**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-2106074**

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Title: TP for TS 38.176-2: OTA transmitted signal quality

Source: CATT

Agenda item: 5.3.2.4.1

Document for: Discussion

# 1 Introduction

This contribution provides the views on the TP for TS 38.176-2: Transmitted signal quality. TP is provided in Annex for review.

# 2 Discussion

Transmitted signal quality requirements include frequency error, modulation quality and time alignment error requirements. IAB-DU test spec can just reuse BS test spec because the requirements are same. For IAB-MT, frequency error requirements are defined as relative requirement. IAB-MT EVM measurement is still under discussion in core spec, the test spec needs to wait the conclusion. There’s no TAE requirement for IAB-MT. So there’re several issues to be discussed before the TP is prepared.

* How to separate IAB-DU part and IAB-MT part

There could be two approaches to separate IAB-DU and IAB-MT. First is that IAB-DU can refer the whole clause of TS 38.141-2, only IAB-MT part is written. Second is that the whole content is copied from TS 38.141-2 and the content is modified to include both IAB-DU and IAB-MT. This issue is common for every requirement. Second approach may be better because there could be some changes such as declarations, reference spec section number, etc compared with TS 38.141. Referring the whole spec for IAB-DU may also not always correct. IAB-MT part needs more consideration.

In last meeting, there’s a guideline in WF that the test procedure can be separated as following if they’re different.

1. The procedure for IAB-DU and IAB-MT preferably use different paragraph starting with “For IAB-DU…” and “For IAB-MT”.

The draft TP in annex uses this approach when it’s needed.

* How to test frequency error for IAB-MT

According to the WF [2], the frequency error test can use two options,

* Option 1: Verification can be done together with EVM and allow the alternative to apply BS test equipment
* Option 2: Verify by UE approach including test set-up and test environment.

The first option make IAB-MT test reuse BS approach which is the same as IAB-DU. The second option reuses UE approach that needs some work. TS 38.521-2 can be the reference but some modifications are needed such as test environment, RMC, etc. Direct referring 38.521-2 is not feasible. Draft TP provides the preliminary structure for this part to collect comments. The details need more work in future meetings.

* EVM test procedure for IAB-MT

EVM test spec can be discussed when core spec is fixed. In the contribution [3], we propose use the same EVM measurement procedure for IAB-DU and IAB-MT. The draft TP is prepared using that assumption. It can be revised if the agreement is different.

# 3 Conclusion

This contribution provides our proposal for the TP for TS 38.176-2: Transmitted signal quality. Draft TP is provided in annex for review. TS 38.141-2 is referred and the modifications are marked to make the review easier. The spec reference number, test model number can be revised when the corresponding TPs are approved.

# Reference

[1] R4-2103856, WF on IAB conformance specification work split and drafting guidelines, Nokia

[2] R4-2103977, WF on Testing aspect on IAB-MT dynamic range, power control and frequency error, Samsung

[3] R4-2104781, Discussion on open issues of IAB-MT EVM measurement, CATT

# TP for TS 38.176-2:

6.6 OTA transmitted signal quality

6.6.1 General

Unless otherwise stated, the requirements in clause 6.6 apply during the *transmitter ON period*.

6.6.2 OTA frequency error

6.6.2.1 Definition and applicability

For IAB-DU, OTA frequency error is the measure of the difference between the actual IAB-DU transmit frequency and the assigned frequency. The same source shall be used for RF frequency and data clock generation.

For IAB-MT, OTA frequency error is the measure of the difference between actual IAB-MT transmit frequency and the carrier frequency received from the parent node.

For IAB-DU and IAB-MT, OTA frequency error requirement is defined as a directional requirement at the RIB and shall be met within the OTA coverage range.

6.6.2.2 Minimum Requirement

The minimum requirements for *IAB-DU type 1-O and IAB-DU type 2-O* are in TS 38.174 [x], clause 9.6.1.1.

The minimum requirement for *IAB-MT type 1-O and IAB-MT type 2-O* are in TS 38.174 [x], clause 9.6.1.2.6.6.2.3 Test purpose

The test purpose is to verify that OTA frequency error is within the limit specified by the minimum requirement.

