**3GPP TSG RAN WG1 #100bis R1-200xxxx**

**e-Meeting, April 20th – 30th, 2020**

**Source: Ad-Hoc Chair (AT&T)**

**Title: Chairman's Notes of AI 7.2.11.6**

**Agenda Item:** **7.2.11.6**

**Document for:** **Endorsement**

1.

#### 7.2.11.6 UE features for eMIMO

[R1-2001868](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001868.zip) Summary on UE features for eMIMO Moderator (AT&T)

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
|  | 16-3a | Regular eType-II | Basic components:1. ~~FFS:~~ {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support regular eType-II including PMI sub-band size (FFS: Support of PMI sub-bands with R=2 as new FG instead)
2. ALT 1-1) 8 parameter combinations [see Alt. 2 in R1-2001868] (FFS: Value of L per the number of antenna ports)ALT 1-2) Support of parameter combinations 1-6
3. ~~Number of PMI sub-bands (R=1 is mandatory, FFS: R=2 is mandatory or optional)~~ Support of PMI sub-bands with value R=1
4. Support ~~Rank restriction~~ of rank 1,2
5. FFS: UCI omission [based on CSI group definition]
6. FFS: CBSR with hard amplitude restriction

Optional components1. ~~Number of PMI sub-bands (R=1 is mandatory, FFS: R=2 is mandatory or optional)~~ Support of PMI sub-bands with R=2
2. ~~Rank 1 to 4~~ Support of rank 3,4
3. ALT 1) CBSR with soft amplitude restriction (capture consequence if not supported 🡪 hard amplitude restriction is supported)
4. ALT 2) CBSR
5. ALT 3) soft amplitude restriction
6. ~~FFS:~~ The maximum number of configured aperiodic CSI Report Settings for all codebook types (ALT 1 new 16-x ALT 2 handle by type or BC: more ports in FR1 than FR2)
7. FFS: new Support of mixed codebook types (new FG)
8. optional parameter combinations (see Alt. 1-1/1-2)
 | TBD |  | N/A |  | FFS: Per band or Per band per BC | N | N |  |  | Optional |
| 16-3b | Port selection eType-II | Basic components:1. FFS: {Max # of Tx ports in one resource, Max # of resources and total # of Tx ports} to support regular eType-II
2. 6 parameter combinations (combos with L=6 don’t apply) (FFS: Value of L per the number of antenna ports)
3. ~~Number of PMI sub-bands (R=1 is mandatory, FFS: R=2 is mandatory or optional)~~ Support of PMI sub-bands with value R=1
4. Rank restriction
5. ~~FFS:~~ UCI omission

Optional components:1. ~~Number of PMI sub-bands (R=1 is mandatory, FFS: R=2 is mandatory or optional)~~ Support of PMI sub-bands with R=2
2. ~~Rank 1 to 4~~ Support of rank 3,4
3. FFS: The maximum number of configured aperiodic CSI Report Settings
4. FFS: Support of mixed codebook types
 | TBD |  | N/A |  | FFS: Per band or Per band per BC | N | N |  |  | Optional |
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| 16-2a | Multi-DCI based multi-TRP | Basic components:1. The maximum number of CORESETs configured per “PDCCH-Config”
2. The maximum number of CORESETs configured per CORESETPoolIndex ( if CORESETPoolIndex is not configured, it is assumed CORESETPoolIndex = 0) per “PDCCH-Config”
3. The value of R=[1,2] for BD/CCE
4. Support of fully/partially time/frequency overlapped PDSCH reception (PDSCHs overlapping types in time and frequency domain) (requires 5/6/7 to schedule)
5. Support of out-of-order operation for PDCCH to PDSCH (FFS whether to be a basic component)
6. Support of out-of-order operation for PDSCH to HARQ-ACK (FFS whether to be a basic component)
7. Support of out-of-order operation for PDCCH to PUSCH (FFS whether to be a basic component)
8. FFS: The maximum number of activated TCI states
9. FFS: The maximum number of MIMO layers of scheduled PDSCHs
10. FFS: the maximum number of CCs supporting multi-DCI based multi-TRP

Optional components:1. Whether the UE shall rate match around configured CRS patterns which is associated with CORESETPoolIndex (if configured) and are applied to the PDSCH scheduled with a DCI detected on a CORESET with the same value of CORESETPoolIndex
2. FFS: Support of two PDSCH scrambling sequences per serving cell
3. Support of default QCL assumption per CORESETPoolIndex
4. Support of separate HARQ-ACK
5. Support of joint HARQ-ACK
6. Support of two TDMed long PUCCHs in a slot
 | TBD |  | N/A |  | TBD [per band / per FSPC] | N | TBD |  |  | TBD |

