**3GPP TSG-RAN WG4 Meeting #111R4-2408675**

**Fukuoka, JP, May 20 – May 24, 2024**

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.751** | **CR** | **0006** | **rev** |  | **Current version:** | **18.1.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network |  |

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| ***Title:*** | [NR\_FR2\_multiRX\_DL-Perf] CR to TR38.751 Receiver assumption and conclusions for FR2 multi-Rx demodulation evaluations | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Qualcomm Inc | | | | | | | | | |
| ***Source to TSG:*** | R4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_FR2\_multiRX\_DL-Perf | | | | |  | ***Date:*** | | | 05/11/2024 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | F |  | | | | | ***Release:*** | | | *Rel-18* |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | It was agreed to include demodulation evaluations for FR2 multi-Rx in TR38.751 with square brackets | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Remove square brackets (per endorsed draftCR R4-2405934 from RAN4#110-bis) | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Sqaure brackets will remain in the specfication | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 8.3, 8.4 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  |  | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  |  | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  |  | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | | Corresponding endorsed draftCR R4-2405934 | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

**--- Start of change 1 ---**

## 8.3 Receiver assumptions

In this section, we discuss the receiver assumptions for FR2 multi-Rx DL reception. During the demodulation performance evaluation, RAN4 considered two types of receiver designs, namely joint processing and independent processing per TRxP, i.e., separate processing. In case of joint processing, UE estimates both channels from TRxPs to the Rx chains through orthogonal DMRS antenna ports. The corresponding MMSE coefficients are derived considering the estimated channels from both TRxPs to UE and estimated noise. In case of separate processing, each Rx chain will treat signal received from the corresponding TRxP while the signal from the second TRxP may be treated as interference. As such, each Rx chain will essentially operate in a single TRxP mode as it will receive data only from the intended TRxP while being impaired by the interference from the second TRxP.

As the joint processing treats interference from the second TRxP into constructing the MMSE channel coefficients, it is expected such an implementation will perform better. In cases with 2+2 layer configuration certain companies’ simulation results show, that it is not feasible to define requirements with separate processing using cross-talk levels above -12dB, however it may be feasible for joint processing using cross-talk levels at -6dB. In addition, it can be noted that one company provided antenna simulation results indicating high cross talk is a likely scenario. Following these certain results, it may be expected that UEs only supporting separate processing may perform poorly in a fully overlapping 2+2 layer configuration with high cross talk power.

Disadvantages of joint processing can also be noted. For example, the implementation complexity for joint processing could be a bottleneck, where the processing complexity will increase exponentially compared to the independent per TRxP processing as UE needs to estimate the interfering channel for transmission from non-intended TRxP as well as incur additional computational complexity due to higher dimensionality of the received signal. Therefore, implementation complexity could be a limiting factor for practical implementation. Additionally, compared to FR1, FR2 involves a higher aggregated bandwidth, e.g., 800MHz., which may require more processing power. In certain implementations of Rx chains, it may not be possible to fully benefit from joint processing, e.g., when Rx chains are placed on the left and right side of the UE. In contrast, separate processing may offer lower implementation complexity with a reasonable performance trade-off in case of fully overlapping and a layer combination of 1+1 where in contrast in the case of fully overlapping and a layer combination of 2+2 the gain of joint processing ishigher and would likely provide a reasonable performance trace-off.

When deciding receiver assumptions for demodulation requirements, RAN4 considered several cross-talk levels for initial evaluations. For example, RAN4 observed the following performance deviations between joint and separate processing for mDCI fully-overlapping scenario.

**Table 1: Performance delta between joint and separate processing for mDCI fully overlapping case.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **MCS** | **Layer Combination** | **FO for TRP2 (Hz)** | **TO for TRP2 (us)** | **r (dB)** | **Performance delta** |
| **17** | **1+1** | **600** | **-0.0625** | **-15** | **0.40** |
| **-12** | **1.10** |
| **-9** | **2.80** |
| **-6** | **2.35** |
| **13** | **2+2** | **600** | **0.0625** | **-15** | **1.05** |
| **-12** | **2.45** |
| **-9** | **3.25** |

In the above table, a positive performance delta refers to improvement that is observed due to joint processing at the receiver side. While this is expected that joint processing would perform better especially for fully-overlapping 2+2 cases, other disadvantaged cannot be ignored for practical implementation of such a receiver. With these constraints in mind, it was decided to only consider separate processing for FR2 multi-Rx in Rel-18. More simulation results can be found in [1].

**--- End of change 1---**

**--- Start of change 2 ---**

## 8.4 Conclusions

In this section, we discussed the demodulation aspects of FR2 multi-Rx DL reception. In particular, we considered the correlation model as well as the receiver assumptions for this WI. We note that the correlation model captures the spatial relationship between two TRPs and UE Rx chains in a compact form, allowing simulations for demodulation performance requirements.With the considered correlation model, RAN4 studied both joint and separate processing for receiver assumptions covering 1+1/2+2 layer combinations with different spatial configurations. To this end, trade-offs around performance and receiver implementation complexity were considered, which led to adoption of separate processing as receiver assumption in Rel-18 with the possibility of introducing joint processing receiver requirements in future releases.

**--- End of change ---**