6.6.2.4 Method of test

Requirement is tested together with OTA modulation quality test, as described in clause 6.6.3.

6.6.2.4.1 Initial conditions

Directions to be tested: OTA coverage range reference direction (D.35).

6.6.2.5 Test Requirements

For IAB-DU, the modulated carrier frequency of each NR carrier configured by the IAB-DU shall be accurate to within the accuracy range given in table 6.6.2.5-1 observed over 1 ms.

**Table 6.6.2.5-1: OTA frequency error test requirement for *IAB-DU type 1-O* and *IAB-DU type 2-O***

|  |  |
| --- | --- |
| **BS class** | **Accuracy** |
| Wide Area BS | ±(0.05 ppm + 12 Hz) |
| Medium Range BS | ±(0.1 ppm + 12 Hz) |
| Local Area BS | ±(0.1 ppm + 12 Hz) |

For IAB-MT type 1-O and IAB-MT type 2-O, the mean value of basic measurements of IAB-MT modulated carrier frequency shall be accurate to within ± (0.1 PPM + 12 Hz) observed over a period of 1 ms of cumulated measurement intervals compared to the carrier frequency received from the parent node.

6.6.3 OTA modulation quality

6.6.3.1 Definition and applicability

OTA modulation quality is defined by the difference between the measured carrier signal and an idealsignal. Modulation quality can e.g. be expressed as Error Vector Magnitude (EVM). The Error Vector Magnitude is a measure of the difference between the ideal symbols and the measured symbols after the equalization. This difference is called the error vector.

OTA modulation quality requirement is defined as a directional requirement at the RIB and shall be met within the *OTA coverage range*.

6.6.3.2 Minimum Requirement

The minimum requirement for *IAB-DU type 1-O*, is in TS 38.174 [x], clause 9.6.2.1.

The minimum requirement for *IAB-DU type 2-O*, is in TS 38.174 [x], clause 9.6.2.1.

The minimum requirement for *IAB-MT type 1-O*, is in TS 38.174 [x], clause 9.6.2.2.

The minimum requirement for *IAB-MT type 2-O*, is in TS 38.174 [x], clause 9.6.2.3.

6.6.3.3 Test purpose

The test purpose is to verify that OTA modulation quality is within the limit specified by the minimum requirement.

6.6.3.4 Method of test

6.6.3.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier:

- B and T; see clause 4.9.1.

*Base station RF bandwidth* positions to be tested for multi-carrier and/or CA:

- BRFBW and TRFBW in single-band operation, see clause 4.9.1;

- BRFBW\_T'RFBW and B'RFBW\_TRFBW in multi-band operation, see clause 4.9.1.

Directions to be tested:

- The OTA coverage range reference direction (D.35).

- The OTA coverage range maximum directions (D.36).

Polarizations to be tested: For dual polarized systems the requirement shall be tested and met for both polarizations.

6.6.3.4.2 Procedure for IAB-DU

1) Place the IAB-DU at the positioner.

2) Align the manufacturer declared coordinate system orientation (D.2) of the IAB-DU with the test system.

3) Orient the positioner (and IAB-DU) in order that the direction to be tested aligns with the test antenna.

4) Configure the beamforming settings of the IAB-DU according to the direction to be tested.

5) Set the IAB-DU to output according to the applicable test configuration in clause 4.8 using the corresponding test models or set of physical channels in clause 4.9.2.

 For IAB-DU type 1-O declared to be capable of single carrier operation only, set the IAB-DU to transmit a signal according to:

- IAB-DU-FR1-TM3.1a if 256QAM is supported by IAB-DU without power back off

- or IAB-DU-FR1-TM3.1a if 256QAM is supported by IAB-DU with power back off, at manufacturer's declared rated output power (Prated,c,EIRP) and IAB-DU-FR1-TM3.1 at maximum power

- or IAB-DU-FR1-TM3.1 if highest modulation order supported by IAB-DU is 64QAM

- or IAB-DU-FR1-TM3.2 if highest modulation order supported by IAB-DU is 16QAM

- or IAB-DU-FR1-TM3.3 if highest modulation order supported by IAB-DU is QPSK.

