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

**e-Meeting, April 20th –30th, 2020**

**Source: Moderator (ZTE)**

**Title: Email Discussion Summary of LS on UE Capability for NE-DC**

**Agenda item: 5**

**Document for:** **Discussion/Decision**

# Introduction

During RAN2#109e, an LS on the applicability of UE capabilities for NE-DC was sent to RAN1 [1]. In this LS, RAN2 asked RAN1 to confirm whether the UE feature *dl-1024QAM-TotalWeightedLayers* and f*d-MIMO-TotalWeightedLayers* need to be signalled for the LTE part of NE-DC band combination.

Per chairman’s guidance, this summary is to collect companies’ views on this LS and try to draft the reply based on companies’ input.

[100b-e-LS-04] Email approval of the reply LS for [R1-2001509](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001509.zip) by 4/22 (ZTE, Xingguang)

# Company’s input

As indicated in RAN2’s LS, UE capability *dl-1024QAM-TotalWeightedLayers* was introduced based on RAN1’s LS (R2-1908429/R1-1907628, see appendix), which indicates the feature was only applicable to the LTE part of EN-DC case. Similarly, for UE capability *fd-MIMO-TotalWeightedLayers*, the definition in TS 38.306 also indicates it applies to the LTE part of EN-DC. The relevant description of these two UE capabilities are as following.

| Definitions for parameters | Per | M | FDD-TDDDIFF | FR1-FR2DIFF |
| --- | --- | --- | --- | --- |
| ***dl-1024QAM-TotalWeightedLayers***Indicates total number of weighted layers for the LTE part of the concerned EN-DC band combination the UE can process for 1024QAM, as described in TS 36.306 [15] equation 4.3.5.31-1. Actual value = (10 + indicated value x 2), i.e. value 0 indicates 10 layers, value 1 indicates 12 layers and so on. For an EN-DC band combination for which this field is not included, *dl-1024QAM-TotalWeightedLayers-r15* as described in TS 36.331 [17] applies, if included. | BC | No | No | No |
| ***fd-MIMO-TotalWeightedLayers***Indicates total number of weighted layers for the LTE part of the concerned EN-DC band combination the UE can process for FD-MIMO, as described in TS 36.306 [15] equation 4.3.28.13-1 and TS 36.331 [17] clause 6.3.6, NOTE 8 in UE-EUTRA-Capability field descriptions. For an EN-DC band combination for which this field is not included, totalWeightedLayers-r13 as described in TS 36.331 [17] applies, if included. | BC | No | No | No |

RAN2 would like to know whether these two UE capabilities can be signalled for NE-DC as well.

To thoroughly understand this issue and based on the contributions submitted to this LS [2][3], the following three questions are prepared for companies to answer. Later, we could draft the reply LS based on companies’ input for these three questions.

**Q1: Technically speaking (e.g., without considering the potential NBC issue), do you think feature *dl-1024QAM-TotalWeightedLayers* and *fd-MIMO-TotalWeightedLayers* need to be supported for the LTE part of NE-DC band combination?**

|  |  |
| --- | --- |
| Company | Comments |
| ZTE | Technically speaking, the two features could be supported for the LTE part of NE-DC band combination.  |
| Apple | Separate capability is needed for NE-DC |
| Nokia | The LTE and NR side of operation in what comes to RAN1 does not change based on which radio is the MN and which is the SN, or what core network the connection goes. Hence we do not see why the same capability could not be applied to NE-DC. |
| Samsung | If there is no NBC issue, two features can be supported for the LTE part of NE-DC band combination. |
| Intel | Technically speaking, two capability parameters can be supported also for NE-DC. |

