**3GPP TSG RAN WG1 #110 R1-2207928**

**Toulouse, France, August 22nd – 26th, 2022**

**Agenda item:** 9.1.1.1

**Source:** Moderator (MediaTek)

**Title:** Moderator summary on extension of unified TCI framework (Round 1)

**Document for:** Discussion and Decision

# Issue 1 – General framework for unified TCI extension

**Proposal 1.A**: On unified TCI framework extension, up to X (X > 1) joint/DL TCI states can be applied simultaneously to CJT-based PDSCH reception, where the UE shall assume that the PDSCH DM-RS port(s) is QCLed with the DL RSs of the joint/DL TCI states

* FFS: PDSCH DM-RS port(s) is QCLed with the more than one joint/DL TCI states with what QCL type(s)
* FFS: RAN1 to make decision in RAN1#110bis-e on the value of X
* Note: CJT in Rel-18 targets only FR1

**Support/fine:**

**Not support:**

**Alternative proposal for Issue 1.1 –**

**Proposal 1.A-1**: On unified TCI framework extension, decide in RAN1#110, whether X (X > 1) joint/DL TCI states can be applied simultaneously to CJT-based PDSCH reception

* FFS: If supported, RAN1 to make decision in RAN1#110bis-e on how the PDSCH DM-RS port(s) is QCLed with the DL RSs of the joint/DL TCI states
* FFS: If supported, RAN1 to make decision in RAN1#110bis-e on the value of X
* Note: CJT in Rel-18 targets only FR1

**Support/fine:**

**Not support:**

**Proposal 1.B-1**: On unified TCI framework extension, at least for the target use cases other than CJT, up to 4 TCI states can be applied in a CC/BWP to DL receptions and UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation

* FFS: The possible combination(s) of joint/DL/UL TCI states that can be applied to DL receptions and/or UL transmissions in a BWP/CC
* FFS: The possible combination(s) of joint/DL/UL TCI states that can be applied to DL receptions and/or UL transmissions per TRP

**Support/fine:**

**Not support:**

Table 1 Additional inputs for Issue 1

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V00 | **Please share your preference and further input, if any, to above moderator proposals** |
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# Issue 2 – TCI state update and activation

**Proposal 2.A-1:** On unified TCI framework extension for M-DCI based MTRP, RAN1 to make decision on support only Option 1 or support both following options in RAN1#110bis-e:

* Option 1: Use the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *coresetPoolIndex* values to indicate the joint/DL/UL TCI state(s) associated with the same *coresetPoolIndex* value
  + The UE shall apply the joint/DL/UL TCI state(s) associated with a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the *coresetPoolIndex* value
* Option 2: Use the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *coresetPoolIndex* values to indicate the joint/DL/UL TCI state(s) associated with the same or different *coresetPoolIndex* value
  + The UE shall apply the joint/DL/UL TCI state(s) associated with a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the *coresetPoolIndex* value
  + FFS: Detail of signaling

**Support/fine:**

**Not support:**

Table 2 Additional inputs for Issue 2

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| **Company** | **Input** |
| Mod V00 | **Please share your preference and further input, if any, to above moderator proposals** |
| Xiaomi | We prefer to support Option 2 in the case of TRP beam failure. |
|  |  |

# Issue 3 – How to associate the indicated TCI state(s) with each target channel/signal

**Proposal 3.B:** On unified TCI framework extension for S-DCI based MTRP, to inform the association with joint/DL TCI state(s) indicated by DCI/MAC-CE and enable dynamic switching between STRP and MTRP operations for PDSCH reception, down-selection one alternative from the followings:

* Alt1: Use an indicator field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 1\_1/1\_2 to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2
  + FFS: PDSCH reception scheduled/activated by DCI format 1\_0
* Alt2: Reuse the existing TCI field in a DCI format 1\_1/1\_2, i.e., the UE shall apply the joint/DL TCI state(s) mapped to the TCI codepoint indicated by the DCI format 1\_1/1\_2 to PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2 if the PDSCH reception is scheduled/activated after the beam application time as defined in Rel-17
* Alt3: Use RRC parameter(s) in a PDSCH configuration in a DL BWP to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception in the DL BWP
  + Note: Dynamic switching between STRP and MTRP operations can be achieved by indication of all the same or different joint/DL TCI states to the indicated joint/DL TCI states if multiple indicated joint/DL TCI states are applied to PDSCH reception in the DL BWP according to the RRC parameter(s)
* Alt4: Use an RRC parameter in a CORESET configuration to inform that the CORESET belongs to which CORESET group(s), and the indicated joint/DL TCI state(s) is associated with each CORESET group. When a scheduling/activation DCI is received in a CORESET group, the indicated joint/DL TCI state(s) associated with the CORESET group is applied to PDSCH reception scheduled/activated by the scheduling/activation DCI.