 For *IAB-DU type 1-O* declared to be capable of multi-carrier and/or CA operation, set the IAB-DU to transmit according to the applicable test signal configuration and corresponding power setting specified in clauses 4.7.2 and 4.8 using the corresponding test models on all carriers configured:

- IAB-DU-FR1-TM3.1a if 256QAM is supported by IAB-DU without power back off

- or IAB-DU-FR1-TM3.1a if 256QAM is supported by IAB-DU with power back off, at manufacturer's declared rated output power (Prated,c,EIRP) and IAB-DU-FR1-TM3.1 at maximum power

- or IAB-DU-FR1-TM3.1 if highest modulation order supported by IAB-DU is 64QAM

- or IAB-DU-FR1-TM3.2 if highest modulation order supported by IAB-DU is 16QAM

- or IAB-DU-FR1-TM3.3 if highest modulation order supported by IAB-DU is QPSK.

 For *IAB-DU type 2-O* declared to be capable of single carrier operation only, set the IAB-DU to transmit a signal according to the applicable test signal configuration and corresponding power setting specified in clause 4.7.2 and 4.8 using the corresponding test models on all carriers configured:

- IAB-DU-FR2-TM3.1a with 256QAM signal if 256QAM is supported by IAB-DU without power back off, or

- IAB-DU-FR2-TM3.1a at manufacturer's declared rated output power if 256QAM is supported by IAB-DU with power back off, and IAB-DU-FR2-TM3.1 with highest modulation order supported without power back off, or

- IAB-DU-FR2-TM3.1 with 64QAM signal if 64QAM is supported by IAB-DU without power back off, or

- IAB-DU-FR2-TM 3.1 with highest modulation order without power back off if 64QAM is not supported by IAB-DU, or

- if 64 QAM is supported by IAB-DU with power back off, IAB-DU-FR2-TM 3.1 with 64QAM at manufacturer's declared rated output power (Prated,c,EIRP) and IAB-DU-FR2-TM3.1 with highest modulation order supported at maximum power.

 For *IAB-DU type 2-O* declared to be capable of multi-carrier and/or CA operation, set the IAB-DU or IAB-MT to transmit according to:

- IAB-DU-FR2-TM3.1a with 256QAM signal if 256QAM is supported by IAB-DU without power back off, or

- IAB-DU-FR2-TM3.1a at manufacturer's declared rated output power if 256QAM is supported by IAB-DU with power back off, and IAB-DU-FR2-TM3.1 at maximum power, or

- IAB-DU-FR2-TM3.1 with 64QAM signal if 64QAM is supported by IAB-DU without power back off, or

- IAB-DU-FR2-TM3.1 with highest modulation order supported without power back off if 64QAM is not supported by IAB-DU, or

- if 64QAM is supported by IAB-DU with power back off, IAB-DU-FR2-TM3.1 with 64QAM signal at manufacturer's declared rated output power (Prated,c,EIRP) and IAB-DU-FR2-TM3.1 with highest supported modulation order at maximum power

 For IAB-DU-FR1-TM 3.1a and IAB-DU-FR2-TM 3.1, power back-off shall be applied if it is declared.

6) For each carrier, measure the EVM and frequency error as defined in annex L.

7) Repeat steps 5 and 6 for IAB-DU-FR1-TM2 if 256QAM is not supported by *IAB-DU type 1-O* or for IAB-DU-FR1-TM2a if 256QAM is supported by *IAB-DU type 1-O*. For IAB-DU-FR1-TM2 and IAB-DU-FR1-TM2a the OFDM symbol power (in the conformance direction) shall be at the lower limit of the dynamic range according to the test procedure in clause 6.4.3.4.2 and test requirements in clause 6.4.3.5.1.

