**3GPP TSG RAN WG1 #101 R1-2004799**

**e-Meeting, May 25th – June 5th, 2020**

Source: moderator (vivo)

Title: Feature lead summary on [101-e-NR-eMIMO-ULFPTx-03]

Agenda Item: 7.2.6.4

Document for: Discussion and Decision

1. Introduction

Per guidance from Mr. Chairman, this is to kick-off following email discussion, please provide your views below.

[101-e-NR-eMIMO-ULFPTx-03] Miscellaneous corrections for full power uplink transmission by 5/29 – Rakesh (vivo)

* TP 3-7 under Issue 2, Issue 3 and Issue 4 of the FL summary
1. Remaining issues
	1. Issue 3: on codebook subset restriction
* ***One of the following alternatives is selected on full-coherent codebook subset for Rel-16 UL full power transmission.***
	+ ***Alt 1: full-coherent codebook subset is not supported for mode 0/mode 1/mode 2;***
	+ ***Alt 2: full-coherent codebook subset is supported for mode 0/mode 1/mode 2, with Rel-15 power scaling factor used;***
	+ ***Alt 3: full-coherent codebook subset is supported for mode 0/mode 1/mode 2, with the same power scaling rule as non-/partial-coherent codebook subset, i.e.,***
		- ***For mode 0, the power scaling factor is 1 for all TPMIs;***
		- ***For mode 1, the power scaling factor is the same as Rel-15 scaling factor;***
		- ***For mode 2, the power scaling factor s equals to 1 for full power TPMIs reported by the UE, and s is determined by #non-zero-PUSCH-port divided by #SRS-ports in the SRS resource indicated by SRI for remaining TPMIs .***
	+ ***Alt 4: full-coherent codebook subset is not supported by mode 1; full-coherent codebook subset is supported by mode 0 and mode 2, with the same power scaling rule as non-/partial-coherent codebook subset for mode 0 and mode 2, i.e.,***
		- ***For mode 0, the power scaling factor is 1 for all TPMIs;***
		- ***For mode 2, the power scaling factor s equals to 1 for full power TPMIs reported by the UE, and s is determined by #non-zero-PUSCH-port divided by #SRS-ports in the SRS resource indicated by SRI for remaining TPMIs .***

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| Company | Comment |
| Intel | Support Alt 4.For full coherent codebook subset, all the TPMIs are included. In addition, the power scaling for Mode 1 is the same as legacy Rel-15 processing. Therefore, to apply Mode 1 for full coherent codebook subset seems to be redundant. |
| Apple | Support Alt 4.We don’t think there is mode 1 for full-coherent codebook. |
| QC | Support Alt 3 or 4, with slight preference on Alt 4. As Intel pointed out, full coherent UE supporting Rel-16 mode 1 is same behaviour as Rel-15 full coherent UE. We see this as a redundant functionality too. But it is acceptable to us.  |
| LG | Support Alt4. Agree with Intel and QC that applying Mode 1 for the UE configured with full coherent codebook subset is redundant.  |
| OPPO | Support Alt.4Share the same view as Intel and QC that full-coherent UE supporting mode 1 is the same as Rel-15.  |
| CATT | Support Alt.4. |
| Spreadtrum | Support Alt 3 or Alt 4, but slightly prefer Alt 4.Although full-coherent UE supporting R16 mode seems to be redundant, it is acceptable to us. |
| Huawei, HiSilicon | Support Alt.4. |
| NTT DOCOMO | We support Alt 3. We do not see a reason why we need to restrict a full coherent UE from using Mode 1 and treat differently. In fact, full-coherent UE will not report Mode 1 for full power. It is up to the UE to determine what Mode to report based on its capability. There is no point of restricting this through the spec. and making spec. more complicated |
| ZTE | Support Alt 4. |
| vivo | Support Alt.4.There is no coverage issue for full-coherent UE operating on Mode 1, and introducing new precoder is not necessary. |
| CMCC | Support Alt 4. There is no need for UE to support full power transmission mode 1 when UE is configured with *codebookSubset* in *PUSCH-Config* set to ‘fullyAndPartialAndNonCoherent’, and this can already be avoided based on table 7.3.1.1.2-2~5A in TS38.212 since full power transmission mode 1 and ‘fullyAndPartialAndNonCoherent’ for *codebookSubset* will not be configured simultaneously. |
| Samsung | Support Alt4 |
| Nokia, NSB | Alt 3 or Alt 4, with a slight preference to Alt 3. There is no harm to assume that full coherent CB subset is supported for Mode 1.  |
| MediaTek | Support Alt.4  |

Offline agreement: [I didn’t see anyone objecting over email]

* + Alt 4: full-coherent codebook subset is not supported by mode 1; full-coherent codebook subset is supported by mode 0 and mode 2, with the same power scaling rule as non-/partial-coherent codebook subset for mode 0 and mode 2, i.e.,
		- For mode 0, the power scaling factor is 1 for all TPMIs;
		- For mode 2, the power scaling factor s equals to 1 for full power TPMIs reported by the UE, and s is determined by #non-zero-PUSCH-port divided by #SRS-ports in the SRS resource indicated by SRI for remaining TPMIs .

