**3GPP TSG-RAN WG4 Meeting # 107 R4-23xxxxx**

**Incheon, Korea (Republic Of), 22nd - 26th May 2023**

**Agenda item:** 8.35.2 & 8.35.3

**Source:** Moderator (Huawei)

**Title:** Topic summary for [107] [151] Netw\_Energy\_NR

**Document for:** Information

# Introduction

RAN#99 meeting approved RP-230566 WI on Network energy savings.

The thread [107] [151] is on Rel-18 WI for NR Network energy savings（RP-230566）. The contributions are under agenda 8.35.2 and 8.35.3, which includes:

* Topic #1: Feasibility study for SSB-less operation
* Topic #2: RF requirements for Cell DTX
* Topic #3: RF requirements for spatial domain techniques

# Topic #1: Feasibility study for SSB-less operation

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307386 | CATT | **Observation 1:** BS inter-band CA TAE requirement for SSB-less operation can wait for the conclusion of RRM discussion **Observation 2:** The inter-band CA TAE for SB-less operation can be optional and manufacturer declared. |
| R4-2307529 | Huawei, Hisilicon | **Observation 1**: Many RUs in the network that support NR also support LTE, which makes it natural for them to support the 260 ns inter-band CA TAE.**Observation 2**: The TAE for NR inter-band CA has been relaxed to 3µs, particularly in non-co-located scenarios. However, in co-located scenarios, the TAE performance is much better than 3µs and achieving 260 ns is feasible.**Proposal 1**: In the case of inter-band CA implemented with the same BB and RF module, the TAE could be controlled within 260ns. Additionally, the air interface propagation delay difference can be ignored. The received power difference can be meet within <= 6dB. So it is feasible to support SSB-less Scell operation.**Proposal 2:** Most, if not all, of the NR-capable RUs in the network also support MSR, including LTE. As a result, the TAE requirement of 260 ns can be met in at least some of co-located inter-band CA scenarios for NR FR1. |
| R4-2307823 | LG Electronics Inc. | **Proposal 1:** Frequency separation between carriers in inter-band CA can be discussed together with reception power difference in RF session. |
| R4-2308020 | China Telecom | **Proposal 1:** RTD requirements can be discussed in RRM session for some of CA combinations, and the definition of specific band combination can be discussed in RF session.**Proposal 2**: In inter-band CA SSB-less SCell activation scenario, for some low frequency inter-band CA combinations, e.g., CA\_n5-n8, CA\_n1-n3, the RTD between target SCell and inter-band active serving cell is able to be within 260ns under practical BS implementation.**Proposal 3:** The reception power difference between target SCell and inter-band active serving cell should be limited within 6dB.**Proposal 4**: Conditions of intra-band case can be the baseline for feasibility studies of FR1 co-located inter-band CA scenario |
| R4-2308621 | Nokia, Nokia Shanghai Bell | **Proposal 1**：RAN4 to prioritize the SSB-less SCell operation for FR1 inter-band collocated CA in Scenario 1 （No SSB but with TRS transmission configured on the SSB-less SCell）identified in RRM.**Observation 1**：Some of the conditions listed above are relevant or impacting to the existing RAN4 RF core specifications.**Proposal 2**：RAN4 to consider providing, if necessary, a list of RF-core specification parameters to RAN4-RRM to efficiently proceed with the RRM feasibility study.**Proposal 3**：RAN4 should not change the currently specified TAE value 3 us even as a support feature for network energy savings, until conclusions are made from the feasibility study in RRM. |
| R4-2308750 | Ericsson | **Observation 1:** SSB-less Scell activation would work with existing TAE of 3 µs, at least for 15 kHz SCS of the reference cell.**Proposal 1:** Ensure the NES features are compatible with existing BS and UE RF requirements.**Proposal 2:** RAN4 should investigate the implementation of SSB-less SCell operation in legacy deployments and adhere to existing requirements as much as possible. |
| R4-2309184 | ZTE Corporation | **Proposal 1:** to confirm that the achievable FR1 inter-band CA TAE requirement in co-located scenario could be optimized down to at least 65ns; |
| R4-2309185 | ZTE Corporation | **Observation 1**: inter-band CA TAE requirement could be optimized down to at least 65ns;**Proposal 1:** RTD for co-located inter-band CA could be achieved within 260ns. **Proposal 2:** propose to consider further relaxation of the 6dB power imbalance for inter-band CA scenario.  |
| R4-2309442 | CMCC | **Observation 1:** The TAE between the two carriers should be less than 1/2CP.**Observation 2:** TAE requirements are based on the synchronization performance of BBU, and the TAE of the BS in the network could be optimized to 300ns – 700ns.**Observation 3:** In most cases, the propagation delay can be ignored.**Proposal 1:** The study for NES could be divided into two parts:For inter-band CA band combinations that have close frequencies.For inter-band CA which has two frequencies that are far apart.**Proposal 2:** Companies are welcome to provide how the gNB should be updated, i.e. software update or hardware update, to achieve energy saving function.**Proposal 3:** The BS in the network could ensure time synchronization, and there is no need to change the inter-band CA TAE requirements. |
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## Open issues summary

