**3GPP TSG-RAN WG4 Meeting # 98-e R4-2103849**

**Electronic Meeting, Jan. 25-Feb. 5, 2021**

Title: WF on IAB-MT EVM measurement in core spec

Source: CATT

Agenda item: 7.4.2.1.2

Document for: Approval

# Background

This WF covers the high level issues of IAB-MT EVM measurement procedure in core spec TS 38.174.

# Way forward

2.1 High level agreements

After the 1st round email discussion and the GTW discussion, the following high level agreements were reached,

**Issue 1-1: Does IAB-MT EVM measurement procedure refer UE spec or follow BS procedure?**

Using BS approach as basis, further discuss on the details required and the modifications not precluded if necessary.

**Issue 1-2: If all of the UL physical channels should be tested for IAB-MT EVM measurement?**

Using BS approach:

1. Core spec: clarify that the EVM (modulation orders) specify for PUSCH.
2. Introduce test models in conformance spec with PUSCH channel.

**Issue 1-3: Should PTRS be used for IAB-MT EVM measurement?**

Follow BS approach to configure PTRS in FR2 with optional.

Further discuss the test model and how to the clarify the optional in conformance specification if needed

**Issue 1-4: How to modify IAB-MT EVM measurement diagram?**

Using BS diagram as basis, further modifications not precluded if necessary.

**Issue 1-6: The basic EVM measurement interval for IAB-MT**

The same as BS approach.

2.2 WF for the details

According to the 1st round discussion agreements, BS approach is used for the IAB-MT EVM measurement as a high level guideline. However, IAB-MT Tx signal is UL signal, some details of BS approach needs to be modified to adapt to UL signal. Every sub-clause of BS EVM is reviewed,

The followings are the preliminary high level estimated modifications for IAB-MT compared with BS EVM measurement procedure.

The CR will be prepared based on the following guidelines, other modifications are not excluded if they’re found technically necessary.

### 2.2.1 FR1 BS approach adaption for IAB-MT

* B.1 Reference point for measurement

 No necessary modifications were observed based on the assumption that only CP-OFDM modulated signals will be used for the EVM test.

[Ericsson] DFT-s-OFDM waveform is less critical for PAPR compared with CP-OFDM signal. If CP-OFDM signal can pass EVM test and it will for DFT-s-OFDM signal from the RF perspective. Maybe the question then whether or not the DFT-s-OFDM signal should be tested. It also related to the test burden reduction discussion as the principle there agreed is to test the more stringent case.

[CATT] Agree. But as the PAPR of DFT-s-OFDM is less than CP-OFDM, the declared output power capability can be larger. I’m not sure if DFT-s-OFDM should be kept especially for FR2. Let’s see the views from other companies.

[Nokia, Nokia Shanghai Bell]: We do not see DFT-s-OFDM is needed as it is an optional feature and we do not expect test models to cover DFT-s-OFDM.

[Samsung]: Agree with Nokia. CP-OFDM waveform for DL and UL is mandatory feature for IAB-MT as captured in TS38.306. Would like to understand benefit and necessity to verify RF requirement for both waveforms. Clarification would be applied for all IAB-MT TX RF requirements.

[CATT] I updated the guideline for this aspect according to the received feedback until now. Please see if you’re ok.

* B.2 Basic unit of measurement

No necessary modifications were observed.

* B.3 Modified signal under test

 No necessary modifications were observed based on the assumption that only CP-OFDM modulated signals will be used for the EVM test.

[Ericsson] the same concern for DFT-s-OFDM signal as discussed above.

[CATT] Let’s see the conclusion of B.1.

* B.4 Estimation of frequency offset

No necessary modifications were observed.

* B.5 Estimation of time offset

Window length for UE is smaller than BS. As IAB-MT is part of a network node, it is estimated that the filter implementation capability can be similar with BS and IAB-DU. Therefore the same window length as IAB-DU is proposed for IAB-MT. Based on that technical assumption, the following can be observed.

No necessary modifications were observed including B.5.1 General and B.5.2 Window length.

[Ericsson] Window length is informative so agree with suggestion but seems argument is better from this aspective.

* B.6 Estimation of TX chain amplitude and frequency response parameters

The UL reference signals are different with DL reference signals, so

Equalizer coefficients calculation method should be modified to adapt to UL signals.

[Ericsson] TS 38.101-1/2 does not specifically give full formular on the equalizer coefficients calculation. Rather the 38.151-1/2 has detailed formular for this. Compared with equalizer calculation the difference is listed as below:

1. TS 38.101-1/2:

In the case of PUCCH and PUSCH, the UL EVM analyzer shall estimate the TX chain equalizer coefficients and  used by the ZF equalizer for all subcarriers by time averaging at each signal subcarrier of the amplitude and phase of the reference and data symbols. The time-averaging length is 1 slot. This process creates an average amplitude and phase for each signal subcarrier used by the ZF equalizer. The knowledge of data modulation symbols may be required in this step because the determination of symbols by demodulation is not reliable before signal equalization.

