**3GPP TSG-RAN4 Meeting #116 *R4-2511872***

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**Source:** vivo

**Title:** TP for TR 38.774 on LP-WUS UE RF General

**Agenda item:** 7.24.3.1

**Document for:** Approval

1. Introduction

This contribution is a text proposal for TR 38.774 to add general part, simulation summary for LP-WUS.

# 2. Reference

[1] TR 38.774 v0.4.0

3. Text Proposal

**<Start of Text Proposal>**

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**Main radio (MR)**: the Tx/Rx module operating for NR signals/channels apart from signals/channel related to low-power wake-up.

**LP-WUR (LR)**: The Rx module operating for receiving/processing signals/channel related to low-power wake-up.

**LP-WUS power boosting:** difference between the average power of LP-WUS REs (which occupy certain REs within a NR transmission bandwidth configuration) and the average power over all REs (from both LP-WUS and the NR carrier containing the LP-WUS REs)

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

NRB Transmission bandwidth configuration, expressed in units of resource blocks

NRB,LP-WUS Number of RBs for LP-WUS

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

<ABBREVIATION> <Expansion>

ACS Adjacent Channel Selectivity

ADC Analog to Digital Converter

ASCS Adjacent Subcarrier selectivity

BB Base Band

BLER Block Error Rate

BPF Band Pass Filter

BS Base Station

CFO Center frequency offset

FAR False Alarm Rate

FR1 Frequency range 1

FR2 Frequency range 2

ICS In-channel Selectivity

IF Intermediate Frequency

LP-WUS Low Power-Wake Up Signal

LP-WUR Low Power-Wake Up Receiver

LP-SS Low Power- Synchronization Signal

LO Local Oscillator

LNA Low Noise Amplifier

LPF Low Pass Filter

LR LP-WUR

MDR Miss Detection Rate

MR Main Radio

NF Noise Figure

OOB Out-of-band

OOK On-Off keying

OFDM Orthogonal Frequency Division Multiplexing

RE Resource Element

REFSENS Reference Sensitivity

RF Radio Frequency

SCS Subcarrier spacing

SINR Signal to Interference plus Noise Ratio

SNR Signal to Noise Ratio

UE User Equipment

Tx Transmitter

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## 6.3 Simulation evaluation results

6.3.1 General

To evaluate some RF performance, link level simulations are performed to collect analysis input.

6.3.2 SNR simulations

In this sub-clause, SNR simulation results from different companies are collected for analysis of target SNR for LP-WUR.

Table 6.3.2-1 SNR simulation summary for FR1 Envelop-detection LP-WUR (OOK-4 M=4)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Companies Input | SNR | RM coding | Timing error | Note |
| A | -6 to -2dB | 32/**16**/8 | 4us | -2.15 dB (8 bit), -4.63 dB (16 bit), -5.94 dB (32 bit) |
| B | -7 to -3dB |  | 0us | 5th order of lowpass Butterworth |
| C | -7.5 dB to -2.5dB | 32/**16**/8 | 0us | simulated SNR with 4bit ADC or 8bit ADC is nearly the same |
| D | -7.1 to -2.5dB | 32/**16**/8 |  | OOK SNR: RM coding, 8bit with -2.5dB, 16bit with -5.3dB, 32bit with -7.1dB. |
| F | -7.7dB to -3.2dB | 32/**16**/8 | 0/0.9us | 0.9us TE will introduce less than 1dB degradation |
| G | -9.2 to -5.9dB |  |  | 8bit with -5.9dB, 16bit with -7.5dB, 32bit with -9.2dB. |
| H | -8.0 dB | 32 bits |  | under 4us TE has no impact |
| I | -7.8 to -5.9 dB | 32/**16**/8 |  | Payload: 5 bits  with RM, w/o MC |

Observations and Summary of SNR simulation outcome for envelop-detection receiver: most companies perform analysis based on RM coding of 8/16/32 bits, and majority views prefer to use 16bit RM coding as RMC and derive target SNR. The final target SNR is agreed as -4.5dB for LP-WUS envelop-detection.

Table 6.3.2-2 SNR simulation summary for FR1 OFDM-based LP-WUR

|  |  |  |  |
| --- | --- | --- | --- |
| Companies Input | SNR | Timing error | Note |
| A | -4dB |  | no big difference for the applicable SNR for both OOK based and OFDM based signals |
| B | -4dB |  |  |
| C | -5.5dB |  |  |
| D | -7.4dB |  |  |
| F | -8.0dB |  | OFDM-based receiver outperforms OOK-based receiver by 2.5~3dB SNR |
| G | -13.8 to -9.9dB |  |  |
| H | -3.5dB |  |  |

Observations and Summary of SNR simulation outcome for OFDM-based receiver: There is no repetition for OFDM-based receiver, the simulated SNR from companies is not much far from the simulated performance of LP-WUS envelop-detection. With consideration of other impacted aspects, the final target SNR of OFDM-based receiver is also specified as -4.5dB.

6.3.3 ASCS simulations

In this sub-clause, some ASCS simulation results from different companies are collected for analysis of in-band interference performance of LP-WUS. This is for information only, because actual implementation choice of filtering is driven by jammer requirements.

In SI phase, RAN4 reach the following conclusion for ASCS:*Based on the following analysis, RAN4 observed that for 5th order filter, the guard RB number for LP-WUS ASCS is in the range of 0RB ~ 1RBs for 30KHz SCS, or 0RBs ~2RBs for 15KHz SCS. Similar number of guard RBs could be applied also with lower filter orders as performance was observed to remain similar with 3rd order filter.*

In the WI phase, further detailed analysis is performed by companies, these analyses show a similar trend that the ASCS degradation is not that significant (0~1dB), even no guard RB is reserved.

Table 6.3.3-1 ASCS simulation summary for FR1 Envelop-detection and OFDM-based LP-WUR

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Companies Input | SNR degradation | Guard RB | Phase noise | Note |
| A | nonnegligible | 1 | Considered |  |
| B | negligible | 0 | N/A | the number of guard RB does not affect the MDR performance significantly |
| C | Less than 0.2dB | 0 | Considered | benefit of guard RB in ASCS case is minor |
| F | negligible | 0 | Considered | With 1 guard RB, there is minor improvement on the required SNR to achieve 1% BLER compared to 0 guard RB |
| H | 1dB | 0 | WiFi phase noise | an approximately 1 dB of degradation in sensitivity level at MDR=1% for both AWGN channel and for the TDL-C300 channel |
| J | ~0.5dB | 0 | N/A | Maximum of 1 guard RB at each side |



**<End of Text Proposal>**