**Support/fine:**

**Not support:**

**Proposal 3.C:** On unified TCI framework extension for S-DCI based MTRP, for PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2, down-selection one alternative from the followings:

* Alt1: Use an indicator field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 0\_1/0\_2 to inform which joint/UL TCI state(s) indicated by MAC-CE/DCI the UE shall apply to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2
* Alt2: PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2 follows the spatial domain transmission filter(s) used for the SRS resource(s) indicated by the DCI format 0\_1/0\_2

FFS: PUSCH transmission scheduled/activated by a DCI format 0\_0 and Type-1 CG-PUSCH

**Support/fine:**

**Not support:**

**Proposal 3.D:** On unified TCI framework extension for S-DCI based MTRP, to inform the association with joint/UL TCI state(s) indicated by DCI/MAC-CE for PUCCH transmission, down-selection at least one alternative from the followings:

* Alt1: Use RRC configuration to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/ group
* Alt2: Use RRC configuration to inform the association between a CORESET group and a PUCCH resource/group, and the indicated joint/UL TCI state(s) associated with the CORESET group applies to the PUCCH resource/group
* Alt3: Use MAC-CE to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group
* Alt4: Use DCI to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group

**Support/fine:**

**Not support:**

Table 3 Additional inputs for Issue 3

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| --- | --- |
| **Company** | **Input** |
| Mod V00 | **Please share your preference and further input, if any, to above moderator proposals** |
| Xiaomi | For proposal 3B:  First, for Alt 1, it is limited to DCI format with DL assignment. We suggest to consider both DCI format with and without DL assignment. And the alt 1 can be revised as below:   * Alt1: Use an indicator field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 1\_1/1\_2 with/without DL assignment to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception scheduled/activated by the same or different DCI format 1\_1/1\_2   + FFS: PDSCH reception scheduled/activated by DCI format 1\_0   Second, for alt 2 and alt 3, it can’t support M-TRP PDCCH + S-TRP PDSCH. For Alt 4, there will be some latency introduced by SS for each corresponding CORESET. It means that if gNB want to schedule M-TRP PDSCH, it needs to wait the search space of CORESET group associated with two TCI states. |
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# Issue 4 – UL power Control for UL MTRP

**Proposal 4.A:** On unified TCI framework extension, if one or both of indicated joint/UL TCI states applying to PUSCH/PUCCH transmission occasions in an UL BWP at least for S-DCI based PUSCH/PUCCH repetition with TDM is/are not associated with UL PC parameter setting (including P0, alpha for PUSCH, and closed loop index) for PUCCH/PUSCH, down-selection one alternative from the followings:

* Alt1: Support two default UL PC parameter settings configured in *BWP-UplinkDedicated*, and the UE should apply the one or two default UL PC parameter settings configured in the corresponding UL BWP
  + FFS: 1-to-1 association between an indicated joint/UL TCI state and a default UL PC parameter setting
* Alt2: No change from Rel-17 unified TCI framework, i.e., the UE should apply the one single default UL PC parameter setting configured in the corresponding UL BWP regardless the UL PC parameter setting is absent from one or both of indicated joint/UL TCI states
* Alt3: A joint/UL TCI state for PUCCH/PUSCH transmission is always associated with a UL PC parameter setting for PUCCH/PUSCH

**Support/fine: CATT, vivo, TransHold, Intel, FGI, Lenovo, Fujitsu, CMCC, ZTE, Sharp**

**Not support: Ericsson**

Table 4 Additional inputs for Issue 4

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| **Company** | **Input** |
| Mod V00 | **Please share your preference and further input, if any, to above moderator proposals** |
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# Issue 5 – Beam reporting and beam failure recovery

Open issues on beam reporting and BFR enhancements and company views are summarized below.