### Sub-topic 1-1 TAE

**Issue 1-1: TAE**

* Proposals
	+ Proposal 1: Maintain the current TAE requirements of 3µs for NR inter-band CA.
		- Ensure the NES features are compatible with existing BS and UE RF requirements. (R4- 2308750)
		- RAN4 should investigate the implementation of SSB-less SCell operation in legacy deployments and adhere to existing requirements as much as possible. (R4- 2308750)
		- RAN4 should not change the currently specified TAE value 3 us even as a support feature for network energy savings, until conclusions are made from the feasibility study in RRM.(R4-2308621)
		- **Proposal 3:** The BS in the network could ensure time synchronization, and there is no need to change the inter-band CA TAE requirements. (R4-2309442)
	+ Proposal 2: The inter-band CA TAE for SB-less operation can be optional and manufacturer declared (R4-2307386)
	+ Proposal 3: TAE limited within 260 ns is feasible for at least some scenarios（R4-2307529）
		- Many RUs in the network that support NR also support LTE, which makes it natural for them to support the 260 ns inter-band CA TAE.
		- The TAE for NR inter-band CA has been relaxed to 3µs, particularly in non-co-located scenarios. However, in co-located scenarios, the TAE performance is much better than 3µs and achieving 260 ns is feasible.
		- In the case of inter-band CA implemented with the same BB and RF module, the TAE could be controlled within 260 ns.
	+ Proposal 4: TAE optimized to at least 65 ns （R4-2309184）
		- the achievable FR1 inter-band CA TAE requirement in co-located scenario could be optimized down to at least 65 ns;
	+ Proposal 5: BS inter-band CA TAE requirement for SSB-less operation can wait for the conclusion of RRM discussion.( R4-2307386)
* Recommended WF
	+ TBA

### Sub-topic 1-2 RTD

**Issue 1-2: RTD**

* Proposals
	+ Proposal 1: In inter-band CA SSB-less SCell activation scenario, for some low frequency inter-band CA combinations, e.g., CA\_n5-n8, CA\_n1-n3, the RTD between target SCell and inter-band active serving cell is able to be within 260ns under practical BS implementation. （R4-2308020）
	+ Proposal 2: RTD requirements can be discussed in RRM session for some of CA combinations, and the definition of specific band combination can be discussed in RF session.( R4-2308020)
* Recommended WF
	+ Discuss on these proposals and decide what is agreeable.

### Sub-topic 1-3 Propagation delay

**Issue 1-3: Propagation delay**

* Proposals: for co-located inter-band CA, the propagation delay could be ignored
	+ Proposal 1: In the case of inter-band CA implemented with the same BB and RF module, the air interface propagation delay difference can be ignored.(R4-2307529）
	+ Proposal 2: In most cases, the propagation delay can be ignored. (assume the distance between two co-located RRU is 6m, the propagation delay is 20ns ) (R4-2309442)
	+ Option 3: others
* Recommended WF
	+ Discuss on these proposals and decide what is agreeable.

### Sub-topic 1-4 The reception power difference

**Issue 1-4: The reception power difference**

* Proposals
	+ Proposal 1: The reception power difference between target SCell and inter-band active serving cell should be limited within 6dB.( R4-2308020）
	+ Proposal 2: In the case of inter-band CA implemented with the same BB and RF module, the received power difference can be meet within <= 6dB. (R4-2307529）
* Recommended WF
	+ Discuss on these proposals and decide what is agreeable.

### Sub-topic 1-5 others

**Issue 1-5: others**

* Proposal 1: in Conditions of intra-band case can be the baseline for feasibility studies of FR1 co-located inter-band CA scenario (R4-2308020)
* Proposal 2: The study for NES could be divided into two parts: (R4-2309442)
	+ - For inter-band CA band combinations that have close frequencies.
		- For inter-band CA which has two frequencies that are far apart.
* Proposal 3**:** Companies are welcome to provide how the gNB should be updated, i.e. software update or hardware update, to achieve energy saving function.
* Proposal 4: RAN4 to prioritize the SSB-less SCell operation for FR1 inter-band collocated CA in Scenario 1 （No SSB but with TRS transmission configured on the SSB-less SCell）identified in RRM. （R4-2308621）
* Proposal 5: Frequency separation between carriers in inter-band CA can be discussed together with reception power difference in RF session. (R4-2307823)
* Recommended WF
	+ Discuss on these proposals and decide what is agreeable.