**Agreement:**

* Introduce at least one or more new FGs for current basic components (5),(6),(7) “out-of-order operation”
	+ All details of new FGs are FFS incl. prerequisite
* FFS: Introduce one new FG for current basic component (4) “fully/partially time/frequency overlapped”

**Proposal:**

Introduce three new FGs for current basic component (4) “fully/partially time/frequency overlapped”

* Support of partially time/frequency overlapped PDSCH reception (PDSCHs overlapping types in time and frequency domain)
* Support of fully time/frequency overlapped PDSCH reception (PDSCHs overlapping types in time and frequency domain)
* Support of non-overlapped PDSCH reception (PDSCHs overlapping types in time and frequency domain)

Agreement: Introduce a new FG 16-2a-1 “Separate CRS rate matching”. The following is the starting point for further discussion by email.

**Alt. 1:**

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| 16-2a-1 | Multi-DCI based multi-TRP CRS rate matching  | Whether the UE shall rate match around configured CRS patterns which is associated with CORESETPoolIndex (if configured) and are applied to the PDSCH scheduled with a DCI detected on a CORESET with the same value of CORESETPoolIndex | 16-2a, TBD |  | N/A |  | TBD [per band / per FSPC] | N | TBD |  |  | TBD |

**Alt. 2:**

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| 16-2a-1 | Multi-DCI based multi-TRP CRS rate matching  | Support of CRS rate matching for Multi-DCI based Multi-TRP operation. “Joint” is mandatory for UE that supports Multi-DCI based Multi-TRP CRS rate matching, but “Separate” is optional * Joint: UE rate match around the union of CRS from both TRPs
* Separate: UE rate match around configured CRS patterns which is associated with CORESETPoolIndex (if not configured, CORESETPoolIndex=0) and are applied to the PDSCH scheduled with a DCI detected on a CORESET with the same value of CORESETPoolIndex
 | 16-2a, TBD |  | N/A |  | TBD [per band / per FSPC] | N | TBD |  |  | TBD |

**Conclusion:** Change the existing FG 16-6a as follows, introduce a new FG 16-6c as follows.

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| Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 16-6a | Low PAPR DMRS for PUSCH without transform precoding | For PUSCH without transform precoding | TBD | Y | N/A | Y | FFS: Per band | N/A | N/A |  |  |  FFS: Optional with capability signalling |
| 16-6c | Low PAPR DMRS for PUSCH with transform precoding and with pi/2 BPSK | For PUSCH with transform precoding and with pi/2 BPSK modulation | TBD | Y | N/A | Y | FFS: Per band | N/A | N/A |  |  |  FFS: Optional with capability signalling |

**Alt. 1: Delete FG 16-5a**

**Alt. 2:**

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| 16-5a | UL full power transmission mode 0 | 1. Supported UL full power transmission [mode 0]
2. Number of ~~Tx~~ SRS antenna ports to support mode 1: {2~~Tx~~, 4~~Tx, 2Tx\_4Tx~~ }
 | 2-13, 2-14 | Y | N/A | Y | FFS: Per FS or Per band or Per band per BC | ~~N~~ N/A | ~~N~~ N/A |  |  | TBD |

**Alt. 3:**

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| 16-5a | UL full power transmission ~~mode 0~~ | 1. Supported UL full power transmission ~~[mode 0]~~
2. ~~Number of Tx SRS antenna ports to support mode 1: {2Tx, 4Tx, 2Tx\_4Tx }~~
 | 2-13, 2-14 | Y | N/A | Y | FFS: Per FS or Per band or Per band per BC | ~~N~~ N/A | ~~N~~ N/A |  |  | TBD |

**Working assumption:** Introduce a new FG 16-5a. The following is the starting point for further discussion by email with the intention to replace “mode 0” by the actual RRC parameter name

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| 16-5a | UL full power transmission [mode 0] | Supported UL full power transmission [mode 0] | 2-13, 2-14 | Y | N/A | Y | FFS: Per FS or Per band or Per band per BC | N/A | N/A |  |  | TBD |

* Address Nokia comment “we need to clarify the content better, as mode 0 is not defined in the specifications” and Qualcomm comment “with mode 0 removed it is unclear that this FG is for the whole Rel-16 full power feature”

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| 16-5c | UL full power transmission mode 2 | 1. Supported UL full power transmission mode 2
2. Number of ~~Tx~~ SRS antenna ports to support mode 1: {2~~Tx~~, 4~~Tx, 2Tx\_4Tx~~ }
3. The maximum number of SRS resources in set with different number of ports [for usage set to ‘codebook’]. FFS on details for supported number of Tx.
4. FFS: Maximum number of ports per SRS resource
5. FFS: Maximum number of different spatial relation info for all SRS resources for usage set to ‘codebook’ in a resource set
6. TPMI group which delivers full power. FFS on details for supported number of Tx.

