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

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

Source: moderator (vivo)

Title: Feature lead summary on ULFPTx-02

Agenda Item: 7.2.6.4

Document for: Discussion and Decision

1. Introduction

Following email thread is assigned for discussion:

[100b-e-NR-eMIMO-ULFPTx-02] Email discussion on Issue #3 in R1-2002746: UE feature/capability related issues. By 4/24 and corresponding TP (if any) by 4/30– Rakesh (vivo)

1. Discussion on issue 3[1]
   1. Issue 3: UE feature/capability related issues
      1. TP on applicability of Rel-16 UL full power TX and codebooksubset

**TS 38.214**

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6.1.1.1 Codebook based UL transmission

<Omitted>

When multiple SRS resources are configured by *SRS-ResourceSet* with *usage* set to 'codebook', the UE shall expect that higher layer parameters *nrofSRS-Ports* in *SRS-Resource* in *SRS-ResourceSet* shall be configured with the same value for all these SRS resources.

A UE reporting its UE capability of ''fullyAndPartialAndNonCoherent' transmission shall not expect to be configured with *ULFPTx or ULFPTxModes*.

A UE can be configured to operate in either Mode 1 or Mode 2 upon reception of the higher layer parameters *ULFPTx=’enabled’* and *ULFPTxModes*.

<Omitted>

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**TS 38.213**

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7.1 Physical uplink shared channel

For a PUSCH transmission on active UL BWP , as described in Clause 12, of carrier  of serving cell , a UE first calculates a linear value  of the transmit power , with parameters as defined in Clause 7.1.1. For a PUSCH transmission scheduled by a DCI format or configured by *ConfiguredGrantConfig* or *semiPersistentOnPUSCH*, if *txConfig* in *PUSCH-Config* is set to 'codebook',

- if ULFPTx in PUSCH-Config is provided and the UE reports its UE capability as 'nonCoherent' or 'partialAndNonCoherent' ~~codebookSubset in PUSCH-Config is set to nonCoherent or partialAndNonCoherent~~, the UE scales by where:

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Please provide your views/comments in the table below