### Sub-topic 1-6 Feasibility conclusion

**Issue 1-6: Feasibility conclusion**

* Proposals
	+ Proposal 1: In the case of inter-band CA implemented with the same BB and RF module, the TAE could be controlled within 260ns. Additionally, the air interface propagation delay difference can be ignored. The received power difference can be meet within <= 6dB. So it is feasible to support SSB-less Scell operation. （R4-2307529）
	+ Proposal 2: others
* Recommended WF
	+ Discuss whether to conduct a step-by-step feasibility study.

# Topic #2: RF requirements for Cell DTX

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307529 | Huawei, Hisilicon | **Proposal 3**: For Cell DTX, there is no need to define switch time and spectrum as it operates within its own transmitter period or frequency band and does not cause interference with other signals. |
| R4-2308621 | Nokia, Nokia Shanghai Bell | **Observation 2**: RAN1 currently discusses identifying signals and channels transmitted by BS/UE during cell DTX/DRX, and other signalling aspects to enable cell DTX/DRX operation.**Proposal 4**: RAN4 should not take decision to specify ON-OFF power requirements for TDD or FDD operation without further investigations. |
| R4-2309184 | ZTE Corporation | **Proposal 2:** for the cell DTX operation, to reuse the TDD ON-OFF power related requirement for it. |
| R4-2309442 | CMCC | **Proposal 4: （**Since the details of DTX/DRX are still pending）Waiting for more conclusions from RAN1/2 before discussing RF requirements for Cell DTX. |
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## Open issues summary

### Sub-topic 2 -1 RF requirements for Cell DTX

**Issue 2-1: RF requirements for Cell DTX**

* Proposals
	+ Proposal 1: there is no need to define switch time and spectrum as it operates within its own transmitter period or frequency band and does not cause interference with other signals.( R4-2307529)
	+ Proposal 2: RAN4 may need to investigate how to minimize the testing effort (i.e., the time and complexity of testing) without reducing the test coverage in conformance testing part. (R4-2308621)
	+ Proposal 3: For the cell DTX operation, to reuse the TDD ON-OFF power related requirement for it.（R4-2309184）
	+ Proposal 4: Pending decision
		- Waiting for more conclusions from RAN1/2 before discussing RF requirements for Cell DTX (R4-2309442)
		- RAN4 should not take decision to specify ON-OFF power requirements for TDD or FDD operation without further investigations. (R4-2308621)
* Recommended WF
	+ TBA

# Topic #3: RF requirements for Cell spatial domain techniques

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307529 | Huawei, Hisilicon | **Proposal 4**: For Spatial adaptation domain techniques, there is no need to define new requirement within its own transmitter period or frequency band and does not cause interference with other signals. |
| R4-2308621 | Nokia, Nokia Shanghai Bell | **Observation 3:** The BS vendors have to comply with the OTA conformance test specification (38.141-2), and that would generate a lot of testing effort for possible huge number of muting patterns of antenna elements.**Observation 4:** RAN1 has not had any consensus about element pattern switching period in the last two concluded meetings.**Proposal 5:** RAN4 may need to investigate how to minimize the testing effort (i.e., the time and complexity of testing) without reducing the test coverage in conformance testing part.**Proposal 6:** RAN4 to wait until RAN1 agrees about element pattern switching periods, which are relevant to RAN4. |
| R4-2309184 | ZTE Corporation | **Proposal 3**: to consider the necessity of switching period of efficient adaption of spatial elements/power adaption and the DL EVM performance deterioration due to the switching behavior from network side and any interruption time expected at UE side during the switching period; |
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## Open issues summary

### Sub-topic 3-1 RF requirements for spatial domain techniques

**Issue 3-1: RF requirements for spatial domain techniques**

* Proposals
	+ Proposal 1: No need to define new requirement for Spatial adaptation domain techniques ( R4-2307529)
	+ Proposal 2: DL EVM performance deterioration should be considered (R4-2309184)
	+ Proposal 3: RAN4 to wait until RAN1 agrees about element pattern switching periods, which are relevant to RAN4.(R4-2308621)
* Recommended WF
	+ Discuss on these proposals and decide what is agreeable