 Repeat steps 5 and 6 for IAB-DU-FR2-TM2 if 256QAM is not supported by *IAB-DU type 2-O* or for IAB-DU-FR2-TM2a if 256QAM is supported by *IAB-DU type 2-O*. For IAB-DU-FR2-TM2 and IAB-DU-FR1-TM2a the OFDM symbol power (in the conformance direction) shall be at the lower limit of the dynamic range according to the test procedure in clause 6.4.3.4.2 and test requirements in clause 6.4.3.5.2.

In addition, for multi-band RIB, the following steps shall apply:

8) For multi-band RIB and single band tests, repeat the steps above per involved band where single band test configurations and test models shall apply with no carrier activated in the other band.

6.6.3.4.3 Procedure for IAB-MT

1) Place the IAB-MT at the positioner.

2) Align the manufacturer declared coordinate system orientation (D.2) of the IAB-MT with the test system.

3) Orient the positioner (and IAB-MT) in order that the direction to be tested aligns with the test antenna.

4) Configure the beamforming settings of the IAB-MT according to the direction to be tested.

5) Set the IAB-MT to output according to the applicable test configuration in clause 4.8 using the corresponding test models or set of physical channels in clause 4.9.2.

 For IAB-MT type 1-O declared to be capable of single carrier operation only, set the IAB-MT to transmit a signal according to:

- IAB-MT-FR1-TM3.1a if 256QAM is supported by IAB-MT without power back off

- or IAB-MT-FR1-TM3.1a if 256QAM is supported by IAB-MT with power back off, at manufacturer's declared rated output power (Prated,c,EIRP) and IAB-MT-FR1-TM3.1 at maximum power

- or IAB-MT-FR1-TM3.1 if highest modulation order supported by IAB-MT is 64QAM

- or IAB-MT-FR1-TM3.2 if highest modulation order supported by IAB-MT is 16QAM

- or IAB-MT-FR1-TM3.3 if highest modulation order supported by IAB-MT is QPSK.

 For *IAB-MT type 1-O* declared to be capable of multi-carrier and/or CA operation, set the IAB-MT to transmit according to the applicable test signal configuration and corresponding power setting specified in clauses 4.7.2 and 4.8 using the corresponding test models on all carriers configured:

- IAB-MT-FR1-TM3.1a if 256QAM is supported by IAB-MT without power back off

- or IAB-MT-FR1-TM3.1a if 256QAM is supported by IAB-MT with power back off, at manufacturer's declared rated output power (Prated,c,EIRP) and IAB-MT-FR1-TM3.1 at maximum power

- or IAB-MT-FR1-TM3.1 if highest modulation order supported by IAB-MT is 64QAM

- or IAB-MT-FR1-TM3.2 if highest modulation order supported by IAB-MT is 16QAM

- or IAB-MT-FR1-TM3.3 if highest modulation order supported by IAB-MT is QPSK.

 For *IAB-MT type 2-O* declared to be capable of single carrier operation only, set the IAB-MT to transmit a signal according to the applicable test signal configuration and corresponding power setting specified in clause 4.7.2 and 4.8 using the corresponding test models on all carriers configured:

- IAB-MT-FR2-TM3.1 with 64QAM signal if 64QAM is supported by IAB-MT without power back off, or

- IAB-MT-FR2-TM 3.1 with highest modulation order without power back off if 64QAM is not supported by IAB-MT, or

- if 64 QAM is supported by IAB-MT with power back off, IAB-MT-FR2-TM 3.1 with 64QAM at manufacturer's declared rated output power (Prated,c,EIRP) and IAB-MT-FR2-TM3.1 with highest modulation order supported at maximum power.

 For *IAB-MT type 2-O* declared to be capable of multi-carrier and/or CA operation, set the IAB-MT to transmit according to:

- IAB-MT-FR2-TM3.1 with 64QAM signal if 64QAM is supported by IAB-MT without power back off, or

- IAB-MT-FR2-TM3.1 with highest modulation order supported without power back off if 64QAM is not supported by IAB-MT, or

- if 64QAM is supported by IAB-MT with power back off, IAB-MT-FR2-TM3.1 with 64QAM signal at manufacturer's declared rated output power (Prated,c,EIRP) and IAB-MT-FR2-TM3.1 with highest supported modulation order at maximum power

 For IAB-MT-FR1-TM 3.1a and IAB-MT-FR2-TM 3.1, power back-off shall be applied if it is declared.