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| --- | --- |
| Company/organization | comments |
| OPPO | we have some comments on the above TPs   1. TP should be updated to align with TS 38.331   ul-FullPowerTransmission-r16 ENUMERATED {fullpower, fullpowerMode1, fullpoweMode2} OPTIONAL -- Need R   1. If TP for TS 38.214 is approved, the TP for TS 38.213 is not needed since full coherent UE cannot be configured with “ul-FullPowerTransmission-r16” 2. The TP does not use the latest version v16.1.0   Thus we suggest to revise the TP for TS 38.214 as follows (and TP for TS 38.213 is not needed)  **TS 38.214**  ---------------------------------------------------------------------------------  6.1.1.1 Codebook based UL transmission  <Omitted>  Except when higher layer parameter *ULFPTxModes* is set to 'Mode 2', when multiple SRS resources are configured by *SRS-ResourceSet* with *usage* set to 'codebook', the UE shall expect that higher layer parameters *nrofSRS-Ports* in *SRS-Resource* in *SRS-ResourceSet* shall be configured with the same value for all these SRS resources.  A UE reporting its UE capability of ''fullyAndPartialAndNonCoherent' transmission shall not expect to be configured with *~~ULFPTx or ULFPTxModes~~* *ul-FullPowerTransmission-r16*  When higher layer parameter *ULFPTxModes* is set to 'Mode 2',  <Omitted>  --------------------------------------------------------------------------------- |
| Samsung | Support this TP (also OK with OPPO’s revision) due to the following agreement stating that “full power UL transmission is supported for non-coherent and partial/non-coherent capable UEs” being either not captured or captured incorrectly.   |  | | --- | | **RAN1#95**  **Agreement**  Full TX power UL transmission with multiple power amplifier is supported at least for codebook based UL transmission for non-coherent and partial/non-coherent capable UEs   * This specification support is a UE optional feature * FFS: Whether this applies for the entire codebook or subset of codebook | |
| CATT | Do not support.  There is no RAN1 agreement that a full-coherent UE does not support mode 0/1/2. Coherent capability and full-power capability address different aspects of UE implementation and they are not mutually exclusive. A UE capable of and intending to support both full-coherent transmission and mode 0/1/2 shall not be precluded. For instance a full-coherent 4Tx UE can still benefit from 2Tx full-power transmission with 2 SRS. This implementation should be allowed. It can be optional, as is the case now. In summary the current specification is not broken and requires no update. |
| Apple | Do not support.  For example, for UE with full-rate PA. We do not understand why we treat coherent UE differently from the non-coherent or partial coherent UE, meaning whether we allow antenna selection TPMI to transmit at full power.  Even though coherent UE can use coherent TPMI to achieve full power, however the UE performance is different between coherent TPMI and antenna selection TPMI  Using 2 PA coherent UE as example, if one of the antennas is blocked especially the secondary antenna, using coherent rank 1 TPMI will not improve coverage, while on the contrary, it just increases the UE power consumption. On the other side, Rel-15 power saving does not allow antenna selection TPMI to transmit at full power which potentially makes the coherent UE performs worse than non-coherent UE. |
| Huawei, HiSilicon | Do NOT support.  Full agree with CATT and Apple. The TPs were discussed many rounds, it is not essential and does not make sense.  From technique, from Rel-15, the UE with full coherent capability, it is also can be configured with non-coherent or partial coherent codebook subsets, which is beneficial for blockage (partial antenna(s)) scenarios with antenna selection pre-coders. For full power transmission, if one or two antennas are blocked for UL transmission, the full power can be transmitted from other remaining antennas. However, with the restriction on the proposed TPs, half power will always be wasted. Please note that for UL transmission, hand-shadowing (blockage for parts of antennas) is not a corner case.  From specs and agreements, there is no agreement to preclude full-coherent UE to full power transmission. Even with Samsung mentioned agreement, it is clear say “at least”. And this agreement is replaced by late approved TS 38.213 and TS 38.214. Please note that the approved spec is also an updated agreement. |
| ZTE | We do not support TP1 with the following two reasons.   1. In Rel-16, for the UE with full-coherent capability, it also can be indicated by partial-coherent or non-coherent TPMIs to implement codebook based UL transmission under certain circumstances, such as part of ports get hand-blocked. However, in Rel-15, such UE can not implement full Tx power with partial-coherent or non-coherent TPMIs. Therefore, this limitation make no sense and should not be captured in current specs. 2. Moreover, RAN1 has never emphasized that full Tx power UL transmission should not support for full-coherent capable UEs.   We do not support TP2 with the following reason.  UE behavior should be configured by gNB rather than its capability reporting, so we think TP2 is not needed. |
| LG | At least for mode 2, we are open for further discussion on support of full power UL transmission for full coherent UE, since configuring multiple SRS resources with different # of SRS ports within the SRS resource set may be useful, e.g., in case of dynamic UL Tx/port switching. |