**Q2: Due to the late stage of Rel-15, do you think reusing the existing UE capability *dl-1024QAM-TotalWeightedLayers* and *fd-MIMO-TotalWeightedLayers* for the LTE part of NE-DC band combination would cause potential non-backward compatibility issues?**

|  |  |
| --- | --- |
| Company | Comments |
| ZTE | It may bring potential non-backward compatibility issues if the two existing UE capabilities are reusing for the LTE part of NE-DC band combination. One example of the potential non-backward compatible issues is as following. For a given band combination supporting both EN-DC and NE-DC, a legacy UE may support the two features for the LTE part when operating on EN-DC, but does not support the two features for the LTE part when operating on NE-DC. However, if the two existing UE capabilities are signalled for the LTE part of NE-DC band combination, network may consider this legacy UE also supports these two UE features for NE-DC as well, which is not the case. |
| Apple | We prefer separate capability for NE-DC, instead of reusing existing capability signalling. |
| Nokia | There are no legacy UEs that1. Support both EN-DC and NE-DC
2. Support dl-1024QAM-TotalWeightedLayers or fd-MIMO-TotalWeightedLayers for EN-DC
3. Do not support dl-1024QAM-TotalWeightedLayers or fd-MIMO-TotalWeightedLayers for NE-DC

However, if there were, the UE can choose what LTE capabilities it indicates to the LTE Master Node when it indicates the EN-DC capabilities, and it can also choose what LTE capabilities it indicates to the NR Mater Node when it is indicating NE-DC capabilities in an NE-DC network, and it would obviously not indicate support for the two when it is in connection to an NR Master Node. |
| ZTE 2 | Add reply to Nokia’s above comments.Nokia’s comments are based on the assumption that UE could report its capability based on the current Master Node. The comments are valid expect for the handover case. If UE is currently in EN-DC and UE reports its capability for EN-DC, later, UE hands over to a NR based station. In this case, this NR station will retrieve the UE capability from the source station (i.e., EN-DC). If the target NR station would operate with NE-DC, the target NR station would thought this UE also supports the UE features for NE-DC based on the UE capability retrieved from the source station.Anyway, we feel like this is more like RAN2 scope. We believe it is fair to use a softer tone, i.e., “Some companies in RAN1 believe there may be potential non-backward compatible issues …”. Regarding whether to reuse the existing UE capability or introduce new UE capability, it is up to RAN2 as long as there no NBC issue.Please see the Draft reply V2 (April 21th) in the conclusion section. |
| Samsung | In general, we’d like to avoid NBC issues if any at this very late stage. But, a question is that there is a band combinations supporting both EN-DC and NE-DC in Rel-15? If yes, we agree with ZTE. Otherwise, maybe no issue. |
| Intel | From the discussion for [R2-1816066](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_103bis/Docs/R2-1816066.zip) (RAN2 LS to RAN1/4) on the following question:Q5: From RAN1 and RAN4 point of view, are there any UE capabilities (defined per-CC or per-band-per-BC or per-BC) that need to signalled differently for NE-DC compared to EN-DC?[R1-1814106](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_95/LS/Outgoing/R1-1814106.zip)* Answer for Q5: There are no physical layer features, other than dynamic power sharing, that are dependent on whether NE-DC or EN-DC is deployed. From RAN1 perspective, not considering IODT aspects, the UE capabilities for NE-DC can re-use all reported EN-DC capabilities, except that for dynamic power sharing. If IODT aspects are considered, it is possible that different features may be deployed for NE-DC and EN-DC and the band combinations or deployed functionality in the set of band combinations that are used/tested may be different, in which case, some IODT differentiation may be necessary. Decisions regarding IODT aspects should be made at the RAN plenary.

