**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. |
|  |  |
|  |  |

#### UMa

Table 111 XR Coverage FR1, UMa

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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.**

|  |  |
| --- | --- |
| 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. |
|  |  |
|  |  |

### FR2

#### DU

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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.**

|  |  |
| --- | --- |
| 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. |
|  |  |
|  |  |

#### InH

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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. |
|  |  |
|  |  |

## Coverage based on Methodology 2

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

### FR1

#### DU

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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.**

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

#### 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 |
|  |  |
|  |  |
|  |  |

### 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.**

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

#### InH

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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. |
|  |  |
|  |  |