**3****GPP TSG RAN WG1 #106b-e R1-xxxxxx**

**e-Meeting, October 11th – 19th**

**Agenda item:** **8.14.1**

**Title: [DRAFT] Observations for XR coverage evaluations in TR**

**Source: Moderator (Qualcomm)**

**Document for: Discussion**

This document is to collect comments from companies regarding observations for XR coverage evaluation based on contributions under AI 8.14.1.

# XR Coverage Evaluation

## Coverage based on Methodology 1

### FR1

#### DU

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Deployment environment | Link | Applications | PDB (ms) | # of UEs / cell | XR Coverage | | source |
| Mean (dB) | Data (dB) |
| FR1, DU | DL | VR/AR30 | 10 | 9 | [-121.9] | [-121.9] | vivo |
| VR/AR30 | 10 | 1 | [-118.7] | [-118.7] | vivo |
| UL | AR 1 stream / scene | 30 | 9 | [-117] | [-117] | vivo |
| AR 1 stream | 30 | 1 | [-118.7] | [-118.7] | vivo |

**Source Specific Observation**

* In Coverage Eval Method 1, FR1, DU, **AR30**, the DL coverage is [better] than that of UL by up to [4.9]dB.

1. **Please provide your comment on the above observations.**

|  |  |
| --- | --- |
| Company | Comment |
| Futurewei | It is expected that for B=1 the DL and UL coverage for such case is the same and can simply be derived simply from coupling gain CDF for all UEs. Furthermore, it is strange that B=1 shows better coverage than B=1 for DL. Need some explanation. |
| Huawei, HiSilicon | The observation might only be suitable for B = capacity. For B = 1, DL coverage is the same as that of UL. |
|  |  |

#### UMa

Table 111 XR Coverage FR1, UMa

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Deployment environment | Link | Applications | PDB (ms) | # of UEs / cell | XR Coverage | | source |
| Mean (dB) | Data (dB) |
| FR1, UMa | DL | CG30 | 15 | Capacity | [-134.38] | [-134.38] | HW |
| 1 | [-141.595] | [-146, -137.19] | HW, Ericsson |
| VR/AR30 | 10 | Capacity | [-132.86] | [-132.86] | HW |
| 1 | [-139.5] | [-141, -140.9, -139, -137.19] | HW, vivo, Ericsson |
| VR/AR45 | 10 | Capacity | [-132.95] | [-132.95] | HW |
| 1 | [-136.58] | [-136.58] | HW |
| UL | Pose | 10 | 1 | [-132.5] | [-136.01, -129] | HW, Ericsson |
| AR 1 stream / scene | 30 | 1 | [-122.90] | [-124.2, -121.61] | HW, vivo, Ericsson |

**General Observation**

* In Coverage Eval Method 1, FR1, DU, **CG30**, the DL coverage is [better] than that of UL by up to [9]dB when B=1.
* In Coverage Eval Method 1, FR1, DU, **VR30**, the DL coverage is [better] than that of UL by up to [7]dB when B=1.
* In Coverage Eval Method 1, FR1, DU, **AR30**, the DL coverage is [better] than that of UL by up to [16.6]dB when B=1.
* In Coverage Eval Method 1, FR1, DU, **AR45**, the DL coverage is [better] than that of UL by up to [13.68]dB when B=1.

**General Observation**

* In Coverage Eval Method 1, FR1, UMa has [better] coverage than DU for the same application.

1. **Please provide your comment on the above observations.**

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| --- | --- |
| Company | Comment |
| Futurewei | For the first set of observation, it should be for UMa. For the second set of observation, can we really say Uma has **better** coverage than DU? What does it really mean? It is simply an artifact of this methodology as we pointed out before. Methodology 1 is flawed. |
| Huawei, HiSilicon | The first set of observations are for UMa.  The second set of observation may not be suitable, since the results for DU and UMa are from different sources. No such observation can be observed. |
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### FR2

#### DU

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Deployment environment | Link | Applications | PDB (ms) | # of UEs / cell, B | XR Coverage | | source |
| Mean (dB) | Data (dB) |
| FR2, DU | DL | CG8 | 15 | 30 | [-100] |  | QC |
| VR/AR30 | 10 | Capacity | [-106.65] | [-108.8, -104.5] | QC, vivo |
| 1 | [-106.9] | [-106.9] | vivo |
| UL | Pose | 10 | 10 | [-105.2] | [-105.2] | QC |
| AR 1 stream / scene | 30 | Capacity | [-103.35] | [-104.8, -101.9] | QC, vivo |
| 1 | [-106.9] | [-106.9] | vivo |

