**3GPP TSG-RAN WG4 Meeting #111 R4-240xxxx**

**Fukuoka City, Fukuoka, Japan, 20th – 24th May, 2024**

**Agenda item:** 10.14.5

**Source:** vivo

**Title:** WF for [111][136] NR\_LPWUS\_UERF

**Document for:** Approval

# Introduction

This is WF for Rel-19 LP-WUS UE RF.

# Topic #1: General and system parameters

### Sub-topic 1-1 General and system parameters

**Issue 1-1-1: Operation bands for LP-WUS feature**

**Agreements:**

RAN4 confirm LP-WUS is a general feature not limited to specific example band(s)

**Issue 1-1-2: FR1 example bands for requirements as phase 1**

**Agreements:**

No need to list specific example band(s)

**Issue 1-1-5: Rx diversity gain assumption for LP-WUR**

**Agreements:**

No diversity gain as baseline for FR1. More Rx could be implementation choice

**Issue 1-1-7: Channel raster for LP-WUR**

**Agreements:**

RAN4 further check whether no channel raster is needed for LP-WUR.

**Issue 1-1-9: Side condition for LP-WUR requirements**

**Agreements:**

* + **FFS RAN4 should consider both idle and connected mode conditions in the side conditions for the LPWUR requirements.**

**Issue 1-1-11: Metric for LP\_WUR requirements**

**Agreements:**

* + **MDR is used as the metric for LP\_WUR Rx RF requirements** 
    - **FFS MDR values.**
  + **FAR will be defined as demodulation requirements**
    - **FFS FAR values.**

# Topic #2: REFSENS, ASCS and ACS requirements

### Sub-topic 2-1 Alignment of LLS parameters to specify ACS/ASCS requirements

**Issue 2-1-1: Center frequencies for LLS simulation**

**Agreement:**

* For ACS and ASCS simulation, select 900MHz, 2.6GHz and 3.5GHz as example frequencies for FR1.
* FFS on FR2 example band(s)

**Issue 2-1-2: Performance metric (MDR/BLER value) for LLS simulation (apply to ACS/ASCS and REFSENS)**

**Agreement:**

* For LLS simulation (apply to ACS/ASCS and REFSENS), the metric includes
  + 1% MDR/BLER as baseline and 5% MDR/BLER as optional
  + The following false alarm rate can be considered
    - 1%
    - 5%
    - Providing the information whether the false alarm rate is considered or not
* Further down-select the performance metric for the requirements and testing

**Issue 2-1-3: Waveform for LLS simulation**

**Agreement:**

* Use both OOK1 and OOK4 based on RAN1 agreements for link level simulations

**Issue 2-1-4: number of LP-WUS RBs for LLS simulation**

**Agreement:**

* Assume 11PRB for LP-WUS signal with 30kHz SCS for simulations
* FFS on RB number(s) for 15KHz SCS depending on RAN1 decision

**Issue 2-1-5: number of ADC assumption for LLS simulation**

**Agreement:**

* Number of ADC assumption for LLS simulation
  + Option 1: 8 bit
  + Option 2: 4 bit
  + Encourage companies to provide simulation results with both options for comparison

**Issue 2-1-6: Frequency error assumption for LLS simulation**

**Agreement**

* Frequency error assumption for LLS simulation
  + Up to 20ppm

**Issue 2-1-7: Phase noise model for LLS simulation**

**Agreement:**

* Not needed in LLS. Consider as RF impairment of implementation.

**Issue 2-1-8: For ASCS, the BWinterferer for ASCS evaluation**

**Agreement:**

* For ASCS evaluation, only 10MHz and 20MHz NR CBWs are assumed and the BWinterferer is
  + All RBs between WUS edge to channel edge

**Issue 2-1-10: The overall simulation parameters for LLS simulation**

**Agreement:**

* Wait for RAN1 conclusion on FR2 to decide the parameters for evaluations
* Adopt the following parameters in table below for FR1 simulation evaluations

|  |  |  |  |
| --- | --- | --- | --- |
| Attributes | Assumptions | | |
| Case name (waveform) | OOK-1 waveform | | OOK-4 waveform |
| Center frequency | 900MHz, 2.6GHz and 3.5GHz | | |
| Channel structure | Total 8/16 bits | | |
| Chip rate | M=1 | M=1/2/4 | |
| WUS duration | FFS | | |
| Coding | 1/2 rate Manchester coding | | |
| Time error | 0 | | |
| Residual Frequency error | 0/10/20 ppm | | |
| SCS | 30kHz | | |
| UE Channel BW | 20MHz (51 RB)-case 1  10MHz (24 RB)-case 2  5MHz (11 RB)-case 3 | | |
| WUS RB | * Fixed 11RB ~ 3.96MHz for 10MHz and 20MHz cases | | |
| Position within channel | * For 10/20MHz CBW, Center for ASCS, edge for ACS [assume no ASCS impact] * For 5MHz CBW, fixed center of channel | | |
| Guardband of NR channel, both wanted cell and interfer cell (ACS) | * For wanted signal: 505kHz for 5MHz, 665kHz for 10MH, 805kHz for 20Mhz * For interference cell2 5MHz: fixed 505kHz | | |
| Guard RB | * For ASCS: 0 or 1RB on each side of LP-WUS bandwidth * For ACS: 1/2/3/4 RB | | |
| Filter | * 3th/5th Order lowpass Butterworth matching fixed 3.96MHz RF bandwidth for 10MHz/20MHz case   + Other order lowpass filter is not precluded * The filter bandwidth is adapted with actual WUS RBs, for 5MHz case | | |
| ASCS | PDSCH mapped on RBs not used for LP-WUS and Guard RB;  EPRE of PDSCH /EPRE of LP-WUS = 0 dB  Same PSD with WUS signal | | |
| ACS | PDSCH mapped on interference RBs (11RB for 5MHz CBW), one side;  EPRE of PDSCH /EPRE of in-band LP-WUS = [20~33] dB  NOTE: decide the interference level depending on SNR | | |
| Wanted signal level | For ACS, REFSENS + 14 dB for LP-WUS | | |
| Sampling rate | 7.68MHz | | |
| ADC bit width | 4/8 bits ADC for ASCS/ACS  Encourage companies to provide simulation results with both options for comparison | | |
| Phase noise | Not modelled | | |
| Non-linearities | Not modelled | | |
| Power boosting | EPRE ratio: 0dB/3dB for OOK-1/OOK-4  NOTE: 3dB is optional for simulation | | |
| Channel Model | Option 1: TDL-C 300  Option 2: AWGN  Note: encourage companies to provide simulation results with both options | | |
| Performance metric | * + 1% MDR/BLER as baseline and 5% MDR/BLER as optional   + The following false alarm rate can be considered     - 1%     - 5%   Providing the information whether the false alarm rate is considered or not | | |

