**3GPP TSG-RAN WG2 Meeting#111-e R2-200xxxx**

**Electronic, 17 - 28 August 2020**

**Agenda Item:**  **6.8.4**

**Source: Huawei, HiSilicon**

**Title: [Post110-e][080][DCCA] Early Measurements and Network Sharing (Huawei)**

**Document for:** **Discussion and Decision**

# 1 Introduction

This document is the summary of the following email discussion:

* **[Post110-e][080][DCCA] Early Measurements and Network Sharing (Huawei)**

Scope: Clarify How Early Measurements work with Network Sharing. Determine the need for Corrections (if any).

Intended outcome: Report

Deadline: Thursday August 6th 0700 UTC

# 2 Discussion

The scenario considered is that:

- there is a cell, "cell 1" such that:

- LTE SIB1 indicates multiple PLMNs, e.g. PLMN A, PLMN B, PLMN C,

- LTE SIB24 includes a list of (up to 8) NR carriers for idle/inactive measurement, f1, f2, f3

- for each indicated NR carrier, EN-DC is only allowed for subscribers of a subset of PLMNs listed in SIB1, e.g. f1 and 2 can be used for subscribers of PLMN A, f3 can be used for subscribers of PLMN B

- there is a UE for which:

- T331 is running,

- the UE did not receive *measIdleCarrierListNR-r16* in the *RRCConnectionRelease* message that moved the UE to RR\_IDLE/RRC\_INACTIVE.

- the UE performs cell reselection to cell 1

In this case, the UE is required to measure all NR carriers listed SIB5, i.e. f1, f2 and f3, even if the UE is a subscriber of PLMN C. With such a network configuration/behaviour, subscribers of PLMN A B and C will measure NR carriers that they cannot use, increasing UE power consumption for no gain.

**Q1: Do companies agree that the UE, which received *measIdleConfig* without an NR frequency list, will behave as described above upon reselection of a shared LTE network cell that broadcasts SIB5 with a list of NR carriers?**

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| **Company** | **Yes/No** | **Comments (if any)** |
| MediaTek | Yes |  |
| Ericsson | Yes | It is true that the UE, when camping in LTE, will get the configuration of frequencies from SIB5 if it is not included in the dedicated configuration. This does not however necessarily mean that “*subscribers of PLMN A B and C will measure NR carriers that they cannot use*” since this depends on deployment of frequencies and features. The broadcast configuration of frequencies anyway has the drawback that it needs to fit all UEs, also in non-shared network. It may thus include frequencies that are not of interest to use for a specific UE for different reasons. |
| BT | Yes |  |
| vivo | Yes |  |
| Qualcomm | Yes | Same understanding as Ericsson |
| ZTE | Yes |  |

During RAN2#110e, it was commented that dedicated signalling could be used in such a situation to ensure that the UE does not perform useless NR measurements.

We would like to assess the feasibility of such a solution, e.g. to understand:

1) the contents of dedicated signalling that could/should be used,

2) whether and how to provide such contents in non-shared network areas

3) whether and how to provide such contents in non-shared network areas

## 2.1 Contents of dedicated signalling

According to TS 36.331, if the UE has stored an NR frequency list received via dedicated signalling, the UE will not measure any NR frequency not in the list, so the list should include all NR carriers that the UE would be allowed to use for EN-DC when the PCell is the shared LTE cell.

If the shared network cell does not broadcast SIB5 or SIB24, the dedicated signalling should also include the SSB measurement configuration, which makes it difficult to provide a configuration valid in more than a single cell, unless the LTE network is synchronised.

If the shared cell broadcasts SIB5 or SIB24, the frequency list in dedicated signalling should not include any frequency in SIB 5 or SIB24 that the UE would not be allowed to use for EN-DC when the PCell is the shared LTE cell.