6) For each carrier, measure the EVM and frequency error as defined in annex L.

7) Repeat steps 5 and 6 for IAB-MT-FR1-TM2 if 256QAM is not supported by *IAB-MT type 1-O* or for IAB-MT-FR1-TM2a if 256QAM is supported by *IAB-MT type 1-O*. For IAB-MT-FR1-TM2 and IAB-MT-FR1-TM2a the OFDM symbol power (in the conformance direction) shall be at the lower limit of the dynamic range according to the test procedure in clause 6.4.3.4.2 and test requirements in clause 6.4.3.5.1.

In addition, for multi-band RIB, the following steps shall apply:

8) For multi-band RIB and single band tests, repeat the steps above per involved band where single band test configurations and test models shall apply with no carrier activated in the other band.

6.6.3.5 Test requirements

6.6.3.5.1 *IAB-DU type 1-O* and *IAB-MT type 1-O*

For *IAB-DU type 1-O or IAB-MT type 1-O*, the EVM of each NR carrier for different modulation schemes on PDSCH or PUSCH shall be less than the limits in table 6.6.3.5.1-1.

**Table 6.6.3.5.1-1: EVM requirements for *IAB type 1-O***

|  |  |
| --- | --- |
| **Modulation scheme for PDSCH or PUSCH** | **Required EVM (%)** |
| QPSK | 18.5  |
| 16QAM | 13.5  |
| 64QAM | 9  |
| 256QAM | 4.5  |

EVM shall be evaluated for each NR carrier over all allocated resource blocks and downlink slots. Different modulation schemes listed in table 6.6.3.5.1-1 shall be considered for rank 1.

For NR, for all bandwidths, the EVM measurement shall be performed for each NR carrier over all allocated resource blocks and downlink slots within 10 ms measurement periods. The boundaries of the EVM measurement periods need not be aligned with radio frame boundaries.

Table 6.6.3.5.1-2, 6.6.3.5.1-3, 6.6.3.5.1-4 below specify the EVM window length (*W*) for normal CP for *IAB type 1-O*.

**Table 6.6.3.5.1-2: EVM window length for normal CP, FR1, 15 kHz SCS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Channelbandwidth (MHz)** | **FFT size** | **Cyclic prefix length for symbols 1‑6 and 8-13 in FFT samples** | **EVM window length *W*** | **Ratio of *W* to total CP length for symbols 1‑6 and 8-13(Note) (%)** |
| 5 | 512 | 36 | 14 | 40 |
| 10 | 1024 | 72 | 28 | 40 |
| 15 | 1536 | 108 | 44 | 40 |
| 20 | 2048 | 144 | 58 | 40 |
| 25 | 2048 | 144 | 72 | 50 |
| 30 | 3072 | 216 | 108 | 50 |
| 40 | 4096 | 288 | 144 | 50 |
| 50 | 4096 | 288 | 144 | 50 |
| NOTE: These percentages are informative and apply to a slot's symbols 1 to 6 and 8 to 13. Symbols 0 and 7 have a longer CP and therefore a lower percentage. |

**Table 6.6.3.5.1-3: EVM window length for normal CP, FR1, 30 kHz SCS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Channelbandwidth (MHz)** | **FFT size** | **Cyclic prefix length for symbols 1‑13 in FFT samples** | **EVM window length *W*** | **Ratio of *W* to total CP length for symbols 1‑13 (Note)****(%)** |
| 5 | 256 | 18 | 8 | 40 |
| 10 | 512 | 36 | 14 | 40 |
| 15 | 768 | 54 | 22 | 40 |
| 20 | 1024 | 72 | 28 | 40 |
| 25 | 1024 | 72 | 36 | 50 |
| 30 | 1536 | 108 | 54 | 50 |
| 40 | 2048 | 144 | 72 | 50 |
| 50 | 2048 | 144 | 72 | 50 |
| 60 | 3072 | 216 | 130 | 60 |
| 70 | 3072 | 216 | 130 | 60 |
| 80 | 4096 | 288 | 172 | 60 |
| 90 | 4096 | 288 | 172 | 60 |
| 100 | 4096 | 288 | 172 | 60 |
| NOTE: These percentages are informative and apply to a slot's symbols 1 through 13. Symbol 0 has a longer CP and therefore a lower percentage. |