**General Observation**

* In Coverage Eval Method 1, FR2, DU, **CG8**, B=30, the UL coverage is [better] than that of DL by up to [5.2]dB when B=Capacity
* In Coverage Eval Method 1, FR2, DU, **VR30**, B=Capacity, the DL coverage is [better] than that of UL by up to [1.45]dB when B=Capacity.
* In Coverage Eval Method 1, FR2, DU, **AR30**, the DL coverage is [better] than that of UL by up to [3.3]dB when B=Capacity.
* In Coverage Eval Method 1, FR2, DU, **AR30**, the DL coverage is similar with that of UL when B=1.

1. **Please provide your comment on the above observations.**

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| --- | --- |
| Company | Comment |
| Futurewei | When comparing the DL and UL results, the B value should be the same for DL and UL simulation. Otherwise, the comparison is not meaningful. So please the companies specify the values of B. |
| Huawei, HiSilicon | Suggest red changes:   * In Coverage Eval Method 1, FR2, DU, **CG8**, ~~B=30,~~ the UL coverage is [better] than that of DL by up to [5.2]dB when B=Capacity * In Coverage Eval Method 1, FR2, DU, **VR30**, ~~B=Capacity,~~ the DL coverage is [better] than that of UL by up to [1.45]dB when B=Capacity. |
|  |  |

#### InH

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Deployment environment | Link | Applications | PDB (ms) | # of UEs / cell | XR Coverage (dB) | | source |
| Mean (dB) | Data |
| FR2, DU | DL | CG8 | 15 | 30 | [-85.4] | [-85.4] | QC |
| VR/AR30 | 10 | Capacity | [-84.8] | [-86.5, -82.9] | QC, vivo |
| 1 | [-85] | [-85] | vivo |
| UL | Pose | 10 | 25 | [-90.5] | [-90.5] | QC |
| AR 1 stream / scene | 30 | Capacity | [-82.55] | [-85, -80.1] | vivo, QC |
| 1 | [-85] | [-85] | vivo |

**General Observation**

* In Coverage Eval Method 1, FR2, InH, **CG8**, B=Capacity, the UL coverage is [better] than that of DL by up to around [5.1]dB.
* In Coverage Eval Method 1, FR2, InH, **VR30**, B=Capacity, the UL coverage is [better] than that of DL by up to [5.8]dB.
* In Coverage Eval Method 1, FR2, InH, **AR30**, the DL coverage is [better] than that of UL by up to [2.15]dB.

**General Observation**

* Coverage Evaluation Methodology 1 in FR1 and FR2:
  + The coverage evaluated in capacity regime (B=Capacity) is in general worse than the coverage measured with B=1.

1. **Please provide your comment on the above observations.**

|  |  |
| --- | --- |
| Company | Comment |
| Futurewei | When comparing the DL and UL results, the B value should be the same for DL and UL simulation. Otherwise, the comparison is not meaningful. So please the companies specify the values of B. |
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## Coverage based on Methodology 2

In methodology 2, we evaluate XR coverage with 1 UE per network.

### FR1

#### DU

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| --- | --- | --- | --- | --- | --- | --- |
| Deployment environment | Link | Applications | PDB (ms) | XR Coverage | | source |
| Mean (dB) | Data (dB) |
| FR1, DU | DL | CG30 | 15 | [-138.45] | [-141.4, -135.5] | QC, Intel |
| VR/AR30 | 10 | [-138.93] | [-144.58, -137.4 -134.80] | vivo, QC, Intel |
| UL | Pose | 10 | [-137.47] | [-140.3, -134.6] | QC, Intel |
| AR 1 stream / scene | 30 | [-126.84] | [-126.84] | vivo |
| AR 2 streams | 10,30 | [-119.9] | [-119.9] | QC |

**General Observation**

* In Coverage Eval Method 2, FR1, DU, **CG30**, the DL coverage is [better] than that of UL by up to around [0.98]dB.
* In Coverage Eval Method 2, FR1, DU, **VR30**, the DL coverage is [better] than that of UL by up to [1.07]dB.
* In Coverage Eval Method 2, FR1, DU, **AR30**, the DL coverage is [better] than that of UL by up to [18.64]dB.

