 shall not specify any restriction on which reference signals (i.e. CSI-RS or CD-SSB) the UE should use when the UE supports Option B-1-1 and Option A. UE simply follows network configurations for measurements.****Proposal 2: RAN4 shall not specify any restriction on which reference signals (i.e. CSI-RS or NCD-SSB) the UE should use when the UE support Option C and Option A. UE simply follows network configurations for measurements.** |

*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: Requirements for combined options

*Sub-topic description: Background.*

*Open issues and candidate options before f2f meeting:*

**Issue 1-4: Requirements/UE behaviour for UE supporting both option B-1-1 and A**

* Proposals
	+ Option 1a: (Vodafone, CMCC, Nokia, Apple, MTK)
		- For UE supporting both option B-1-1 and option A, UE shall perform L1 measurement according to network configuration, there is no need to define requirements/ UE behaviour.
	+ Option 1b: (Huawei)
		- For UE supporting both option B-1-1 and A, if configured by NW, UE should perform L1 measurement on both CD-SSB outside active BWP and CSI-RS within active BWP. No additional requirements will be defined for such scenario.
	+ Option 2: (vivo)
		- For UE supporting both option B-1-1 and A, if CSI-RS is configured within the active BWP for L1 measurements, then UE is NOT expected to perform RLM/BFD/BM based on CD-SSB outside active BWP.
		- It is clarified in the SSB based L1 measurement requirements that if UE supports both option B-1-1 and option A then the UE is not required to measure the SSB if it is outside active BWP.
	+ Option 3: (CATT)
		- No need to define requirements for supporting multiple options.
* Recommended WF
	+ Further discuss.

**Issue 1-5: Requirements/UE behaviour for UE supporting both option C and A**

* Proposals
	+ Option 1a: (Vodafone, CMCC, Nokia, Apple, MTK)
		- For UE supporting both option C and option A, UE shall perform L1 measurement according to network configuration, there is no need to define requirements/ UE behaviour.
	+ Option 1b: (vivo, Huawei)
		- For UE supporting both option C and A, both CSI-RS and NCD-SSB within the active BWP can be configured for L1 measurements. No additional requirements/UE behaviour is needed.
	+ Option 2: (CATT)
		- No need to define requirements for supporting multiple options.
* Recommended WF
	+ For UE supporting both option C and A, if configured by NW, UE should perform L1 measurement on both NCD-SSB within active BWP and CSI-RS within active BWP. No additional requirements/UE behaviour is needed.

**Issue 1-6: Reporting behaviour for UE supporting both option B-1-1 and B-1-2**

* Proposals
	+ Option 1a: (Vodafone, Nokia)
		- A UE supporting both Option B-1-1 and Option B-1-2 shall NOT indicate support of option B-1-1 if interruptions occur due to supporting option B-1-2 in the other band(s) in the same band combination.
	+ Option 1b: (vivo, CMCC, Apple)
		- A UE shall not indicate support of both option B-1-1 and option B-1-2 per BC.
	+ Option 2: (Huawei)
		- RAN4 not to discuss reporting behaviour for UE supporting both option B-1-1 and B-1-2.
	+ Option 3: (Ericsson)
		- No clarification is needed regarding UE behaviour regarding UE supporting both option B-1-1 and option B-1-2 per BC.
* Recommended WF
	+ Further discuss.

**Issue 1-7: LS to RAN2 on RAN4 conclusions**

* Proposals
	+ Option 1: (vivo)
		- LS to RAN2 on conclusion of issue 1-6 if necessary.
* Recommended WF
	+ Further discuss.

**Issue 1-8: Requirements/UE behaviour for UE supporting both option C and B-1-1**

*For UE supporting both option B-1-1 and C, a scenario needs to be discussed is the case wherein UE active BWP does NOT contain neither CD-SSB nor NCD-SSB, shall UE measure CD-SSB or NCD-SSB?*



* Proposals
	+ Option 1: (Apple)
		- for UE supporting both option B-1-1 and C, RAN4 shall discuss which SSB UE shall measure when active BWP does NOT contain neither CD-SSB nor NCD-SSB. Candidate solutions:
			* Option 1: Leave it to network control.
			* Option 2: UE always measures CD-SSB unless the active BWP contains NCD-SSB.
* Recommended WF
	+ Further discuss.