**Table 6.6.3.5.1-4: EVM window length for normal CP for NR, FR1, 60 kHz SCS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Channelbandwidth (MHz)** | **FFT size** | **Cyclic prefix length in FFT samples** | **EVM window length *W*** | **Ratio of *W* to total CP (Note) (%)** |
| 10 | 256 | 18 | 8 | 40 |
| 15 | 384 | 27 | 11 | 40 |
| 20 | 512 | 36 | 14 | 40 |
| 25 | 512 | 36 | 18 | 50 |
| 30 | 768 | 54 | 26 | 50 |
| 40 | 1024 | 72 | 36 | 50 |
| 50 | 1024 | 72 | 36 | 50 |
| 60 | 1536 | 108 | 64 | 60 |
| 70 | 1536 | 108 | 64 | 60 |
| 80 | 2048 | 144 | 86 | 60 |
| 90 | 2048 | 144 | 86 | 60 |
| 100 | 2048 | 144 | 86 | 60 |
| NOTE: These percentages are informative and apply to all OFDM symbols within subframe except for symbol 0 of slot 0 and slot 2. Symbol 0 of slot 0 and slot 2 may have a longer CP and therefore a lower percentage. |

6.6.3.5.2 *IAB-DU type 2-O* and *IAB-MT type 2-O*

For *IAB-DU type 2-O* and *IAB-MT type 2-O*, the EVM of each NR carrier for different modulation schemes on PDSCH or PUSCH shall be less than the limits in table 6.6.3.5.2-1.

**Table 6.6.3.5.2-1: EVM requirements for *IAB type 2-O***

|  |  |
| --- | --- |
| **Modulation scheme for PDSCH or PUSCH** | **Required EVM (%)** |
| QPSK | 18.5  |
| 16QAM | 13.5  |
| 64QAM | 9  |
| 256QAM | 4.5 |
| Note: 256QAM is not supported by FR2 IAB-MTPUSCH |

EVM requirements shall apply for each NR carrier over all allocated resource blocks and downlink slots. PT-RS should be configured for localized setting for every fourth symbol for every second RB. Different modulation schemes listed in table 6.6.3.5.2-1 shall be considered for rank 1.

For NR, for all bandwidths, the EVM measurement shall be performed for each NR carrier over all allocated resource blocks and downlink slots within 10 ms measurement periods. The boundaries of the EVM measurement periods need not be aligned with radio frame boundaries.

Table 6.6.3.5.2-2 and 6.6.3.5.2-3 below specify the EVM window length (*W*) for normal CP for *IAB-DU type 2-O* and *IAB-MT type 2-O*.

**Table 6.6.3.5.2-2: EVM window length for normal CP, FR2, 60 kHz SCS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Channel bandwidth (MHz)** | **FFT size** | **Cyclic prefix lengthin FFT samples** | **EVM window length *W*** | **Ratio of *W* to total CP length (Note)****(%)** |
| 50 | 1024 | 72 | 36 | 50 |
| 100 | 2048 | 144 | 72 | 50 |
| 200 | 4096 | 288 | 144 | 50 |
| NOTE: These percentages are informative and apply to all OFDM symbols within subframe except for symbol 0 of slot 0 and slot 2. Symbol 0 of slot 0 and slot 2 may have a longer CP and therefore a lower percentage. |