Table 5-1 Summary for Issue 5-1

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| **#** | **Issue** | **Companies’ views** | **Moderator notes/observation** |
| 3.1 | Enhance/extend group-based reporting to support simultaneous UL transmission | Support: QC, Docomo, ZTE, vivo, Nokia  Concern: OPPO, Huawei/HiSilicon | This issue can be discussed once any Rel-18 MTRP scheme for STxMP is agreed |
| 3.2 | Enhance/extend Rel-17 UE capability index reporting to support simultaneous UL transmission | Support: QC, OPPO, Docomo, NEC, ZTE, IDC, LG, Nokia  Concern: Huawei/HiSilicon | This issue can be discussed once any Rel-18 MTRP scheme for STxMP is agreed |
| 3.3 | Enhancement to TRP-specific BFR under unified TCI framework | Support: QC, OPPO, Huawei/HiSilicon, Docomo, NEC, ZTE, IDC, vivo, Nokia  Concern: |  |

Table 5-2 Additional inputs for Issue 5

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| **Company** | **Input** |
| QC | Support 3.1 and 3.2, but fine to wait till STxMP decision is clear  Support 3.3. We think the same principle agreed for sTRP is also beneficial for mTRP |
| OPPO | For Issue 3.1, we understand the group-based beam reporting was for DL MTRP operation, while the STxMP is for UL only. It seems unnecessary to combine these two features.  Support Issue 3.2 and 3.3. It seems reasonable to discuss Issue 3.2 when STxMP is agreeable. |
| Huawei, HiSi | **3.1 and 3.2:**  We agree with the moderator and prefer to wait the progress of 9.1.4.1.  **3.3:**  we support such enhancement. |
| Docomo | Our views added in the table.  For 3.1 and 3.2, we support the enhancements on beam reporting to support STxMP, and fine to wait for progress in 9.1.4.1.  For 3.3, we support to study it. |
| NEC | We support to have enhancements as said in 3.2 and 3.3 |
| ZTE | Our views are provided in the table. BTW, for group based reporting, we think that, for STxMP, the UE capability report should be based on group based report rather than non-group. |
| InterDigital | Our views are updated in the table. |
| Futurewei | For Issues 3.1 and 3.2, we agree with moderator that the discussions should wait for decisions in agenda item 9.1.4.1. |
| Samsung | We prefer to complete STxMP discussion before go into details for 3.1 or 3.2. And we prefer 3.1 as staring point, if STxMP is supported.  Support 3.3. |
| Xiaomi | Support 3.1 and 3.2, ok to discuss the details till STxMP is agreed.  Support 3.3 for mTRP case. |
| CATT | Support 3.1 and 3.2.  For Issue 3.3, detailed issues to be discussed need to be clarified. |
| vivo | Agree with Moderates’ notes. |
| TransHold | Support 3.1 and 3.2, fine to discuss the details till STxMP is agreed.  For 3.3, we support to study it. |
| Nokia | 3.1 and 3.2: Enhancement to beam reporting is needed to provide network information about feasibility of STxMP but this can discussed when STxMP schemes are more clear.  3.3: enhancements needed to BFR operation should be studied to cover the unified TCI extension to mTRP BFR specified in R17. |
| Ericsson | Issue 3.1: This has nothing to do with the unified TCI framework: it’s a reporting enhancement.  Issue 3.2: Nothing to do with the unified TCI framework. Having said that, we have concerns on (some) extensions of the capability index reporting.  Issue 3.3: Low prio. Editorial updates can be considered. |
| CMCC | For 3.1 and 3.2, we think they are important issues to facilitate STxMP, but we are not sure whether they should be discussed in unified TCI framework.  For 3.3, agree with Ericsson. Editorial updates can be considered. |

# Other potential issues

Table 6 Inputs for other potential issues

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| **Company** | **Input** |
| Huawei, Hisilicon | Considering enhancements for common TCI state update for mTRP where sTRP and mTRP CCs can be configured in the same CC list. |