# Topic #2: RRM Core requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318334 | CATT | **Proposal 1: The requirements for the case when handover directly to NCD-SSB for 2Rx RedCap UE can be reused for the non-RedCap UE supporting option C.** **Proposal 3: For option B-1-2, existing SSB based BM/RLM/BFD measurement requirements without gap can apply.** **Proposal 4: For option B-1-2, the interruption requirements can be defined based on HARQ ACK/NACK loss framework with a maximum missed ACK/NACK rate up to 0.5%. And the length for each interruption shall not exceed the RF retuning time (0.5ms for FR1 and 0.25ms for FR2).**  |
| R4-2318597 | Apple | **Proposal 5: for handover requirements for the additional handover cases involving NCD-SSB in source and/or target cell, existing handover requirements for RedCap UE with 2Rx are used as baseline. Wording can be directly discussed in CR.****Proposal 6: Interruption length for option B-1-2: Interruption length is max (slot length of the cell, 0.5ms) for FR1 and max(slot length of the cell, 0.25ms) for FR2.****Proposal 7: the following options can be considered to define interruption for option B-1-2:*** **Option 1: define explicit interruption length without mentioning interruption ratio. (preferred)**
* **Option 2: X%=interruption length \* 2 / L1-RS periodicity, where X% is the interruption ratio, interruption length is 0.5ms in FR1 and 0.25ms in FR2, and L1-RS periodicity is the periodicity of SSB configured for BM/RLM/BFD after taking scaling factor P into account.**
 |
| R4-2318598 | Apple | **CR for UE supporting option B-1-1** |
| R4-2318931 | CMCC | **Proposal 1: Existing handover requirements and handover scenarios of RedCap UE with 2Rx can be applied to option C.****Proposal 2:** * **For UE supporting option C, the handover requirements for known inter-frequency cell are specified as follows.**
	+ **if the measured SSB is the target SSB for handover of the target cell, Tsearch = 0ms;**
	+ **if the measured SSB and the target SSB for handover belong to the same NR target cell and fulfil the following conditions, Tsearch = Trs ms:**
		- **CD-SSB in initial DL BWP is the measured SSB and NCD-SSB in first active DL BWP is the target SSB for handover**
		- **NCD-SSB in DL BWP is the measured SSB and CD-SSB in initial DL BWP is the target SSB for handover**
		- **Both measured SSB and the target SSB for handover are NCD-SSB within different DL BWPs**

**Proposal 3: Interruption length is 0.5ms for FR1 and 0.25ms for FR2.****Proposal 4: The interruption requirements can be defined based on HARQ ACK/NACK loss framework with a maximum missed ACK/NACK rate up to 0.5%.**  |
| R4-2319038 | vivo | **Proposal 1: The handover requirements for option C should be captured in the clause for legacy handover requirements. Existing handover requirements for RedCap UE with 2Rx are reused as baseline as much as possible and necessary changes can be made.****Proposal 2: For UE supporting option C, the handover requirements for known inter-frequency cell are specified as follows.****if the measured SSB is the target SSB for handover of the target cell, Tsearch = 0ms;** **if the measured SSB and the target SSB for handover belong to the same NR target cell and fulfil the following conditions, Tsearch = Trs ms:****- CD-SSB in initial DL BWP is the measured SSB and NCD-SSB in first active DL BWP is the target SSB for handover****- NCD-SSB in a DL BWP is the measured SSB and CD-SSB in initial DL BWP is the target SSB for handover****- Both measured SSB and the target SSB for handover are NCD-SSB within different DL BWPs****Proposal 3: For UE supporting option C, the handover requirements in terms of Tsearch for other cases than known inter-frequency cell are to reuse the requirements for RedCap UE with 2Rx.****Proposal 4: RF retuning time is 0.5ms for FR1 and 0.25ms for FR2 for option B-1-2.****Proposal 5:** **Requirements for interruption length is defined in slot granularity by rounding up RF retuning time and 1 additional slot is added for async case.****Proposal 6: For UE supporting option B-1-2, the probability of missed ACK/NACK is 1% for ALL RLM/BFM/BM(L1-RSRP/L1-SINR) measurements based on SSB outside active BWP.** |
| R4-2319039 | vivo, Vodafone | **Draft CR on handover requirements for option C for BWP operation without restriction** |
| R4-2320010 | Huawei, HiSilicon | **Proposal 1: Existing HO requirements for RedCap UE with 2Rx are reused for option C as baseline.****Proposal 2: Interruption requirements for B-1-2 are defined based on interruption length of 0.5ms for FR1 and 0.25ms for FR2.****Proposal 3: For B-1-2, interruption ratio X% for each applicable serving cell is defined as** **X%=interruption length \* 2 / L1 periodicity,****where** * **interruption length is 0.5ms for FR1 and 0.25ms for FR2, and**
* **L1 periodicity is max(lower bound, SSB periodicity), FFS value of the lower bound**
 |
| R4-2320011 | Huawei, HiSilicon | **draftCR on L1 measurement requirements for option C** |
| R4-2320290 | Nokia, Nokia Shanghai Bell | 1. Option 1, interruption length shall not exceed 0.5ms for FR1 and 0.25ms for FR2.
2. Any interruption due to RLM, BFD and BM shall be limited to be occurring just before and just after the CD-SSB.