**Table 6.6.3.5.2-3: EVM window length for normal CP, FR2, 120 kHz SCS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Channel bandwidth (MHz)** | **FFT size** | **Cyclic prefix length in FFT samples** | **EVM window length *W*** | **Ratio of *W* to total CP length (Note)****(%)** |
| 50 | 512 | 36 | 18 | 50 |
| 100 | 1024 | 72 | 36 | 50 |
| 200 | 2048 | 144 | 72 | 50 |
| 400 | 4096 | 288 | 144 | 50 |
| NOTE: These percentages are informative and apply to all OFDM symbols within subframe except for symbol 0 of slot 0 and slot 4. Symbol 0 of slot 0 and slot 4 may have a longer CP and therefore a lower percentage. |

6.6.4 OTA time alignment error

6.6.4.1 Definition and applicability

This requirement shall apply to frame timing in MIMO transmission, carrier aggregation and their combinations.

Frames of the NR signals present in the radiated domain are not perfectly aligned in time. In relation to each other, the RF signals present in the radiated domain may experience certain timing differences.

For a specific set of signals/transmitter configuration/transmission mode, the OTA Time Alignment Error (OTA TAE) is defined as the largest timing difference between any two different NR signals. The OTA time alignment error requirement is defined as a *directional requirement* at the RIB and shall be met within the *OTA coverage range.*

6.6.4.2 Minimum requirement

The minimum requirement for *IAB-DU type 1-O* is in TS 38.174 [2], clause 9.6.3.1.

The minimum requirement for *IAB-DU type 2-O* is in TS 38.174 [2], clause 9.6.3.1.

6.6.4.3 Test purpose

To verify that the OTA time alignment error is within the limit specified by the minimum requirement.

6.6.4.4 Method of test

6.6.4.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: M; see clause 4.9.1.

*Base Station RF Bandwidth* positions to be tested for multi-carrier and/or CA:

- MRFBW in single-band operation, see clause 4.9.1;

- BRFBW\_T'RFBW and B'RFBW\_TRFBW in multi-band operation, see clause 4.9.1.

Directions to be tested: OTA coverage range reference direction (D.35).

Polarizations to be tested: For dual polarized systems the requirement shall be tested and met considering both polarisations. If the measurement antenna does not support dual polarization, time alignment error shall be measured under the condition that measurement antenna is aligned between the IAB-DU polarisations such that it receives half the power from each polarisation.

6.6.4.4.2 Procedure for IAB-DU

1) Place the IAB-DU at the positioner.

2) Align the manufacturer declared coordinate system orientation (D.2) of the IAB-DU with the test system.

3) Orient the positioner (and IAB-DU) in order that the direction to be tested aligns with the test antenna.

4) Configure the beamforming settings of the IAB-DU according to the direction of the testing.

5) Set the *IAB-DU type 1-O* to transmit IAB-DU-FR1-TM1.1 or any DL signal using MIMO transmission or carrier aggregation, using the configuration with the minimum number of cells and reference signals.

 Set the *IAB-DU type 2-O* to transmit IAB-DU-FR2-TM 1.1 or any DL signal using MIMO transmission or carrier aggregation, using the configuration with the minimum number of cells and reference signals.

NOTE: For MIMO transmission, different ports may be configured in IAB-DU-FR1-TM1.1 and IAB-DU-FR2-TM 1.1 (using DMRS ports *p* = 1000 and 1001 with CDM).

 For a IAB-DU declared to be capable of single carrier operation only, set the IAB-DU to transmit according to the applicable test configuration in clause 4.8 using the corresponding test model at manufacturer's declared rated output power, Prated,c,TRP.

 If the IAB-DU supports intra band contiguous or non-contiguous Carrier Aggregation set the IAB-DU to transmit using the applicable test configuration and corresponding power setting specified in clauses 4.7.2 and 4.8.

 If the IAB-DU supports inter band carrier aggregation set the IAB-DU to transmit, for each band, a single carrier or all carriers, using the applicable test configuration and corresponding power setting specified in clauses 4.7.2 and 4.8.

 For *IAB-DU type 1-O* declared to be capable of multi-carrier operation, set the IAB-DU to transmit according to the applicable test signal configuration and corresponding power setting specified in clauses 4.7.2 and 4.8 using the corresponding test model on all carriers configured.

