3GPP TSG RAN #94
Electronic Meeting, December, 06 - 17, 2021

RP-212879

Motivation on the simultaneous Rx/Tx capability for intra-band NC CA/DC UE

LG Electronics

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Motivation

- **In the Rel-17, a simultaneous Rx/Tx capability is defined only for inter-band CA/DC band combinations. However, this is not applicable for intra-band CA/DC band combinations.**
- **Similar scenario was discussed in intra-band con-current V2X operation in TDD band in Rel-17 and related agreement was made as follows.**
  - RAN4 do not allow simultaneous UL Tx and SL Rx for non-contiguous and contiguous V2X intra-band con-current operation in Rel-17.
  - SL V2X operation will consider simultaneous Rx/Tx capability after RAN4 study the feasibility of simultaneous Rx/Tx capability for intra-band CA UE of NR Uu
- **Therefore, RAN4 needs to study the feasibility of the simultaneous Rx/Tx operation for intra-band CA/DC band combinations with sufficient frequency gap in TDD band. And if feasible, RAN4 needs to define the related RF core requirements.**

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Comments in RAN#94e-Pre meeting

- **What are the deployment scenarios & Use case ?**
  (Nokia, Skyworks, Intel)

- **How to resolve self-desense problems from Tx interference into own Rx in the same UE ?**
  (Skyworks, Apple, Qualcomm, Ericsson)

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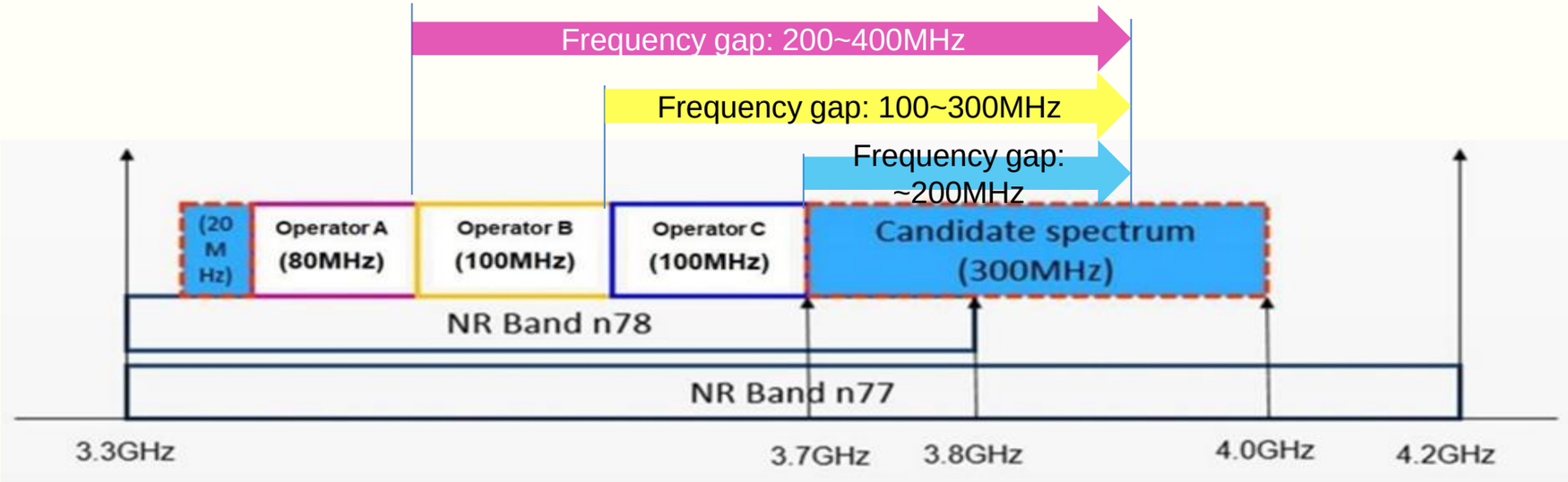
Clarification of deployment scenario

- **Deployment scenario**
  - Intra-band NC-CA/DC UE with wide frequency gap
    - Scenario 1: Single operator in a same band
    - Scenario 2: Multiple operators in a same band
      - Indoor-to-Macro
      - Indoor-to-Indoor
      - Note : Macro-to-Marco scenario is not considered due to CLI.
  - For scenario 2, the example operations in a n77 are shown as follow
    - Operator A: 200-400 MHz frequency gap is guaranteed.
    - Operator B: 100-300 MHz frequency gap is guaranteed.
    - Operator C: Max. 200 MHz frequency gap is guaranteed



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Clarification on self-interference problems

- **Based on analysis in Annex, we share our observations as follows**
  - Observation1: 25.3dB MSD level is expected in 77 band when RAN4 assumed -125dBm/Hz PA noise level with adjacent carrier
  - Observation2: -139dBm/Hz PA Rx noise level is observed when frequency gap is 153MHz apart from the upper edge Tx frequency.
  - Observation3: 11.6dB MSD level is expected in 77 band when RAN4 assumed -139dBm/Hz PA noise level with 150MHz frequency gap
  - Observation4: 3.2dB MSD level is expected in 77 band when RAN4 assumed -150dBm/Hz PA noise level with 500MHz frequency gap