Interruption length requirements (in number of slots) for option B-1-2:1. Interruptions for option B-1-2 are caused by RF retuning on serving carrier (PCell).
2. Interruption length in slots shall not exceed 0.5ms for FR1 and 0.25ms for FR2.

Interruption ratio for option B-1-2:1. Randomly dropped packages due to retuning has significant impact on the system operation and performance.
2. A high upper limit of interruption ratio will deem B-1-2 infeasible as a solution in practical deployment scenarios.
3. Option 2a. Interruption ratio shall not exceed [1.0]%. A lower interruption ratio is also agreeable.

Principle for specifying handover requirements for Option C:1. The existing handover requirements defined in clause 6.1.1 (NR Handover) of TS 38.133 are also applicable for HO when the NCD-SSB is in the active DL BWP of the source cell.

Tsearch in handover requirements for known inter-frequency cell:1. Current handover requirements for known inter-frequency cell, including Tsearch, applies for option C.

Tsearch in handover requirements for other cases than known inter-frequency cell:1. Current handover requirements for other cases than known inter-frequency cell, including Tsearch, applies for option C.
 |
| R4-2320695 | Ericsson | **Option C: Principle of HO requirements*** **Proposal #1**: Existing handover requirements and handover scenarios of RedCap UE with 2Rx can be applied to option C.

**Option C: Tsearch in HO requirements*** **Observation #1**: Option 2 in issue 4-5 does not contain the case when the measured SSB is the same as the SSB of the target known inter-frequency cell.
* **Observation #2**: Tsearch for inter-frequency known cell when the measurement SSB and target SSB are different should NOT be more relaxed for UE supporting Option C compared to RedCap 2Rx UE
* **Proposal #2**: Regardless of which option under issue 4-5 is chosen, Tsearch = 0ms if the measured SSB is the target SSB for handover of the target cell.
* **Proposal #3**: We support Option 1 under issue 4-4.
* **Proposal #4**: Tsearch in handover requirements for cases other than known inter-frequency cell for UE supporting Option C are reused from the corresponding Tsearch requirements defined for RedCap UE with 2Rx

**Option B-1-2: Interruption length in ms:*** **Observation #3**: The interruption length in ms should be the actual RF tuning time specified in TS 38.133 for FR1 (0.5 ms) and FR2 (0.25 ms), which is the same regardless of the cause of the RF tuning.
* **Proposal #5**: Interruption length in ms is 0.5ms for FR1 and 0.25ms for FR2.