| Intel | It is up to UE implementation. With full power Tx capability, the UE can select whether to support full power Tx or not. And there is no need to introduce such restriction. |
| Spreadtrum | Support the TP or OPPO’s revision.  Firstly, the agreement posted by Samsung only states that “full power UL transmission is supported for non-coherent and partial/non-coherent capable UEs”. No RAN1 agreements have stated that it supports full power transmission for full/partial/non-coherent capable UEs.  Secondly, from the technical perspective, as some companies point out that supporting full power transmission for full/partial/non-coherent UE is beneficial for blockage case. However, if following the current specification TS38.213 7.1 shown below,  - if ULFPTx in PUSCH-Config is provided and codebookSubset in PUSCH-Config is set to nonCoherent or partialAndNonCoherent, the UE scales by where:  - if ULFPTxModes in PUSCH-Config is set to Mode1, and each SRS resource in the SRS-ResourceSet with usage set to 'codebook' has more than one SRS port', is the ratio of a number of antenna ports with non-zero PUSCH transmission power over the maximum number of SRS ports supported by the UE in one SRS resource  - if ULFPTxModes in PUSCH-Config is set to Mode2, for full power TPMIs reported by the UE [16, TS 38.306], and is the ratio of a number of antenna ports with non-zero PUSCH transmission power over a number of SRS ports for remaining TPMIs, where the number of SRS ports is associated with a SRS resource indicated by SRI if more than one SRS resources are configured in the SRS-ResourceSet with usage set to 'codebook', or the number of SRS ports is associated with the SRS resource if only one SRS resource is configured in the SRS-ResourceSet with usage set to 'codebook', and  - if ULFPTxModes in PUSCH-Config is not provided,  - else, if each SRS resource in the SRS-ResourceSet with usage set to 'codebook' has more than one SRS port, the UE scales the linear value by the ratio of the number of antenna ports with a non-zero PUSCH transmission power to the maximum number of SRS ports supported by the UE in one SRS resource.  even if supporting full power transmission for full/partial/non-coherent capable UE, but if configured with fullPartialAndNonCoherent codebook subset, it still should adopt linear power scaling and could not achieve full power transmission when antenna selection codebook is used for blockage case. If to support full power transmission for antenna selection codebook, full/partial/non-coherent UE could be only configured with nonCoherent or partialAndNonCoherent codebook subset. The coherent combing gain is loss. In our opinion, the coherent combing gain is very important for full/partial/non-coherent capable UE, especially for non-blockage case. |
| DOCOMO | As per our view, UL full power transmission should be supported by a UE reporting its capability as, ‘nonCoherent’, ‘partialAndNonCoherent’ or ‘fullyAndPartialAndNonCoherent’. This is because, coherent capability does not come along with full power capability and it is necessary to make sure full coherent UE does not perform worse than (in terms of UL Tx power) non or partial coherent UEs. Further, as per our understanding, configuration of maximum of 4 SRS resources within an SRS resource set is beneficial for more flexible PUSCH beam indication for fully coherent UE. |
| CMCC | Not support.  We think there is no need to restrict and exclude full coherent capability UE to use full power transmission modes. Rel-15 full coherent UE cannot support full power transmission with port selection TPMIs, which may perform better performance than non-port selection TPMIs in some scenarios. We think the current spec description can provide more flexibility. Therefore the TP is not needed. |
| QC | Do not support  Agree with CATT, Apple, Huawei and many other companies, we don’t see the logic to penalize a full coherent UE by disallowing it to use this Rel-16 full power feature, given the UE is capable to support this feature without any additional cost. This TP intentionally make Rel-16 full coherent UE less capable than a non-coherent or partial coherent UE, which is unnecessary. |
| Ericsson | We do not support the TP, and have similar rationale with other companies that do not support the TP.  If a fully coherent UE can support full power operation, we see no reason to preclude the UE from indicating its support. |
| vivo | Support this TP and fine with OPPO’s revision, as support of full power transmission for full-coherent UE has not explicitly agreed, and there is no coverage issue for full-coherent transmission. |
| InterDigital | Support the TP and also the revised version by OPPO.  In our view, the suggested use case of allowing full power mode for fully coherent UE does not seem realistic. Since blockage is a dynamic phenomenon, entering/exiting full power mode requires repeated RRC re-configurations that is not efficient in terms of signaling overhead.  Having said that, even if a fullcoherent UE really determines that because of some issues, like a permanent blockage or a defect, it would be better off operating in one of the Rel-16 full power modes, it can simply report a partialcoherent capability instead of fullcoherent. Then, it will be configured and operated as such. |