- **Observation 3&4 along with deployment scenario show the simultaneous Rx/Tx operation is feasible with reasonable MSD (3.2~11.6dB) which can be further reduced by introducing A-MPR approach and RB restrictions.**

- **The feasibility can be studied in Rel-18 with more input from other companies.**

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Proposals

- **Based on analysis of deployment scenarios and self-interference in this document, we propose as follow**
  - Proposal 1: Based on the deployment scenarios in slide 4, RAN4 needs SID on feasibility study for the simultaneous Rx/Tx operation in intra-band NC-CA/DC UE considering followings.
    - Frequency gap, UL RB restriction for REFSENS and A-MPR approach or combination of the candidate solutions to achieve the reasonable MSD values and cell coverage to keep the system performance
  - Proposal 2: Propose the SID objectives as follow
    - Study the feasibility on the simultaneous Rx/Tx operation with the required frequency gap considering the reasonable desense levels for intra-band non-contiguous CA/DC UE.
    - Depending on the feasibility study, define the related RF core requirements.
      - Specify the MPR and MSD requirements according to frequency gap.

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Annex: Analysis on self-interference problem [1]

- **Expected self-interference level in n77 (10MHz CBW, SCS 15kHz)**
  - No expected duplexer isolation level (40~50dB) with adjacent carrier

NR band	n77 band		
	Primary RX		Diversity Rx
C/N requirement (dB)	-1.0		-1.0
Total NF(IM + RF NF=2.2+10.5) (dB)	12.7		12.7
Noise floor at antenna connector (dBm/Hz)	-161.3		-161.3
PA & RFIC Rx band noise level at Antenna connector (dBm/MHz)	-122-4-10 =-136.0	(-125+3) dBm/Hz(PA +RFIC RxBN)-FE IL(4dB)-Ant ISO(10dB))	-136.0
Total RXBN at Antenna connector (dBm/Hz)	-136.0		-136.0
Sensitivity with RXBN (dBm/10MHz CBW)	-136+70-1 = -67.0		-67.0
REFSENS After MRC	-70.0	*25.3dB Desense Level	

- **Observation1: 25.3dB MSD level is expected in 77 band when RAN4 assumed -125dBm/Hz PA noise level with adjacent carrier**

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Annex: Analysis on self-interference problem [2]

- **Analyze the PA isolation characteristics according to frequency gap in Band 12**