**Option B-1-2: Interruption length requirement in slots:*** **Observation #4**: The proposed interruption length in Option 2 in issue 5-2b is still expressed in ms and not in slots.
* **Observation #5**: The length of each interruption depends on RF tuning (interruption length in ms) as well as on additional factors such as slot length, CA/DC, synchronization level (e.g. sync or async DC) etc.
* **Proposal #6**: The maximum length of each interruption based on the interruption length in ms and additional factors, is defined as follows:

***Interruption length in NR CA:*****Table 1: Interruption due to RLM and RLP measurements on other active serving cell in inter-band NR CA**

|  |  |  |
| --- | --- | --- |
|  | **NR Slot length (ms) of victim cell** | **Interruption length X2 (slots)** |
| 0 | 1 |  | 1  |
| 1 | 0.5 |  | 1  |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 2  |
|  |  | Either aggressor cell or victim cell is on FR1 | 3 |
| 3 | 0.125 | Aggressor cell is on FR2 | 4  |
|  |  | Aggressor cell is on FR1 | 5  |
| 5 | 0.03125 | Aggressor cell is on FR1 | 17 |
| 6 | 0.015625 | Aggressor cell is on FR1 | 33 |

**Table 2: Interruption due to RLM and RLP measurements on other active serving cell in intra-band NR CA**

|  |  |  |
| --- | --- | --- |
|  | **NR Slot length (ms)** | **Interruption length (slots)** |
| 0 | 1 | 1 + NSSB |
| 1 | 0.5 | 1 + NSSB |
| 2 | 0.25 | 2 + NSSB |
| 3 | 0.125 | 4 + NSSB |
| 5 | 0.03125 | 16 + NSSB |
| 6 | 0.015625 | 32 + NSSB |
| NOTE: NSSB is the number of slots containing the configured SSB(s) for RLM/BFD, CBD or L1-RSRP/L1-SINR |

***Interruption length in NR DC:**** For synchronous inter-band NR-DC, the interruption length is the same as in table 2.
* For asynchronous inter-band NR-DC, the interruption length is shown in table 3.

**Table 3: Interruption due to RLM and RLM on other active serving cell in asynchronous inter-band NR-DC**

|  |  |  |
| --- | --- | --- |
|  | **NR Slot length (ms) of victim cell** | **Interruption length X2 (slots)** |
| 0 | 1 |  | 1  |
| 1 | 0.5 |  | 1  |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 3  |
|  |  | Either aggressor cell or victim cell is on FR1 | 4 |
| 3 | 0.125 | Aggressor cell is on FR2 | 5  |
|  |  | Aggressor cell is on FR1 | 6  |
| 5 | 0.03125 | Aggressor cell is on FR1 | 18 |
| 6 | 0.015625 | Aggressor cell is on FR1 | 34 |

***Interruption length in EN-DC and NE-DC:***For inter-band EN-DC, the interruption on the active LTE serving cell shall not exceed:* 1 subframe for synchronous inter-band EN-DC or
* 2 subframes for asynchronous inter-band EN-DC.

For synchronous intra-band EN-DC, the interruption shall not exceed:* the duration of NSSB + 2 subframes.

For inter-band NE-DC, the interruption on the active LTE serving cell shall not exceed:* 1 subframe for synchronous inter-band NE-DC or
* 2 subframes for asynchronous inter-band NE-DC.

For synchronous intra-band NE-DC, the interruption shall not exceed:* the duration of NSSB + 2 subframes.

Where, NSSB is the number of slots containing the configured SSB(s) for RLM/BFD, CBD or L1-RSRP/L1-SINR.**Option B-1-2: Interruption ratio/probability requirement:*** **Observation #6**: Option 3 (X%=interruption length \* 2 / L1-RS periodicity) will cause large number of interruptions (e.g. 5% for 20 ms RLM-RS period) resulting in significant outage due to extensive loss of data scheduling, CSI and HARQ feedback.
* **Observation #7**: Option 2 (1% interruption probability) is a reasonable compromise between the data loss and the UE power saving.
* **Proposal #7**: The probability of missed ACK/NACK for a UE supporting Option B-1-2, due to interruptions caused by UE performing BM/RLM/BFD measurements based on SSB outside the active BWP, shall not exceed 1 %.
 |
| R4-2320696 | Ericsson | **Draft CR on interruption for BWP operation without restriction for option B-1-2 in 36.133** |
| R4-2320931 | MediaTek inc. | **Proposal 3: RAN4 shall agree on the below interruption requirements to define the requirements for Option B-1-2.**