Proposal:

TP for 38.214

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A UE ~~reporting its UE capability of 'fullAndPartialAndNonCoherent' transmission~~ shall not expect to be configured with higher layer parameter*ul-FullPowerTransmission* set to ‘*fullpowerMode1'*and codebook subset to*'fullAndPartialAndNonCoherent'*simultaneously.

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* 1. Issue 2 : TPs for correction on power scaling

TP#3

if *ul-FullPowerTransmission* in *PUSCH-Config* is provided and *codebookSubset* in *PUSCH-Config* is set to 'nonCoherent' or 'partialAndNonCoherent', the UE scales $\hat{P}\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ by $s$ where:

- if *ul-FullPowerTransmission* in *PUSCH-Config* is set to *fullpowerMode1*, and each SRS resource in the *SRS-ResourceSet* with *usage* set to 'codebook' has more than one SRS port, $s$ 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 *ul-FullPowerTransmission* in *PUSCH-Config* is set to *fullpowerMode2*

- $s=1$ for full power TPMIs reported by the UE [16, TS 38.306], and $s$ 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 a SRI field in a DCI format scheduling the PUSCH transmission if more than one SRS resource is 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',

- $s=1$, if a SRS resource with a single port is indicated by a SRI field in a DCI format scheduling the PUSCH transmission when more than one SRS resource is provided in the *SRS-ResourceSet* with *usage* set to 'codebook', or if only one SRS resource with a single port is provided in the *SRS-ResourceSet* with *usage* set to 'codebook', and

- if *ul-FullPowerTransmission* in PUSCH-Config is set to *fullpower*, $s=1$

- if *ul-FullPowerTransmission* in *PUSCH-Config* is provided and set to *fullpower* or *fullpowerMode2*, and *codebookSubset* in *PUSCH-Config* is set to 'fullAndPartialAndNonCoherent', the UE scales $\hat{P}\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ by $s$ where:

- if *ul-FullPowerTransmission* in *PUSCH-Config* is set to *fullpowerMode2*

- $s=1$ for full power TPMIs reported by the UE [16, TS 38.306], and $s$ 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 a SRI field in a DCI format scheduling the PUSCH transmission if more than one SRS resource is 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',

- $s=1$, if a SRS resource with a single port is indicated by a SRI field in a DCI format scheduling the PUSCH transmission when more than one SRS resource is provided in the *SRS-ResourceSet* with *usage* set to 'codebook', or if only one SRS resource with a single port is provided in the *SRS-ResourceSet* with *usage* set to 'codebook', and

- if *ul-FullPowerTransmission* in PUSCH-Config is set to *fullpower*, $s=1$

- 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.

TP#4

- if *ul-FullPowerTransmission* in *PUSCH-Config* is provided ~~and~~ *~~codebookSubset~~* ~~in~~ *~~PUSCH-Config~~* ~~is set to 'nonCoherent' or 'partialAndNonCoherent'~~, the UE scales $\hat{P}\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ by $s$ where:

- if *ul-FullPowerTransmission* in *PUSCH-Config* is set to *fullpowerMode1*, and *codebookSubset* in *PUSCH-Config* is set to 'nonCoherent' or 'partialAndNonCoherent', and each SRS resource in the *SRS-ResourceSet* with *usage* set to 'codebook' has more than one SRS port, $s$ 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

TP#5

- if *ul-FullPowerTransmission* in *PUSCH-Config* is provided and *codebookSubset* in *PUSCH-Config* is set to 'nonCoherent' or 'partialAndNonCoherent' or 'fullyAndPartialAndNonCoherent', the UE scales $\hat{P}\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ by $s$ where:

TP#6

if *ul-FullPowerTransmission* in *PUSCH-Config* is provided ~~and~~ *~~codebookSubset~~* ~~in~~ *~~PUSCH-Config~~* ~~is set to 'nonCoherent' or 'partialAndNonCoherent'~~, the UE scales $\hat{P}\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ by $s$ where:

TP#6 above (for 213) + following TP (for 214, 6.1.1.1)

A UE reporting its UE capability of 'fullAndPartialAndNonCoherent' transmission shall not expect to be configured with higher layer parameter *ul-FullPowerTransmission* set to ‘*fullpowerMode1'*.