[R4-1905208](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_90Bis/Docs/R4-1905208.zip)A5: RAN4 understanding is that the same capabilities for EN-DC can be reused for NE-DC if the same band combination for EN-DC can be supported for NE-DC. RAN4 has not reached a conclusion on dynamic power sharing capability, which is indicated in RAN1 reply LS. Additional capabilities can be discussed in the next releases which may or may not require different signalling for EN-DC and NE-DC.When R1-1907628 was agreed, there was a question if this can be applied to NE-DC. However, it was not captured in the agreement part. TS38.306 was updated accordingly to accommodate both EN-DC and NE-DC (i.e. MR-DC). At any case, from the RAN1/4 agreements, our understanding is that the capability signaling of ***dl-1024QAM-TotalWeightedLayers*** and ***fd-MIMO-TotalWeightedLayers*** should be able to be supported also for NE-DC without clarification. Thus, there is no non-backward compatible issue.Overall, it is curious why RAN2 questioned from the beginning if the feature for EN-DC can be applied for NE-DC in spite of RAN1/4’s agreements. |

In addition to the above two questions, do you figure out any other potential issues? If yes, please provide your detailed comments in the below table.

**Q3: Any other issue (if any)?**

|  |  |
| --- | --- |
| Company | Comments |
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|  |  |
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# Conclusion

Based on the contributions submitted to this meeting [2][3], a preliminary reply is drafted as below. The reply could be updated later based on companies’ input.

**Draft reply V1 (April 20th)**

RAN1 would like to thank RAN2 for the LS on the applicability of UE capabilities for NE-DC (R2-2002221).

RAN1 confirms that the feature *dl-1024QAM-TotalWeightedLayers* and *fd-MIMO-TotalWeightedLayers* need to be supported for the LTE part of NE-DC band combination. RAN1 figures out that there may be non-backward compatible issues if the existing UE capability *dl-1024QAM-TotalWeightedLayers* and *fd-MIMO-TotalWeightedLayers* are reused for the LTE part of NE-DC band combination and RAN1 assumes that RAN2 would avoid introducing any non-backward compatible issues.

One example of the non-backward compatible issue is as following. For a given band combination supporting both EN-DC and NE-DC, a legacy UE may support the two features for the LTE part when operating on EN-DC, but does not support the two features for the LTE part when operating on NE-DC. However, if the two existing capabilities are signalled for the LTE part of NE-DC band combination, network may consider this legacy UE also supports these two features for NE-DC as well, which is not the case.

**Draft reply V2 (April 21th)**

RAN1 would like to thank RAN2 for the LS on the applicability of UE capabilities for NE-DC (R2-2002221).

RAN1 confirms that the feature *dl-1024QAM-TotalWeightedLayers* and *fd-MIMO-TotalWeightedLayers* need to be supported for the LTE part of NE-DC band combination.

Some companies in RAN1 believe there may be potential non-backward compatible issues if the existing UE capability *dl-1024QAM-TotalWeightedLayers* and *fd-MIMO-TotalWeightedLayers* are reused for the LTE part of NE-DC band combination. One example of the potential non-backward compatible issue is as following. For a given band combination supporting both EN-DC and NE-DC, a legacy UE may support the two features for the LTE part when operating on EN-DC, but does not support the two features for the LTE part when operating on NE-DC. However, if the two existing capabilities are signalled for the LTE part of NE-DC band combination, network may consider this legacy UE also supports these two features for NE-DC as well, which is not the case.

It’s up to RAN2 whether to reuse the existing UE capability *dl-1024QAM-TotalWeightedLayers* and *fd-MIMO-TotalWeightedLayers* or introduce corresponding new UE capabilities for the LTE part of NE-DC band combination as long as there is no non-backward compatible issue.

**Draft reply V3**

To be updated based on more companies’ input.

# Reference

1. R2-2002221, LS on the applicability of UE capabilities for NE-DC, RAN2#109e.
2. R1-2001628, [DRAFT] Reply LS on the applicability of UE capabilities for NE-DC, ZTE.
3. R1-2002678, draft reply LS on the applicability of UE capability for NE-DC, Huawei, HiSilicon.