* + 1. Additional UE capability signaling, e.g. mode0, mode1, mode2, TPMI in mode2
    - new UL codebook set(s) when the UE reports mode1 as its capability
    - TPMI group signalling when the UE reports mode2 as its capability
    - Separate capability signalling for mode0, mode1, and mode2
    - Multiple modes signalling is *not supported*, e.g., mode1AndMode2

Please provide your views/comments in the table below

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| --- | --- |
| Company/organization | comments |
| OPPO | Topic 1: not needed  Topic 2: ok  Topic 4: Not support signaling of multiple modes for a UE |
| Samsung | Topic 1: not needed  Topic 2: not needed (If TPMI group signaling is optional (hence, may not be provided by a UE) and the UE reports mode2 as its capability, then the UE has to be configured with multiple SRS resources with different number of SRS ports in order to achieve full power, which has more SRS resource overhead when compared with a solution which works with a single SRS resource.)  Topic 3: since mode0-2 correspond to 3 different solutions, UE capability should be separate for the three  Topic 4: Not support signaling of multiple modes for a UE (Since a UE will most likely implement only one of the 3 modes in practice, a UE supporting multiple modes is not meaningful and lack use case in real UE implementations) |
| Apple | Topic 1: not needed  Topic 2: support  Topic 3: support  Topic 4: Open for discussion |
| Huawei, HiSilicon | For each items, our view is also listed as follows:  Topic 1: Not needed, since only one codebook subset for Mode-1. If Mode-1 is supported, the unique codebook subset is supported.  Topic 2: Supportive. There are multiple TPMI groups agreed, e.g., G0~G6. Which TPMI groups is supported for the UE should be reported by UE. The UE reporting on TPMI group for full power transmission is also an agreement. Furthermore, **One** or more SRS resources can be configured for Mode-2, not only multiple resources always.  Topic 3: Only Mode-1 and Mode-2 is needed, and fine to split. There is no definition on Mode-0.  Topic 4: Supportive, and optional for the feature. If UE have the capability to support Mode-1 and Mode-2, it should allow UE to report and also allow NW to freely select the best mode based on the scenarios or situation. For example, if both both mode-1 and 2 are supported by UE, in the case of blockage, Mode-2 will be selected, and Model-1 will be used for low non-blockage case. |
| ZTE | Topic 1 is not needed.  It can be matched with the corresponding description of Mode 1 in the current specs.  Topic 2 is not needed.  To reduce unnecessary signaling overhead, how about we can use one entry of TPMI group reporting to implicitly indicate this UE capability.  Topic 3 is needed.  To match with the edit of three full power operation modes from RAN1 in the current specs, we think separate capability signaling is needed.  Topic 4 is needed.  For the flexibility of enabling full Tx power UL transmission, we think this UE capability signaling is needed. |
| LG | Topic 1: not needed  Topic 2: support  Topic 3: support  Topic 4: We think the motivation of supporting both modes is weak, but we are open for further discussion. |
| Intel | Topic 1: It is not needed  Topic 2: TPMI group signaling should be mandatory for Mode 2  Topic 3: It is fine to have separate signaling  Topic 4: With separate signaling for full power Tx mode, it is up to UE whether it can support multiple modes. |
| Spreadtrum | Topic 1: not needed  Topic 2: support  Topic 3: support  Topic 4: not needed. But we are open for further discussion. |
| DOCOMO | Topic 4: Multiple modes signaling (i.e. supporting mode1Andmode2) should be supported. This allows more flexibility for the NW to enable UL full power transmission. In fact, since it is possible to configure the mode of operation through RRC signaling (ULFPTxModes), if a UE can support both modes, it is beneficial to let it report that and NW can subsequently decide mode of operation of that UE. |
| CMCC | Topic 1: not needed  Topic 2: support  For mode 2, in our understanding, for 2Tx UE reporting ‘non-coherent’ capability, UE can report 2-port TPMI(s) in *codebookSubset = oncoherent* that can support full power transmission. For 4Tx UE reporting ‘non-coherent’ capability, UE can report 2-port and/or 4-port TPMI(s) in *codebookSubset = oncoherent* that can support full power transmission. For 4Tx UE reporting ‘partial/non-coherent’ capability, UE can report 2-port TPMI(s) in *codebookSubset = oncoherent* and/or 4-port TPMI(s) in *codebookSubset = oncoherent* and/or 4-port TPMI(s) in *codebookSubset = partialandNonCoherent* that can support full power transmission. Therefore, we think TPMI group related capability signaling is needed to report which TPMIs are supported when the UE reports mode2 as its capability.  Topic 3: support  Topic 4: support. This provides more flexibility and better performance for different scenarios. |
| QC | Topic 1: The proposal is not needed. UE reports support mode 1 should support new codebook automatically, as we don’t see other ways to support full power under mode 1.  Topic 2: TPMI group signaling should be optional under mode2. In our opinion, a UE that reports it can support full power under mode 2 is allowed to NOT report TPMI grouping. In this case, full power is supported by using SRS resource with different # SRS ports. For example, full power can be support on a SRS resource with single SRS port. In summary, we support separate capability signaling for mode 2 and TPMI group signaling.  Topic 3: Support separate capability signaling for mode0, mode1, and mode2  Topic 4: No strong view here. But prefer to allow a UE reports multiple modes signaling, e.g., mode1AndMode2. We don’t see a reason to prohibit UE to do so. If a UE is capable and willing to pay the cost to support multiple modes, why we want to prohibit the UE to do so? |
| Ericsson | Topic 1: The TPMIs we have agreed for Mode 1 are sufficient.  Topic 2: A Mode 2 capable UE should be able to indicate which, if any, TPMI group it supports.  Topic 3: Capability for modes ‘0’, 1, and 2 should be independently signaled. RAN2 RRC signaling already configures ‘mode 0’, Mode 1, and Mode 2 independently. UE capability signaling must be used to indicate support for each of these modes.  Topic 4: It should be up to UE whether it supports any combination of modes ‘0’, 1, and 2. Restricting to only certain combinations like Mode1AndMode2 does not make sense to me. |
| vivo | Topic 1: not needed  Topic 2: support, suggest waiting UE feature discussion output  Topic 3: support, suggest waiting UE feature discussion output  Topic 4: support, suggest waiting UE feature discussion output  Support of multi modes is not needed. |
| InterDigital | Topic 1: Not needed  Topic 2: Support, as suggested by Intel, TPMI group signaling should be mandatory for Mode 2.  Topic 3: Support separate indication signaling for modes 0 to 2. However, as Huawei pointed out, need to define mode 0.  Topic 4: Support multi-mode signaling. |

# References

[1] R1-2002746, Summary of prep email discussion on ULFPTx, RAN1#100b-e