TP#7

- if ul-FullPowerTransmission in PUSCH-Config is provided and codebookSubset in PUSCH-Config is set to ' fullyAndPartialAndNonCoherent ', the UE scales $\hat{P}\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ by $s$ where:

- if ul-FullPowerTransmission in PUSCH-Config is set to fullpowerMode2

- $s=1$ for full power TPMIs reported by the UE [16, TS 38.306],

- $s=1$, if an SRS resource with a single port is indicated by a SRI field in a DCI format scheduling the PUSCH transmission when more than one SRS resource is provided in the SRS-ResourceSet with usage set to 'codebook', or if only one SRS resource with a single port is provided in the SRS-ResourceSet with usage set to 'codebook', and

- if ul-FullPowerTransmission in PUSCH-Config is set to fullpower, $s=1$

- 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.

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| Company | Comment |
| Intel | Support TP #3.But we can discuss the detailed TP after consensus is reached on Issue #3. |
| Apple | We need to conclude on whether SRS enhancement is allowed for mode 2 operation for full-coherent codebook.TP#3 or TP#4 are okay if we allowTP#7 is okay if we don’t allow |
| QC | These 5 TPs are very similar to each other in spirit. We prefer TP 3, or 4, 5, as they are more concise. But we are open to discuss down select to which one after issue 3 is settled.  |
| LG | We also think corresponding TP should be discussed after making a decision on issue 3.  |
| OPPO | If we agree Alt.4 for Issue 2, then it is expected there will some description on the configuration restriction somewhere in the spec. Given that, TP 6 is more concise.  |
| Spreadtrum | We can discuss it after making a decision on issue 3. |
| Huawei, HiSilicon | Support TP#4 or TP#3.Since TP#5/6 is with Mode-1 for full-coherent codebook subset, TP#7 is rule out non-full power transmission for the full-coherent codebook subset for Mode-2.  |
| NTT DOCOMO | We support TP#5. It succinctly captures necessary spec. support for full-coherent UE to operate in Mode 2 especially without introducing additional complexities to the spec. However, we also agree that the issue 2 should be discussed after a conclusion is reached for issue 3. |
| ZTE | From our perspective, both of TP#3 and TP#4 can be reached to address this issue, and we prefer TP#4 for the sake of brevity and readability. TP#5 and TP#6 is not accurate enough. TP#7 still with some logical holes. |
| vivo | Generally fine with TP#3, but prefer TP#4, since it is concise.TP#5 and TP#6 have impact to full-coherent UE operate on Mode1, it is not necessary.In the case of TPMI groups are not reported by the UE, the description of TP#7 is not aligned with current specification.  |
| CMCC | We prefer TP#5. We think there are no essential difference among TP#3~TP#6. Some companies argue that TP#5/6 is with Mode-1 for full-coherent codebook subset which is conflict with Alt.4 of issue 3, however, as we pointed out in the answer to issue 3, there is already restriction in TS38.212 that full power transmission mode 1 and ‘fullyAndPartialAndNonCoherent’ for *codebookSubset* cannot be configured simultaneously based on table 7.3.1.1.2-2~5A of TS38.212. We think this is the description on the configuration mentioned by OPPO. Additionally, we prefer a concise and extendable solution for this issue, so we slightly prefer TP#5. |
| Samsung | In our view, TP#3 and #7 are unnecessarily lengthy, and includes duplicate 213 speciation (for mode0 and mode2). In 213, we just need to define the power scaling for the three modes. Perhaps, a better place to capture “mode1 can’t be configured to a full-coherent UE” is 214. So, we prefer TP#6 (since it has the min spec change in 213) and the followed TP for 214.**TP for 38.214, Section 6.1.1.1 Codebook based UL transmission**A UE reporting its UE capability of 'fullAndPartialAndNonCoherent' transmission shall not expect to be configured with higher layer parameter *ul-FullPowerTransmission* set to ‘*fullpowerMode1'*. |
| Nokia, NSB | TP #3 or TP #4 is okay.TP#5 or TP #6 is okay, but these are related to the Mode 1 full-coherent UE, in the previous discussion. |
| MediaTek | Which TP should be discussed after conclusion of issue 3. Agree with Samsung that 38.213 can just define power scaling for each of 3 modes without being specific to coherency. TP#6 seems to have minimum change.  |

From comments above, all the TPs addressing the same issue and considering the simplicity, two alternatives TP#5 and TP#6 are proposed for downselection

Proposal:

Agree on following TP for 38.213

Alt:1 TP#5

- if *ul-FullPowerTransmission* in *PUSCH-Config* is provided and *codebookSubset* in *PUSCH-Config* is set to 'nonCoherent' or 'partialAndNonCoherent' or 'fullyAndPartialAndNonCoherent', the UE scales $\hat{P}\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ by $s$ where:

Alt2: TP#6

if *ul-FullPowerTransmission* in *PUSCH-Config* is provided ~~and~~ *~~codebookSubset~~* ~~in~~ *~~PUSCH-Config~~* ~~is set to 'nonCoherent' or 'partialAndNonCoherent'~~, the UE scales $\hat{P}\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ by $s$ where:

* 1. Issue 4: on SRS resource configuration in Mode2

38.214

\*\*\* Unchanged text is omitted \*\*\*

For codebook based transmission, the UE may be configured with a single *SRS-ResourceSet* with *usage* set to 'codebook' and only one SRS resource can be indicated based on the SRI from within the SRS resource set. Except when higher layer parameter *ul-FullPowerTransmission* is set to '*fullpowerMode2*' and *codebookSubset* in *PUSCH-Config* is not set to ' *fullyAndPartialAndNonCoherent* ', the maximum number of configured SRS resources for codebook based transmission is 2. If aperiodic SRS is configured for a UE, the SRS request field in DCI triggers the transmission of aperiodic SRS resources.

The UE shall transmit PUSCH using the same antenna port(s) as the SRS port(s) in the SRS resource indicated by the DCI format 0\_1 or 0\_2 or by *configuredGrantConfig* according to clause 6.1.2.3.

The DM-RS antenna ports $\left\{\tilde{p}\_{0},…,\tilde{p}\_{v-1}\right\}$ in Clause 6.4.1.1.3 of [4, TS38.211] are determined according to the ordering of DM-RS port(s) given by Tables 7.3.1.1.2-6 to 7.3.1.1.2-23 in Clause 7.3.1.1.2 of [5, TS 38.212].

Except when higher layer parameter *ul-FullPowerTransmission* is set to ' *fullpowerMode2*' and *codebookSubset* in *PUSCH-Config* is not set to ' *fullyAndPartialAndNonCoherent* ', 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.

When higher layer parameter *ul-FullPowerTransmission* is set to ' *fullpowerMode2*' and *codebookSubset* in *PUSCH-Config* is set to *'nonCoherent'* or *'partialAndNonCoherent'*,

- the UE can be configured with one SRS resource or multiple SRS resources with same or different number of SRS ports within an SRS resource set with *usage* set to ‘*codebook*’.

- up to 2 different spatial relations can be configured for all SRS resources in the SRS resource set with usage set to ‘codebook’ when multiple SRS resources are configured in the SRS resource set.

- subject to UE capability, a maximum of 2 or 4 SRS resources are supported in an SRS resource set with *usage* set to ‘codebook’

\*\*\* Unchanged text is omitted \*\*\*

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| Company | Comment |
| Intel | We are fine with the motivation to restrict the SRS configuration same as Rel-15 for full coherent codebook subset.The TP can be discussed next week. |
| Apple | We can first agree on whether SRS enhancement is needed for full coherent codebook with Mode 2 operation and then discuss the TP. The purpose of the TP is not to allow SRS enhancement for full coherent codebook with Mode 2 operationFull coherent codebook automatically provides the antenna virtualization which is essentially what mode 1 uses, but in a more comprehensive way due to the coherent capability. It does not have strong motivation to require UE to send additional SRS resource to perform similar antenna virtualization. Furthermore, when UE is capability coherent transmission, coherent beam forming is a more effective solution for antenna virtualization.  |
| QC | We have a question for clarification: Why exclude full coherent UE to operate in mode 2 via antenna virtualization? Although there might be no strong motivation to do so, but if a full coherent UE, say with 20dBm+20dBm PAs, want to do antenna virtualization to virtualize into a single port, why disallow it? |
| LG | Similar sprit for issue 3, we slight prefer not to restrict the SRS configuration only for full coherent codebook subset. But, we are open for further discussion.  |
| OPPO | This restriction seems not necessary |
| CATT | Slightly prefer not to introduce such restriction. |
| Spreadtrum | Not needed. |
| Huawei, HiSilicon | The restriction is not necessary. |
| NTT DOCOMO | We do not support this TP. We also fail to see any valid technical reason why full-coherent UE is restricted to use SRS enhancements with Mode 2 operation. Further, this TP brings additional complexity to the spec. since full-coherent UE has to be treated differently compared to the others. |
| ZTE | We have similar reason with other companies that slightly do not support this TP. |
| vivo | This TP is not necessary. |
| CMCC | We do not seem the motivation and necessity to restrict full coherent UE to use SRS enhancement in Mode 2. We do not support this TP. |
| Samsung | Not needed |
| Nokia, NSB | No need for the mode 2 restriction. |
| MediaTek | Not support. SRS enhancement is one of main part that full coherent UE doesn’t have in R15 (the other one should be power scaling), it is better to have. |

From comments provided by companies, there is no consensus on having this TP.

Proposal:

* + Do not support the TP proposed under issue#4

# References

[1] R1-2003402, “Feature lead summary on ULFPTx”, vivo, RAN1#101-e