1. TS 38.104 annex B3.

The difference is the averaging approach for Equalizer Coefficeints (EC), for UE, it time averaging at both data and reference symbol while BS approach is to average the reference symbol and apply the linear interpolation for data symbol. The basic formular to calculate the equalizer coefficients is the same when compared with TS 38.104 and TS 38.151-1/2. UE approach needs to be more “pessimistic” as there is later on a spectrum flatness requirements to pass while it is not the case for BS. From this aspects, we think BS EC approach is better for IAB-MT as IAB-MT has no spectrum flatness requirements. On the other hand, if UE system emulator is used, it would not matter if it can pass the EVM test if DUT has better margin. So the conclusion is that BS EC approach is ok to be specified in the TS 38.174.

Again, we see it less critical for UL signal verse DL signal (of course, we need UL signal of PUSCH) other than how to calculate the EC.

[CATT] I’m a little confused with DL signal here. Is DL signal used as IAB-MT Tx signal for the requirement and test? For the UL signal equalizer coefficients, no interpolation is needed. The reason for DL equalizer interpolation is that REFSENS signal doesn’t exist for every carrier thus interpolation is used to get the channel response for all of the carriers. For UL, REFSENS signal is placed on every carrier. Therefore, technically BS EC approach can’t be used for UL signals. Please think it again.

[Ericsson] Your comments confuse me, so please allow me to use my imagination to guess what you mean. do you mean the **reference** signal in each **subcarrier** ? (in your comments “REFSENS signal doesn’t exist for every carrier”), i assume we talk about the Tx signal quality measurement and not RX REFSENS, right? Furthermore, do you mean the DFT-OFDM reference signal and NOT the CP-OFDM reference signal? Again maybe it is issue of DFT-s-OFDM signal verse the CP-OFDM signal. Your clarification would be needed.

[CATT] Sorry that REFSENS is a typo. It should be reference signal. It seems I’m a more RAN4 people not RAN1… My understanding was that it’s the difference between UL and DL, not CP-OFDM and DFT-s-OFDM. However, after check the BS physical channel configuration, DMRS is used for PDSCH. And if DFT-s-OFDM is the only modulation signal for Tx, then maybe the same approach can be used with the clarification that PDSCH needs to be changed to PUSCH.

[Keysight] As TE vender, please consider to re-use existing Equalizer definition for UL signal (one in TR38.521), not to make changes (even small) which makes specific implementation for UL from IAB-MT. I need to repeat the same comment, that even small text change, which makes TE vender to modify existing UL signal measurement which wouldn’t become available at the time vender need to use.

* B.7 Averaged EVM

Change $N\_{dl}$ to $N\_{ul}$, $N\_{ul}^{TDD}$ to $N\_{ul}^{TDD}$. How to do the adaption can be discussed further in the CR.

[Ericsson] some general text could be added if BS annex was referred in the end.

[CATT] It seems only very small modifications are needed, but not sure if it’s clear enough only using some clarification.

### 2.2.2 FR2 BS approach adaption for IAB-MT

FR2 modifications are very similar with FR1.

* C.1 Reference point for measurement

 No necessary modifications were observed based on the assumption that only CP-OFDM modulated signals will be used for the EVM test.

[Ericsson] same comments with FR1.

[CATT] See the response for FR1.

[Nokia, Nokia Shanghai Bell]: The principles should be aligned for FR1 and FR2. It is better to discuss in FR1 section.

* C.2 Basic unit of measurement

No necessary modifications were observed.

* C.3 Modified signal under test

 No necessary modifications were observed based on the assumption that only CP-OFDM modulated signals will be used for the EVM test.

[Ericsson] same comments with FR1.

[CATT] See the response for FR1.

* C.4 Estimation of frequency offset

No necessary modifications were observed.

* C.5 Estimation of time offset

No necessary modifications were observed including B.5.1 General and B.5.2 Window length.

* C.6 Estimation of TX chain amplitude and frequency response parameters

 No necessary modifications were observed based on the assumption that only CP-OFDM modulated signals will be used for the EVM test.

[Ericsson] same comments with FR1. Above all, there is PT-RS signal need to be considered.

[CATT] See the response for FR1. For PTRS, my understanding is that no mention in core spec, it’ll be discussed in test model.

* C.7 Averaged EVM

Change $N\_{dl}$ to $N\_{ul}$, $N\_{ul}^{TDD}$ to $N\_{ul}^{TDD}$. How to do the adaption can be discussed further in the CR.

[Ericsson] some general text could be added if BS annex was referred in the end.

[CATT] See the response for FR1.

# Reference

[1] R4-2103744 Email discussion summary for [98e][305] NR\_IAB\_RF\_Maintenance

[2] R4-2100365 Discussion on IAB-MT EVM measurement process CATT

[3] R4-2100826 Discussion on EVM measurement methodology for IAB-MT CMCC

[4] R4-2102012 IAB EVM procedure Nokia, Nokia Shanghai Bell

[5] R4-2102333 IAB-EVM procedure Ericsson