|  |
| --- |
| * **TCycle is used for interruption requirements specification implementation:**
	+ The UE is allowed to cause a certain interruption every TCycle period with a certain interruption ratio,
		- Interruption length (L) = 0.5 ms in FR1 and L = 0.25 ms in FR2;
	+ 2L is needed for each TCycle;
	+ Lower bound of TCycle = 40ms.
	+ FFS whether the UE is required to Tx/Rx while measuring the SSB, if yes, FFS scheduling restrictions requirements.
* **Interruption ratio (x%) =** $\frac{2 \* interruption length }{TCycle}=\frac{2 \* interruption length }{max(40 ms,   L1\\_RS periodicity)}$
	+ L1-RS periodicity: is the periodicity of SSB configured for BM/RLM/BFD after taking scaling factor P into account.
* **Interruption length requirements are defined in number of slots for option B-1-2.**
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| R4-2320932 | MediaTek inc. | **Draft CR for Option B-1-2 applicability conditions** |
| R4-2320959 | Qualcomm Incorporated | **Proposal 1: For Option B-1-2, the interruption requirements are defined as below:*** **Interruption length is larger than 0.5ms and smaller than 1ms.**
* **Interruption ratio is not smaller than 1.25%.**
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*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1: Requirements for Option C

*Sub-topic description: Background.*

*Open issues and candidate optio ns before f2f meeting:*

**Issue 4-1: Principle for specifying handover requirements for Option C**

* Proposals
	+ Option 1: (Apple)
		- For handover requirements for the additional handover cases involving NCD-SSB in source and/or target cell, existing handover requirements for RedCap UE with 2Rx are used as baseline. Wording can be directly discussed in CR.
	+ Option 2: (CMCC, Ericsson)
		- Existing handover requirements and handover scenarios of RedCap UE with 2Rx can be applied to option C.
	+ Option 3: (vivo)
		- The handover requirements for option C should be captured in the clause for legacy handover requirements. Existing handover requirements for RedCap UE with 2Rx are reused as baseline as much as possible and necessary changes can be made.
	+ Option 4: (Huawei)
		- Existing HO requirements for RedCap UE with 2Rx are reused for option C as baseline.
	+ Option 5: (Nokia)
		- The existing handover requirements defined in clause 6.1.1 (NR Handover) of TS 38.133 are also applicable for HO when the NCD-SSB is in the active DL BWP of the source cell.
* Recommended WF
	+ Discuss draft CR R4-2319039 directly.

**Issue 4-4: Tsearch in handover requirements for known inter-frequency cell**

* Proposals
	+ Option 1: (vivo, CMCC, Ericsson)
		- For UE supporting option C, the handover requirements for known inter-frequency cell are specified as follows.
			* if the measured SSB is the target SSB for handover of the target cell, Tsearch = 0ms;
			* if the measured SSB and the target SSB for handover belong to the same NR target cell and fulfil the following conditions, Tsearch = Trs ms:
				+ CD-SSB in initial DL BWP is the measured SSB and NCD-SSB in first active DL BWP is the target SSB for handover
				+ NCD-SSB in DL BWP is the measured SSB and CD-SSB in initial DL BWP is the target SSB for handover
				+ Both measured SSB and the target SSB for handover are NCD-SSB within different DL BWPs
	+ Option 2: (Nokia)
		- Current handover requirements in section 6.1.1 for known inter-frequency cell, including Tsearch, applies for option C.
* Recommended WF
	+ Further discuss.

**Issue 4-5: Tsearch in handover requirements for other cases than known inter-frequency cell**

* Proposals
	+ Option 1: (vivo, Ericsson)
		- For UE supporting option C, the handover requirements in terms of Tsearch for other cases than known inter-frequency cell are to reuse the requirements for RedCap UE with 2Rx.
	+ Option 2: (Nokia)
		- Current handover requirements in section 6.1.1 for other cases than known inter-frequency cell, including Tsearch, applies for option C.
* Recommended WF
	+ Agree on option 1.
		- Note: For other cases than known inter-frequency cell, current handover requirements in section 6.1.1 and the handover requirements for RedCap UE with 2Rx are the same in terms of Tsearch.

### Sub-topic 2-4: Requirements for Option B-1-2

*Sub-topic description: Background.*

*Open issues and candidate optio ns before f2f meeting:*

**Issue 5-2a: Interruption length (in ms) for option B-1-2**

* Proposals
	+ Option 1: (CATT, CMCC, Apple, vivo, Huawei, Ericsson)
		- Interruption length is 0.5ms for FR1 and 0.25ms for FR2.
	+ Option 2: (Qualcomm)
		- Interruption length is larger than 0.5ms and smaller than 1ms.
* Recommended WF
	+ Discuss issue 5-2c for interruption ratio requirements firstly, where there is package being proposed in which interruption length is included.