 For *IAB-DU type 2-O* declared to be capable of multi-carrier operation, set the IAB-DU to transmit according to the applicable test signal configuration and corresponding power setting specified in clauses 4.7.2 and 4.8 using the corresponding test model on all carriers configured.

6) Measure the time alignment error between the different reference symbols on different beams on the carrier(s).

In addition, for a multi-band RIB, the following steps shall apply:

7) For a multi-band RIB and single band tests, repeat the steps above per involved band where single band test configurations and test models shall apply with no carrier activated in the other band.

6.6.4.4.2 Procedure for IAB-MT

1) Place the IAB-MT at the positioner.

2) Align the manufacturer declared coordinate system orientation (D.2) of the IAB-MT with the test system.

3) Orient the positioner (and IAB-MT) in order that the direction to be tested aligns with the test antenna.

4) Configure the beamforming settings of the IAB-MT according to the direction of the testing.

5) Set the *IAB-MT type 1-O* to transmit IAB-MT-FR1-TM1.1 or any DL signal using MIMO transmission or carrier aggregation, using the configuration with the minimum number of cells and reference signals.

 Set the *IAB-MT type 2-O* to transmit IAB-MT-FR2-TM 1.1 or any DL signal using MIMO transmission or carrier aggregation, using the configuration with the minimum number of cells and reference signals.

NOTE: For MIMO transmission, different ports may be configured in IAB-MT-FR1-TM1.1 and IAB-MT-FR2-TM 1.1 (using DMRS ports *p* = 1000 and 1001 with CDM).

 For a IAB-MT declared to be capable of single carrier operation only, set the IAB-MT to transmit according to the applicable test configuration in clause 4.8 using the corresponding test model at manufacturer's declared rated output power, Prated,c,TRP.

 If the IAB-MT supports intra band contiguous or non-contiguous Carrier Aggregation set the IAB-MT to transmit using the applicable test configuration and corresponding power setting specified in clauses 4.7.2 and 4.8.

 If the IAB-MT supports inter band carrier aggregation set the IAB-MT to transmit, for each band, a single carrier or all carriers, using the applicable test configuration and corresponding power setting specified in clauses 4.7.2 and 4.8.

 For *IAB-MT type 1-O* declared to be capable of multi-carrier operation, set the IAB-MT to transmit according to the applicable test signal configuration and corresponding power setting specified in clauses 4.7.2 and 4.8 using the corresponding test model on all carriers configured.

 For *IAB-MT type 2-O* declared to be capable of multi-carrier operation, set the IAB-MT to transmit according to the applicable test signal configuration and corresponding power setting specified in clauses 4.7.2 and 4.8 using the corresponding test model on all carriers configured.

6) Measure the time alignment error between the different reference symbols on different beams on the carrier(s).

In addition, for a multi-band RIB, the following steps shall apply:

7) For a multi-band RIB and single band tests, repeat the steps above per involved band where single band test configurations and test models shall apply with no carrier activated in the other band.

6.6.4.5 Test Requirement

6.6.4.5.1 *IAB-DU type 1-O*

For MIMO transmission, at each carrier frequency, OTA TAE shall not exceed 90 ns.

For intra-band contiguous carrier aggregation, with or without MIMO, OTA TAE shall not exceed 285 ns.

For intra-band non-contiguous carrier aggregation, with or without MIMO, OTA TAE shall not exceed 3.025 µs.

For inter-band carrier aggregation, with or without MIMO, OTA TAE shall not exceed 3.025 µs.

6.6.4.5.2 *IAB-DU type 2-O*

For MIMO transmission, at each carrier frequency, OTA TAE shall not exceed 90 ns.

For intra-band contiguous carrier aggregation, with or without MIMO, OTA TAE shall not exceed 155 ns.

For intra-band non-contiguous carrier aggregation, with or without MIMO, OTA TAE shall not exceed 285 ns.

For inter-band carrier aggregation, with or without MIMO, OTA TAE shall not exceed 3.025 µs.