### Sub-topic 2-2 REFSENS requirements

**Issue 2-2-3: SNR value (not requirement) for REFSENS**

**Agreement:**

* + Stick to last meeting agreements: Wait for RAN1 SNR progress

**Issue 2-2-4: NF Gap between LR and MR for REFSENS (assume MR as 9dB)**

**Agreement:**

* + RAN4 further discuss potential NF for OOK-based and OFDM-based receiver.
  + Linked to resolution of Issue 2-2-8

**Issue 2-2-6: IM value for REFSENS**

**Agreement:**

* + RAN4 further discuss potential IM value for OOK-based and OFDM-based receiver.

**Issue 2-2-8: Whether a baseline architecture is needed for LP-WUS receiver**

**Agreement:**

* + RAN4 will further discuss and decide baseline architecture(s) for OOK-based receiver and OFMD-based receiver.

### Sub-topic 2-3 ASCS requirements

**Issue 2-3-1: Align the definition of ASCS requirements**

**Agreement:**

* + RAN4 can use the following ASCS definition as starting point.
    - **Adjacent SubCarrier Selectivity (ASCS) is a measure of a receiver's ability to receive an LP-WUS signal at its assigned channel frequency in the presence of adjacent subcarrier NR signal(s) at a given frequency offset (guard RB) between LP-WUS and NR. ASCS is the ratio of the receive filter attenuation on the assigned LP-WUR channel frequency to the receive filter attenuation on the adjacent NR subcarrier**

**Issue 2-3-2: ASCS requirements value**

**Agreement:**

* + RAN4 further discuss whether ASCS requirements value should be specified, or just the test parameter are specified, i.e., LP\_WUS and NR signal bandwidths and power levels, and guard RBs.

**Issue 2-3-3: Required number of guard RB for ASCS**

**Agreement:**

* + RAN4 further discuss required number of guard RB for ASCS based on LLS simulation outcome next meeting.

**Issue 2-3-4: Test case for ASCS**

**Agreement:**

* + RAN4 further discuss detailed test parameters for ASCS.

### Sub-topic 2-4 ACS requirements

**Issue 2-4-1: Whether to update the ACS definition for LP-WUS**

**Agreement:**

* + RAN4 consider the following clarified ACS requirements definition for LP-WUS as starting point.
    - **Adjacent channel selectivity (ACS) is a measure of a receiver's ability to receive an ~~NR~~ LP-WUS signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the center frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).**

**Issue 2-4-2: ACS requirements value**

**Agreement:**

* + RAN4 consider the how to specify ACS requirements. FFS same as MR.
    - Decision will be made based on LLS outcome

**Issue 2-4-3: Required guard RB for ACS case**

**Agreement:**

* + RAN4 further discuss required number of guard RB for ACS based on LLS simulation outcome next meeting.

# Topic #3: Other RF requirements

### Sub-topic 3-1 General for UE RF

**Issue 3-1-1: IBB and OBB assumption**

**Agreement:**

* + RAN4 further check and discuss whether same interference level of IBB and OBB as MR is assumed for LP-WUR.
    - With assumption that Rx dynamic range for LR may not be as good as MR

**Issue 3-1-2: IBB and OBB requirements**

**Agreement:**

* + RAN4 further discuss detailed test condition for IBB and OBB, e.g., location of LP-WUS in-band, MR channel bandwidth, whether guard RBs are allocated, power level.
    - FFS IBB and OBB requirements

**Issue 3-1-4: Intermodulation requirements**

**Agreement:**

* + RAN4 further discuss detailed test condition for Intermodulation requirements, e.g., location of LP-WUS in-band, MR channel bandwidth, whether guard RBs are allocated, power level.
    - FFS Intermodulation requirements requirement

### Sub-topic 3-2 spurious emissions and response requirements

**Issue 3-2-1: Spurious emissions requirements**

**Agreement:**

* + RAN4 conclude Spurious emissions requirements can be reused for LP-WUR.

**Issue 3-2-2: spurious response requirements**

**Agreement:**

* + RAN4 further discuss whether spurious response requirements is needed for LP-WUR.

### Sub-topic 3-3 Other Rx requirements

**Issue 3-3-1: Maximum input level requirements**

**Agreement:**

* + RAN4 further discuss whether maximum input level requirements can be reused for LP-WUR.
    - FFS side condition

**Issue 3-3-2: Narrow band blocking requirements**

**Agreement:**

* + FFS RAN4 no need to define narrow band blocking requirements for LP-WUR.