**Issue 5-2b-1: Principle of defining interruption length requirements (in number of slots) for option B-1-2**

* Proposals
	+ Option 1: (vivo)
		- Requirements for interruption length is defined in slot granularity by rounding up RF retuning time and 1 additional slot is added for async case.
	+ Option 2: (Apple)
		- Interruption length for option B-1-2: Interruption length is max (slot length of the cell, 0.5ms) for FR1 and max(slot length of the cell, 0.25ms) for FR2.
	+ Option 3: (Nokia)
		- Interruption length in slots shall not exceed 0.5ms for FR1 and 0.25ms for FR2.
	+ Option 4: (Ericsson)
		- The length of each interruption depends on RF tuning (interruption length in ms) as well as on additional factors such as slot length, CA/DC, synchronization level (e.g. sync or async DC) etc.
* Recommended WF
	+ If there is no principle being agreeable to derive interruption requirements (in number of slots), it is to discuss directly if issue 5-2b is agreeable.

**Issue 5-2b: Interruption length requirements (in number of slots) for option B-1-2**

* Proposals
	+ Option 1: (Ericsson)
		- The maximum length of each interruption based on the interruption length in ms and additional factors, is defined as follows:

***Interruption length in NR CA:***

**Table 1: Interruption due to RLM and RLP measurements on other active serving cell in inter-band NR CA**

|  |  |  |
| --- | --- | --- |
|  | **NR Slot length (ms) of victim cell** | **Interruption length X2 (slots)** |
| 0 | 1 |  | 1  |
| 1 | 0.5 |  | 1  |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 2  |
|  |  | Either aggressor cell or victim cell is on FR1 | 3 |
| 3 | 0.125 | Aggressor cell is on FR2 | 4  |
|  |  | Aggressor cell is on FR1 | 5  |
| 5 | 0.03125 | Aggressor cell is on FR1 | 17 |
| 6 | 0.015625 | Aggressor cell is on FR1 | 33 |

**Table 2: Interruption due to RLM and RLP measurements on other active serving cell in intra-band NR CA**

|  |  |  |
| --- | --- | --- |
|  | **NR Slot length (ms)** | **Interruption length (slots)** |
| 0 | 1 | 1 + NSSB |
| 1 | 0.5 | 1 + NSSB |
| 2 | 0.25 | 2 + NSSB |
| 3 | 0.125 | 4 + NSSB |
| 5 | 0.03125 | 16 + NSSB |
| 6 | 0.015625 | 32 + NSSB |
| NOTE: NSSB is the number of slots containing the configured SSB(s) for RLM/BFD, CBD or L1-RSRP/L1-SINR |

***Interruption length in NR DC:***

* For synchronous inter-band NR-DC, the interruption length is the same as in table 2.
* For asynchronous inter-band NR-DC, the interruption length is shown in table 3.

**Table 3: Interruption due to RLM and RLM on other active serving cell in asynchronous inter-band NR-DC**

|  |  |  |
| --- | --- | --- |
|  | **NR Slot length (ms) of victim cell** | **Interruption length X2 (slots)** |
| 0 | 1 |  | 1  |
| 1 | 0.5 |  | 1  |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 3  |
|  |  | Either aggressor cell or victim cell is on FR1 | 4 |
| 3 | 0.125 | Aggressor cell is on FR2 | 5  |
|  |  | Aggressor cell is on FR1 | 6  |
| 5 | 0.03125 | Aggressor cell is on FR1 | 18 |
| 6 | 0.015625 | Aggressor cell is on FR1 | 34 |

***Interruption length in EN-DC and NE-DC:***

For inter-band EN-DC, the interruption on the active LTE serving cell shall not exceed:

* 1 subframe for synchronous inter-band EN-DC or
* 2 subframes for asynchronous inter-band EN-DC.

For synchronous intra-band EN-DC, the interruption shall not exceed:

* the duration of NSSB + 2 subframes.