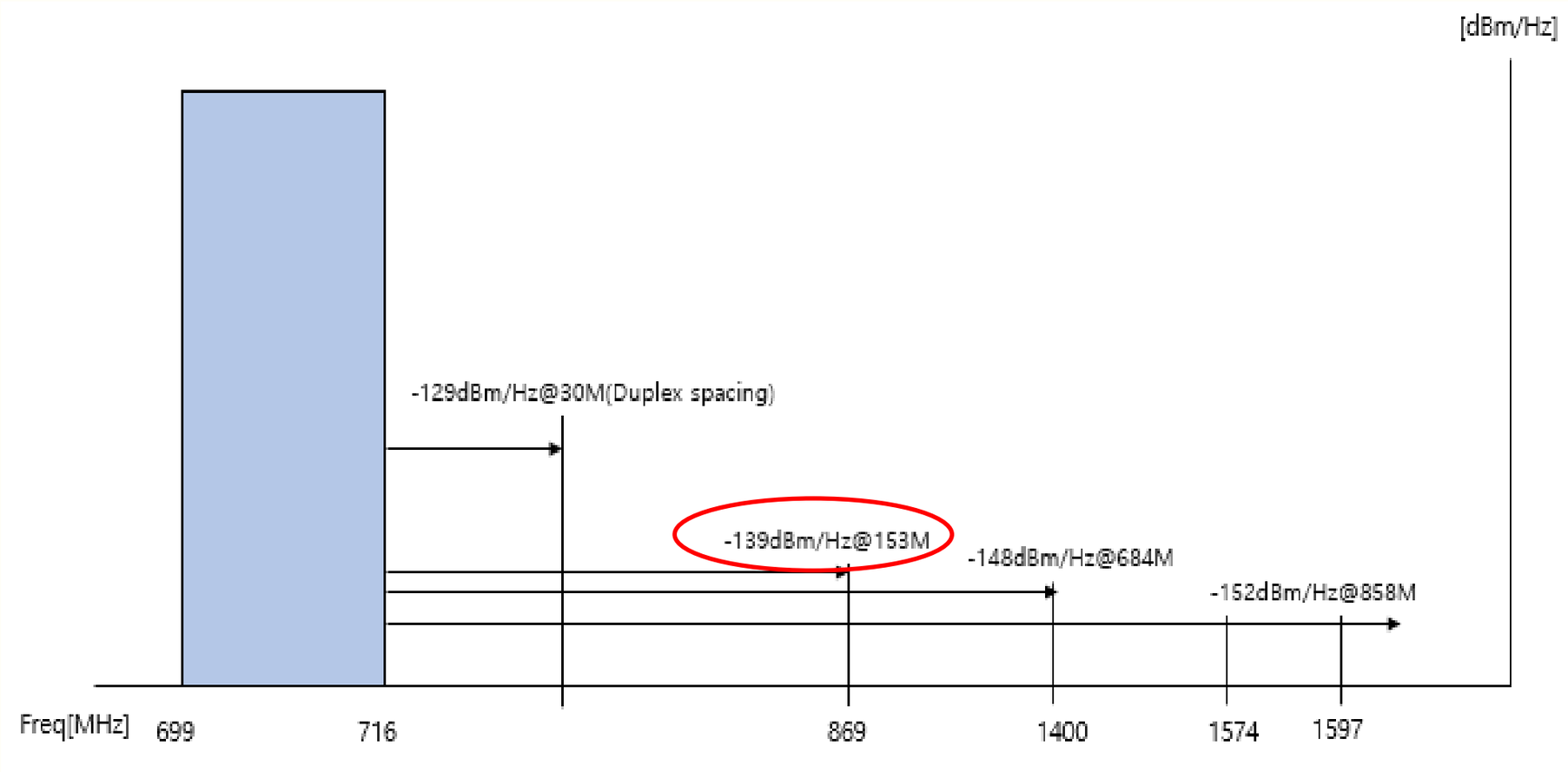

Figure 1. B12 PA Rx noise level characteristics according to the frequency gap

- **Observation2: -139dBm/Hz PA Rx noise level is observed when frequency gap is 153MHz apart from the upper edge Tx frequency.**

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Annex: Analysis on self-interference problem [3]

- **The observed Rx isolation levels by PA in some operating bands**

B12 PA characteristics		
	Freq offset [MHz]	Noise power [dBm/Hz]
Ref. frequency (716MHz)	30M	-129
	153M	-139
	684M	-148
	858M	-152

B5 PA characteristics		
	Freq offset [MHz]	Noise power [dBm/Hz]
Ref. frequency (849MHz)	45M	-131
	551M	-151

B8 PA characteristics		
	Freq offset [MHz]	Noise power [dBm/Hz]
Ref. frequency (915MHz)	45M	-132
	485M	-151

B13 PA characteristics		
	Freq offset [MHz]	Noise power [dBm/Hz]
Ref. frequency (787MHz)	82M	-131
	613M	-151

B42 PA characteristics		
	Freq offset [MHz]	Noise power [dBm/Hz]
Ref. frequency (3800MHz)	700M	-133
	1100M	-155

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Annex: Analysis on self-interference problem [4]

- **Expected self-interference level in n77 (10MHz CBW, SCS 15kHz)**
  - Consider -139dBm/Hz noise level is assumed with 150MHz frequency gap.

NR band	**n77 band**		
	Primary RX		Diversity Rx
C/N requirement (dB)	-1.0		-1.0
Total NF(IM + RF NF=2.2+10.5) (dB)	12.7		12.7
Noise floor at antenna connector (dBm/Hz)	-161.3		-161.3
PA & RFIC Rx band noise level at Antenna connector (dBm/MHz)	-136-4-10 =-150.0	(-139+3) dBm/Hz(PA +RFIC RxBN)-FE IL(4dB)-Ant ISO(10dB))	-150.0
Total RXBN at Antenna connector (dBm/Hz)	-149.7		-149.7
Sensitivity with RXBN (dBm/10MHz CBW)	-149.7+70-1 = -80.7		-80.7
REFSENS After MRC	-83.7	*11.6dB Desense Level	

- **Observation3: 11.6dB MSD level is expected in 77 band when RAN4 assumed -139dBm/Hz PA noise level with 150MHz frequency gap**

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Annex: Analysis on self-interference problem [5]

- **Expected self-interference level in n77 (10MHz CBW, SCS 15kHz)**
  - Consider -150dBm/Hz noise level is assumed with 500MHz frequency gap.

NR band	**n77 band**		
	Primary RX		Diversity Rx
C/N requirement (dB)	-1.0		-1.0
Total NF(IM + RF NF=2.2+10.5) (dB)	12.7		12.7
Noise floor at antenna connector (dBm/Hz)	-161.3		-161.3
PA & RFIC Rx band noise level at Antenna connector (dBm/MHz)	-147-4-10 =-161.0	(-150+3) dBm/Hz(PA +RFIC RxBN)-FE IL(4dB)-Ant ISO(10dB))	-161.0
Total RXBN at Antenna connector (dBm/Hz)	-158.1		-158.1
Sensitivity with RXBN (dBm/10MHz CBW)	-158.1+70-1 = -89.1		-89.1
REFSENS After MRC	-92.1	*3.2dB Desense Level	

- **Observation4: 3.2dB MSD level is expected in 77 band when RAN4 assumed -150dBm/Hz PA noise level with 500MHz frequency gap**

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