# Appendix: R1-1907628

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| --- | --- |
| **1. Overall Description:** 1.1 FD-MIMOIn RAN1-96b, RAN1 reached the following agreement (which was included in previous LS to RAN2 (R1-1905576):**Agreement:**Adopt the following baseband capability signalling for Rel-13 FD-MIMO:For a UE configured with FD-MIMO, for a band combination for which the UE does not report FD-MIMO capabilities, a configuration related to a set of CCs is supported by the UE if the following inequality is met$$\sum\_{i \in configured CCs}^{}w\_{i}∙l\_{i}\leq y$$where - $ l\_{i}$ is the maximum number of DL layers configured for CC $i$ * $w\_{i}=\left\{\begin{matrix}x\_{0}, if CC i is configured with FD-MIMO and l\_{i}=2\\x\_{1}, if CC i is configured with FD-MIMO and l\_{i}=4\\\begin{matrix}x\_{2}, if CC i is configured with FD-MIMO and l\_{i}=8\\1, if CC i is not configured with FD-MIMO\end{matrix}\end{matrix}\right.$
* $y$ is the “total number of weighted layers” the UE can process

Notes: * Legacy capability signalling can still be used after this capability is introduced (to e.g. signal a subset of supported band combinations).
* Detailed design of the capability signalling is left to RAN2

In RAN1#97, RAN1 made the following additional agreement:* Value of y (“Total number of weighted layers”) can also be signalled in EN-DC band combination. Signalling details are up to RAN2.
	+ Note: this agreement applies to only LTE part of EN-DC

1.2 1024QAMIn RAN1#97, RAN1 made the following agreement:

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| --- |
| Introduce the following additional capability signalling to existing one for support of 1024QAM in LTE:* In a band combination, the UE supports 1024QAM in a set of CC provided that:
1. The set of CC belong to bands that are indicated to support 1024QAM in that band combination, and
2. The following inequality is met: $w'⋅Num\_{Layers, 1024QAM}+Num\_{Layers, non1024QAM}\leq y'$, where
	1. $Num\_{Layers, 1024QAM}$ is the total number of layers across all configured CCs configured with 1024QAM
	2. $Num\_{Layers, non1024QAM}$ is the total number of layers across all configured CCs not configured with 1024QAM
	3. $w'\in \left\{1,\frac{6}{5},\frac{5}{4}\right\}$ and $y'\in \{10:2:30\}$ are UE capabilities (per UE)
* In case the UE does not report w’ and y’, legacy capability signalling applies (i.e., the inequality does not apply)
* Request RAN2 to introduce a mechanism to ensure backwards compatibility considering both existing and new capability signalling
* Value of y’ can also be signalled in EN-DC band combination. Signalling details are up to RAN2.
	+ Note: this agreement applies to only LTE part of EN-DC
	+ Note: maximum data rate for LTE part of EN-DC should take y’ into account
 |

To address the note regarding maximum data rate, RAN1 endorsed the following TP for TS 38.306:For EUTRA in case of MR-DC, the approximate data rate for a given number of aggregated carriers in a band or band combination is computed as follows.Data rate (in Mbps) = cid:image001.png@01D50982.1DE987A0whereinJ is the number of aggregated EUTRA component carriers in MR-DC band combinationcid:image002.png@01D50982.1DE987A0is the total maximum number of DL-SCH transport block bits received within a 1ms TTI for j-th CC, as derived from TS36.213 [22] based on the UE supported maximum MIMO layers for the j-th CC, and based on the maximum modulation order for the j-th CC according to indicated UE capabilities and number of PRBs based on the bandwidth of the j-th CC.**2. Actions to RAN2:**RAN1 respectfully requests RAN2 to update the UE capability signalling according to the above agreements.RAN1 respectfully requests RAN2 to update 38.306 according to the above text proposal.**3. Date of Next TSG-RAN WG1 Meetings:**TSG RAN WG1 Meeting #98 26 - 30 Aug 2019  Prague, CZTSG RAN WG1 Meeting #98-bis 14 - 18 Oct 2019  CN |