For inter-band NE-DC, the interruption on the active LTE serving cell shall not exceed:

* 1 subframe for synchronous inter-band NE-DC or
* 2 subframes for asynchronous inter-band NE-DC.

For synchronous intra-band NE-DC, the interruption shall not exceed:

* the duration of NSSB + 2 subframes.

Where, NSSB is the number of slots containing the configured SSB(s) for RLM/BFD, CBD or L1-RSRP/L1-SINR.

* Recommended WF
	+ Agree on option 1, if conclusion of issue 5-2a is option 1.

**Issue 5-2c: Interruption ratio requirements (package) for option B-1-2**

*In the previous RAN4 meeting, it was agreed to introduce interruption length and interruption ratio requirements for Option B-1-2.*

* Proposals
	+ Option 1a: (CATT)
		- For option B-1-2, existing SSB based BM/RLM/BFD measurement requirements without gap can apply.
		- For option B-1-2, the interruption requirements can be defined based on HARQ ACK/NACK loss framework with a maximum missed ACK/NACK rate up to 0.5%.
		- And the length for each interruption shall not exceed the RF retuning time (0.5ms for FR1 and 0.25ms for FR2).
	+ Option 1b: (CMCC)
		- The interruption requirements can be defined based on HARQ ACK/NACK loss framework with a maximum missed ACK/NACK rate up to 0.5%
	+ Option 2a: (vivo)
		- For UE supporting option B-1-2, the probability of missed ACK/NACK is 1% for ALL RLM/BFM/BM(L1-RSRP/L1-SINR) measurements based on SSB outside active BWP.
	+ Option 2b: (Nokia)
		- Interruption ratio shall not exceed [1.0]%. A lower interruption ratio is also agreeable.
	+ Option 2c: (Ericsson)
		- The probability of missed ACK/NACK for a UE supporting Option B-1-2, due to interruptions caused by UE performing BM/RLM/BFD measurements based on SSB outside the active BWP, shall not exceed 1 %.
	+ Option 3a: (Huawei)
		- For B-1-2, interruption ratio X% for each applicable serving cell is defined as
			* X%=interruption length \* 2 / L1 periodicity, where
				+ interruption length is 0.5ms for FR1 and 0.25ms for FR2, and
				+ L1 periodicity is defined as max(lower bound, SSB periodicity), FFS value of the lower bound
	+ Option 3b: (Apple)
		- X%=interruption length \* 2 / L1-RS periodicity, where X% is the interruption ratio, interruption length is 0.5ms in FR1 and 0.25ms in FR2, and L1-RS periodicity is the periodicity of SSB configured for BM/RLM/BFD after taking scaling factor P into account.
	+ Option 4: (MTK)
		- TCycle is used for interruption requirements specification implementation:
			* The UE is allowed to cause a certain interruption every TCycle period with a certain interruption ratio,
			* Interruption length (L) = 0.5 ms in FR1 and L = 0.25 ms in FR2;
			* 2L is needed for each TCycle;
			* Lower bound of TCycle = 40ms.
			* FFS whether the UE is required to Tx/Rx while measuring the SSB, if yes, FFS scheduling restrictions requirements.
		- Interruption ratio (x%) = $\frac{2 \* interruption length }{TCycle}=\frac{2 \* interruption length }{max(40 ms,   L1\\_RS periodicity)}$
			* L1-RS periodicity: is the periodicity of SSB configured for BM/RLM/BFD after taking scaling factor P into account.
		- Interruption length requirements are defined in number of slots for option B-1-2.
	+ Option 5: (Qualcomm)
		- Interruption length is larger than 0.5ms and smaller than 1ms.
		- Interruption ratio is not smaller than 1.25%, i.e.,
			* Y = 2\*X / L \* 100, where
				+ X [ms] = interruption length to a victim cell due to L1 measurements on SSB outside active DL BWP.
				+ L [ms] = L1 measurement period (which can be for RLM/BFD, CBD, and L1-RSRP/SINR measurements)
				+ Y [%] = interruption ratio (to be defined by RAN4)
			* Y = 1.25% when L = 160ms and X = 1ms.
	+ Option 6: (Apple)
		- RAN4 shall define interruption length for Option B-1-2 and shall not define interruption ration for the same option.
* Recommended WF
	+ Further discuss.

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