Note: UE indicating mode 2 shall support full power transmission for 1 antenna port | 2-13, 2-14, 16-5b | Y | N/A | Y | FFS: Per FS or Per band or Per band per BC | ~~N~~ N/A | ~~N~~ N/A |  |  | TBD |

Single FG: supported by 8 companies

Split FG: supported by 5 companies

**Proposal:** Agree number of FGs, continue discussion by email

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| 16-1a | L1-SINR reporting | 1. The maximum number of L1-SINR based beam measurement and reporting based on ZP IMR and/or NZP IMR (FFS details on the sub-components, e.g., FG 2-24)
2. FFS: Support of group-based reporting for L1-SINR
 | TBD  |  | N/A |  | TBD[Per band] | N | N |  |  | TBD |

**Working assumption:** There will be three FGs for L1-SINR reporting structured similarly to R15 L1-RSRP

* RS related capability
* Number of non-group based L1-SINR reports
* Group-based L1 SINR report

Note: candidate component values and other details to be discussed in second round

Continue discussion by email using R15 L1-RSRP as starting point for R16 L1-SINR description

* Apple to share wording for FL to update email discussion summary in Inbox

**Alt. 2:**

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| 16-1b | TCI state activation and spatial relation update | 1. ~~[~~Support of ~~/ maximum number of lists for]~~ Simultaneous TCI state activation across multiple CCs: PDCCH, PDSCH ~~(FFS whether to be a separate UE feature, e.g. 16-1b)~~
2. ~~[Support of / maximum number of lists for] Simultaneous spatial relation update across multiple CCs: AP-SRS, SP-SRS~~
3. ~~[Support of / The maximum number of] PUCCH resource groups per BWP for simultaneous spatial relation update~~
4. FFS: details on whether/how to indicate band pairs which can share the same DL TCI state
5. ~~FFS: details on whether/how to indicate band pairs which can share the same UL spatial relation info~~
 | Component 1: 2-1, 2-4~~Component 2: 2-59, 2-60~~~~Component 3: 2-53, 2-59, 4-24~~ |  | N/A |  | TBD[Per BC or per band] | N | Y |  |  | TBD |
| 16-1b-2 | Spatial relation update across multiple CCs | 1. Support of Simultaneous spatial relation update across multiple CCs: AP-SRS, SP-SRS
2. FFS: details on whether/how to indicate band pairs which can share the same UL spatial relation info
 | Component 1: 2-59, 2-60 |  | N/A |  | TBD[Per BC or per band] | N | Y |  |  | TBD |
| 16-1b-3 | Spatial relation update for PUCCH group | Support of PUCCH resource groups per BWP for simultaneous spatial relation update | 2-53, 2-59, 4-24 |  | N/A |  | TBD[Per BC or per band] | N | Y |  |  | TBD |

**Alt. 3:**

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| ~~16-1b~~ | ~~TCI state activation and spatial relation update~~ | 1. ~~[Support of / maximum number of lists for] Simultaneous TCI state activation across multiple CCs: PDCCH, PDSCH (FFS whether to be a separate UE feature, e.g. 16-1b)~~
2. ~~[Support of / maximum number of lists for] Simultaneous spatial relation update across multiple CCs: AP-SRS, SP-SRS~~
3. ~~[Support of / The maximum number of] PUCCH resource groups per BWP for simultaneous spatial relation update~~
4. ~~FFS: details on whether/how to indicate band pairs which can share the same DL TCI state~~
5. ~~FFS: details on whether/how to indicate band pairs which can share the same UL spatial relation info~~
 | ~~Component 1: 2-1, 2-4~~~~Component 2: 2-59, 2-60~~~~Component 3: 2-53, 2-59, 4-24~~ |  | ~~N/A~~ |  | ~~TBD~~~~[Per BC or per band]~~ | ~~N~~ | ~~Y~~ |  |  | ~~TBD~~ |
| 16-1b1 | Cross-CC TCI state activation | Support of simultaneous TCI state activation across multiple CCs: PDCCH, PDSCH  | 2-1, 2-4 |  | N/A |  | FFS | N/A | N/A |  |  | TBD |
| 16-1b2 | Cross-CC spatial relation update | Support of simultaneous spatial relation update across multiple CCs: AP-SRS, SP-SRS | 2-59, 2-60 |  | N/A |  | FFS | N/A | N/A |  |  | TBD |
| 16-1b3 | PUCCH resource groups  | Support of PUCCH resource groups per BWP for simultaneous spatial relation update | 2-53, 2-59, 4-24 |  | N/A |  | FFS | N/A | N/A |  |  | TBD |