# Appendix A: Agreements before/in RAN1#110

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| **RAN1#109e** |
| **Agreement**  On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17   * Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP   **Agreement**  On unified TCI framework extension at least for single-DCI based MTRP, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate multiple joint/DL/UL TCI states in a CC/BWP or a set of CCs/BWPs in a CC list   * FFS: Detail of mapping joint/DL/UL TCI state ID(s) to a TCI codepoint, e.g., possible combinations of joint, DL, and/or UL TCI state IDs that can be mapped to a TCI codepoint * FFS: Whether to increase the max number of MAC CE activated TCI codepoints, i.e., more than 8 codepoints * FFS: Whether to increase the max number of TCI field bits, i.e., more than 3 bits * Note: This doesn't imply that support of one additional TCI field or a field associating the TCI field to the TRP(s) is precluded   Note: The term TRP is used only for the purposes of discussions in RAN1 and whether/how to capture this is FFS  **Agreement**  On unified TCI framework extension for M-DCI based MTRP, consider the following alternatives for TCI state update:   * Alt1: Reuse the same TCI state update scheme for S-DCI based MTRP * Atl2: Use the existing TCI field in the DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *CORESETPoolIndex* values to indicate the joint/DL/UL TCI state(s) corresponding to the same *CORESETPoolIndex* value * Alt3: Use the existing TCI field in any DCI format 1\_1/1\_2 (with or without DL assignment) to indicate all joint/DL/UL TCI states corresponding to both *CORESETPoolIndex* values   + Study the association between the indicated joint/DL/UL TCI state(s) and a *CORESETPoolIndex* value * Alt4: Use the existing TCI field in the DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *CORESETPoolIndex* values to indicate joint/DL/UL TCI state(s) corresponding to the same or different *CORESETPoolIndex* value.   + Study whether the indicated joint/DL/UL TCI state(s) applies to the channels/signals associated with the same *CORESETPoolIndex* value or different *CORESETPoolIndex* value is indicated by DCI   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, consider at least the following alternatives to map/associate a joint/DL TCI state to PDCCH reception(s)   * Atl1: Use RRC configuration to inform the mapping/association between a configured or indicated joint/DL TCI state and a CORESET or a CORESET group * Alt2: Use RRC configuration to inform the mapping/association between a configured or indicated joint/DL TCI state and a search space set * Alt3: Use MAC-CE to inform the mapping/association between an activated or indicated joint/DL TCI state and a CORESET or a CORESET group * Alt4: Use DCI to inform the mapping/association between an indicated joint/DL TCI state and a CORESET or a CORESET group * Alt5: Based on a fixed mapping/association rule, e.g., the first indicated joint/DL TCI state always applies to PDCCH receptions   Consider above alternatives for PDCCH repetition, PDCCH-SFN, PDCCH w/o repetition/SFN, and potential support of dynamic switching between S-TRP and M-TRP for PDCCH. It is not precluded to adopt one single alternative or multiple alternatives to support these cases.  **Agreement**  On unified TCI framework extension, if an indicated joint or UL TCI state applies to a PUSCH/PUCCH transmission occasion at least for S-DCI based PUSCH/PUCCH repetition with TDM and the indicated joint or UL TCI state is associated with an UL PC parameter setting for PUSCH /PUCCH (including P0, alpha for PUSCH, and closed loop index) and a PL-RS, the UE should apply the UL PC parameter setting and the PL-RS for the PUSCH /PUCCH transmission occasion.   * FFS: How to extend to other Rel-18 MTRP scheme(s) with STxMP, if supported * FFS: UL PC enhancement for CB and non-CB SRS in above case   FFS: The applied UL PC parameter setting if one or both indicated joint or UL TCI state(s) is not associated with an UL PC parameter setting (including P0, alpha for PUSCH, and closed loop index) for PUCCH/PUSCH  **Agreement**  On UE power limitation for STxMP for FR2, send LS to RAN4 to check the followings:   * Whether it is feasible to assume power limitation per panel for STxMP (Assumption 1) * Whether it is feasible to assume a total power limitation per UE over all UE panels used for STxMP (Assumption 2) * In either of Assumption1 or Assumption 2, whether the total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP can be different from (greater than) the existing power limitation for a given power class? * If both Assumption 1 and Assumption 2 are feasible, whether both assumptions can be applied to a same UE, and what is the relationship between the per-panel power limitation and total power limitation if both are applied (e.g., the sum of per-panel power limitation can be larger than the total power limitation per UE, or should be always the same)?   FFS: Detail of exact LS if agreed  Note: Scenarios of above include at least single carrier scenario for FR2  Note: Above power limitation includes both total radiated power and EIRP  LS to RAN4 is endorsed in R1-2205639. |
| **RAN1#110** |
| **Agreement**  On unified TCI framework extension for S-DCI based MTRP, to inform the association with the joint/DL TCI state(s) indicated by DCI/MAC-CE for PDCCH repetition, PDCCH-SFN, and PDCCH w/o repetition/SFN, down-selection at least one alternative from the followings:   * Alt1-1: Use RRC parameter(s) in a CORESET configuration to inform the UE whether and/or which indicated joint/DL TCI state(s) shall be applied to the corresponding PDCCH receptions on the CORESET   + FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE * Alt1-2: Use an RRC parameter in a CORESET configuration to inform that the CORESET belongs to which CORESET group(s), and the indicated joint/DL TCI state(s) is associated with each CORESET group   + FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the CORESET group(s)   + FFS: How to associate the indicated joint/DL TCI state(s) with each CORESET group   + FFS: The UE applies the indicated joint/DL TCI state(s) to a CORESET according to the CORESET group(s) the CORESET belongs to, or the UE applies the indicated joint/DL TCI state(s) associated with the CORESET group(s) in which the beam indication DCI is received to all PDCCH receptions * Alt2: The association between a CORESET and the indicated joint/DL TCI state(s) is determined based on a fixed rule, and the UE shall apply the indicated joint/DL TCI state(s) to the corresponding PDCCH receptions on the CORESET   + FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE * Alt3: Use MAC-CE to inform the UE whether and/or which indicated joint/DL TCI state(s) shall be applied to the corresponding PDCCH receptions on a CORESET   + FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE   Switching between multi-TRP and single TRP operation is not precluded |