1. **Please provide your comment on the above observations.**

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| --- | --- |
| Company | Comment |
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|  |  |

#### UMa

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Deployment environment | Link | Applications | PDB (ms) | XR Coverage (dB) Mean, Range | source |
| FR1, UMa | DL | CG30 | 15 | [-147.16, (-148.2, -146.4)] | HW, Intel, QC |
| VR/AR30 | 10 | [-144.67, (-150.07, -141.6)] | HW, vivo, Intel, QC |
| VR/AR45 | 10 | [-143.85] | HW |
| UL | Pose | 10 | [-139.73, (-140.5, -137.81)] | HW, Intel, QC |
| AR 1 stream / scene | 30 | [-124.48, (-126.39, -122.57)] | HW, vivo |
| AR 2 stream | 10,30 | [-121.7] | QC |

**General Observation**

* In Coverage Eval Method 2, FR1, UMa, **CG30**, the DL coverage is [better] than that of UL by up to around [7.43]dB.
* In Coverage Eval Method 2, FR1, UMa, **VR30**, the DL coverage is [better] than that of UL by up to [4.93]dB.
* In Coverage Eval Method 2, FR1, UMa, **AR30**, the DL coverage is [better] than that of UL by up to [22.15]dB.

**General Observation**

* For Coverage Evaluation Methodology 2 in FR1;
  + In DU/UMa, DL coverage is [better] than UL coverage, which indicates that [UL] is ***bottleneck***.
  + Applications with relaxed requirements (e.g., lower data rate, larger PDB) has larger coverage.
  + UMa has [better] coverage than DU due to higher tx power (5dB).
  + UMa and DU have similar UL coverage.
  + UL Pose has [1~7]dB [worse] coverage than CG30 DL.
  + UL Pose has [1~5]dB [worse] coverage than VR30 DL.
  + AR UL has [18~ 22]dB [worse] coverage than AR30 DL.

1. **Please provide your comment on the above observations.**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei, HiSilicon | For the second set of observations,  Sub-bullet#3 is only correct for DL.  Sub-bullet#3 and #4 are from different sources. Companies may have different simulation setups.  Sub-bullet#5~#7 are already captured in the first set of observations. No need to capture again. |
|  |  |
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### FR2

#### DU

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Deployment environment | Link | Applications | PDB (ms) | XR Coverage (dB) Mean, Range | # of data points |
| FR2, DU | DL | AR30 | 10 | -127.66 | 1 (vivo) |
| UL | AR 1 stream / scene | 30 | -120.17 | 1 (vivo) |

**General Observation**

* In Coverage Eval Method 2, FR2, DU, **AR30**, the DL coverage is [better] than that of UL by up to around [7.51]dB.

**General Observation**

* In Coverage Eval Method 2, DU, AR30 DL, the DL coverage of FR1 is [better] than that of FR2 by up to [10.88]dB.
* In Coverage Eval Method 2, DU, AR30 UL, the UL coverage of FR1 is [better] than that of FR2 by up to [6.67]dB.

1. **Please provide your comment on the above observations.**

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| --- | --- |
| Company | Comment |
| Huawei, HiSilicon | For the first set of observations, source specific observation might be better, since there is only one source.  For the second set of observations, comparison between FR1 and FR2 may not be proper, since they may have different sources and thus different simulation setups. |
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#### InH

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| --- | --- | --- | --- | --- | --- |
| Deployment environment | Link | Applications | PDB (ms) | XR Coverage (dB) Mean, Range | # of data points |
| FR2, InH | DL | AR30 | 10 | -102.67 | 1 (vivo) |
| UL | AR 1 stream / scene | 30 | -108.17 | 1 (vivo) |

**Source Specific Observation**

* In Coverage Eval Method 2, FR2, InH, **AR30**, the UL coverage is [better] than that of DL by up to around [5.5]dB.

**Source Specific Observation**

* The coverage of Coverage Evaluation Methodology 1 (w/ B=1) is in general smaller than that measured based on Evaluation Methodology 2 for the same case.

1. **Please provide your comment on the above observations.**

|  |  |
| --- | --- |
| Company | Comment |
| Futurewei | Comparing methodology 1 and 2 is interesting though we all knew this even before doing simulation as methodology 1 included inter-cell interference and hence does not really give conventional coverage result. |
| Huawei, HiSilicon | For the second set of observations, the observation is somehow reasonable, since methodology 1 includes inter-cell interference and hence the results can be smaller than that measured based on methodology 2. However, comparison between different methodologies may not be needed. Just capturing the results of both methodologies is enough. |
|  |  |