**Working assumption:** AssumepreviousFG 16-1b requires three FGs, use Alt. 2 for further email discussion

FFS: maximum component values and all other details FFS

**Alt. 1: Delete FG 16-1g**

**Alt. 2:**

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| 16-1g | ~~FFS:~~ Resources for beam management, pathloss measurement, BFD, and BFR | 1. FFS: The maximum number of SSB/CSI-RS resources within a slot across all CCs for any of L1-RSRP measurement, L1-SINR measurement, ~~pathloss measurement, BFD~~, and new beam identification.
2. FFS: The maximum number of SSB/CSI-RS resources within a slot across all CCs for pathloss measurement
3. FFS: The maximum number of SSB/CSI-RS resources within a slot across all CCs for BFD
4. FFS: The maximum number of SSB/CSI-RS resources across all CCs for new beam identification
 |  |  | N/A |  | TBD | N |  |  |  | TBD |

**Alt. 3:**

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| 16-1g | ~~FFS:~~ Resources for beam management, pathloss measurement, BFD, and BFR | 1. The total number (sum of periodic/semi-persistent/aperiodic) of
	* SSB/NZP-CSI-RS/CSI-IM resources configured for L1-RSRP/L1-SINR, and
	* BFR resources configured for new beam identification, and
	* BFD resources configured for beam failure detection, and
	* Pathloss RS resources configured for pathloss measurement

across all CCs shall not exceed M\_11. The total number of aperiodic NZP-CSI-RS/CSI-IM resources configured for L1-RSRP/L1-SINR across all CCs shall not exceed M\_2
2. The total number (sum of periodic/semi-persistent/aperiodic) of
	* SSB/NZP-CSI-RS resources to perform measurement on CMR for L1-RSRP/L1-SINR, and
	* BFR resources to perform measurement for new beam identification, and
	* BFD resources to perform measurement for beam failure detection, and
	* Pathloss RS resources to perform measurement for pathloss

across all CCs within a slot shall not exceed M\_31. The total number (sum of periodic/semi-persistent/aperiodic) of NZP-CSI-RS/CSI-IM resources to perform measurement on IMR for L1-SINR across all CCs within a slot shall not exceed M\_4
2. ~~FFS: The maximum number of SSB/CSI-RS resources across all CCs for any of L1-RSRP measurement, L1-SINR measurement, pathloss measurement, BFD, and new beam identification.~~
3. ~~FFS: The maximum number of SSB/CSI-RS resources across all CCs for pathloss measurement~~
4. ~~FFS: The maximum number of SSB/CSI-RS resources across all CCs for BFD~~
5. ~~FFS: The maximum number of SSB/CSI-RS resources across all CCs for new beam identification~~
 | 2.24 |  | N/A |  | TBD | N |  |  |  | TBD |

**Proposal:** Down-select either Alt. 2 or Alt. 3 for further email discussion (i.e., there will be a dedicated FG 16-1g for resources for beam management, pathloss measurement, BFD, and BFR)

[R1-2001604](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001604.zip) NR eMIMO UE features ZTE

[R1-2001722](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001722.zip) Discussion on Rel-16 eMIMO UE features vivo

[R1-2001738](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001738.zip) Discussion on Rel-16 eMIMO UE features OPPO

[R1-2001794](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001794.zip) UE features for MIMO China Unicom

[R1-2001829](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001829.zip) Views on Rel-16 UE features for NR eMIMO MediaTek Inc.

[R1-2002020](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002020.zip) UE features for NR eMIMO Intel Corporation

[R1-2002071](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002071.zip) Discussion of UE features for NR MIMO CATT

[R1-2002155](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002155.zip) UE features for eMIMO Samsung

[R1-2002161](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002161.zip) Discussion on RAN1 UE feature for NR eMIMO LG Electronics

[R1-2002274](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002274.zip) Discussions on UE features for eMIMO Spreadtrum Communications

[R1-2002353](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002353.zip) Views on Rel-16 eMIMO UE feature list Apple

[R1-2002476](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002476.zip) On UE features for eMIMO Nokia, Nokia Shanghai Bell

[R1-2002494](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002494.zip) eMIMO UE features Ericsson

[R1-2002499](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002499.zip) Discussion on UE features for eMIMO CMCC

[R1-2002567](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002567.zip) Discussion on eMIMO UE features Qualcomm Incorporated

[R1-2002592](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002592.zip) Rel-16 UE features for MIMO Huawei, HiSilicon

[R1-2002628](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002628.zip) Discussion on UE capability issues Fraunhofer IIS, Fraunhofer HHI