# Appendix B: Proposal Pool

**Proposal 1.B**: On unified TCI framework extension, up to 4 TCI states can be applied to DL receptions and/or UL transmissions in a CC/BWP, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation

* One of the following combinations can be applied to DL receptions and/or UL transmissions in a CC/BWP for MTRP operation:
  + 2 joint TCI states for joint DL/UL TCI update in the CC/BWP
  + 2 pairs of DL and UL TCI states for separate DL/UL TCI update in the CC/BWP
  + 1 pair of DL and UL TCI states + 1 DL TCI state for separate DL/UL TCI update in the CC/BWP
  + 1 pair of DL and UL TCI states + 1 UL TCI state for separate DL/UL TCI update in the CC/BWP
* In addition to the above combinations, study whether to support the following combinations:
  + 3 joint TCI states for joint DL/UL TCI update in the CC/BWP
  + 4 joint TCI states for joint DL/UL TCI update in the CC/BWP
  + 1 joint TCI state for joint DL/UL TCI update in the CC/BWP + 1 pair of DL and UL TCI states for separate DL/UL TCI update in the same CC/BWP
  + 1 joint TCI state for joint DL/UL TCI update in the CC/BWP + 1 DL TCI state for separate DL/UL TCI update in the same CC/BWP
  + 1 joint TCI state for joint DL/UL TCI update in the CC/BWP + 1 UL TCI state for separate DL/UL TCI update in the same CC/BWP
* Note: 1 joint TCI state is already supported by Rel-17 unified TCI framework
* Note: 1 pair of DL and UL TCI states is already supported by Rel-17 unified TCI framework
* Note: As in Rel-17, a joint TCI state in any above combination is applied for UL transmission only if applicable
* FFS: The possible combination(s) of joint/DL/UL TCI states that can be applied per TRP

**Proposal 2.A:** On unified TCI framework extension for M-DCI based MTRP, use the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *coresetPoolIndex* values to indicate **at least** the joint/DL/UL TCI state(s) associated with the same *coresetPoolIndex* value

* The UE shall apply the joint/DL/UL TCI state(s) associated with a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the *coresetPoolIndex* value
* FFS: Whether and how to indicate the joint/DL/UL TCI state(s) associated with another *coresetPoolIndex* value, e.g., reusing the same TCI state update scheme for S-DCI based MTRP or the DCI format 1\_1/1\_2 can inform the indicated joint/DL/UL TCI state(s) is associated with which *coresetPoolIndex* value

**Support (21): Qualcomm, OPPO, Huawei/HiSilicon, Docomo, NEC, Spreadtrum, Fraunhofer, Futurewei, Lenovo, Apple, LG, CATT, vivo, Nokia, Intel, Panasonic, FGI, Fujitsu, CMCC, ZTE, CEWiT**

**Not support (6): Google, InterDigital, Xiaomi, TransHold, Samsung, Ericsson**