**Q2: Do companies agree that, in the above-described scenario, a dedicated NR frequency list preventing UEs from performing useless idle/inactive NR measurements while camping on a shared LTE cell would need to:**

**1) contains all the NR frequencies, that the UE is allowed to use for EN-DC (according to its home PLMN), and that are available in the coverage of the shared LTE cell?**

**2) (if the shared LTE cell broadcasts SIB5/SIB24), does not contain any NR frequency in SIB5/SIB24 that the UE is not allowed to use for EN-DC (according to its home PLMN)?**

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| **Company** | **Yes/No** | **Comments (if any)** |
| MediaTek | See Comment | For 1), basically yes, but whether the network want to provide all NR frequencies or piratical frequencies is up to network.  For 2), we don’t understand the limitation of the content in SIB5/SIB24. Once the dedicated frequency list is provided, the UE perform early measurement on the dedicated frequencies, not the frequencies in SIB5/SIB24. (The UE may perform cell reselection based on SIB24 though). So, it seems that no limitation on this. |
| Ericsson | See comment | The dedicated configuration does not need to contain all the NR frequencies that the UE is allowed to use for EN-DC, but should rather include frequencies of interest based on e.g. the current services and requirements. In a scenario where EN-DC (for such a configured NR frequency) would not be supported in another cell in the area, the measurement results for that frequency would not be useful if the UE establishes the connection in that particular cell. This could be the case also without NW sharing. |
| BT | Yes | In order to avoid useless UE measurements, the network shouldn’t configure any frequency that is not supported by the home PLMN.  Yes, for case 1). It’s the only way an operator makes sure the UE may connect to any NR frequency available in the coverage of the shared LTE cell.  Yes, for case 2). SIB5 and SIB24 should include frequencies that aren’t included in dedicated signalling. If the goal is to avoid useless UE measurements, SIB5 and SIB24 shouldn’t include any NR frequency not supported by its home PLMN. |
| vivo | See comment | We agree that 1) can avoid useless idle/inactive measurements. However, I am not sure how 2) works. |
| Qualcomm | See comments | Basically, same understanding as MediaTek.  For 2), if gNB provides frequency list for EMR in dedicated signalling, the UE ignores the freq list in SIB5/24 according to current spec. Thus at least from spec perspective, it is possible that SIB5/24 includes some frequency not available for one UE, and rely on dedicated signalling to preclude these frequency for this particular UE. |
| ZTE | See comment | For 1), we agree that by using dedicated signalling, the network needs to include all NR frequencies that are supported by the home PLMN (and probably equivilent PLMNs in roaming case).  For 2), we share the same understanding with MediaTek, that once frequency list is provided by dedicated siganlling, the UE will ignore the frequency list broadcast in system information. Maybe it is better to clarify 2) a bit more. |

**Q3: Do companies think about another solution using dedicated signalling?**

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| **Company** | **Yes/No** | **Comments (if any)** |
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One question is whether the dedicated signalling can/should include the *ssb-MeasConfig* or not.

The *ssb-MeasConfig* includes the SMTC offset, i.e. a time offset between the SSB to measure and the beginning of LTE subframe 0. Upon cell reselection, the UE is not required to adjust the SMTC offset according to the SFN time difference between the source and the target cell.

If the *ssb-MeasConfig* is included while the LTE network is not synchronised, the UE might search for the NR SSB at a wrong time location and not find it at all, thus increasing power consumption for no gain. To avoid useless power consumption in that case, if this is supported by the UE, the network could configure a validity area consisting of only the cell from which it has received the dedicated signalling configuration. However, if the UE performs cell reselection even only once before the next data transmission, the UE may not have any valid NR measurement results.

If the LTE network is synchronised, such a solution might work better, provided the source cell is able to provide a relevant validity area to the UE.

**Q4: Do companies agree that in the case of a non-synchronised LTE network, providing the *ssb-MeasConfig* in dedicated signalling implies that the UE may not be able to obtain idle/inactive NR measurements after cell reselection?**

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| **Company** | **Yes/No** | **Comments (if any)** |
| MediaTek | Yes | This has been discussed during the previous meeting. For non-sync network, the SSB configuration from dedicate message is not so useful. |
| Ericsson | No | This should typically not be an issue since UE implementation can handle this. The UE performs the measurements when camping in a first cell. It can then keep track of the SSB transmission occasions on NR frequencies on which it had already performed measurements also after cell reselection.  For frequencies that are part of the cell reselection system information it is then also possible to make use of the broadcasted ssb measurement configuration instead of including it in the dedicated signalling. |
| BT | Yes | With current 36.331 definition, in case the UE has received its configuration via dedicated signalling including the validity area, after a cell reselection the measurements are not longer required. Then, in non-synchronised LTE networks it is required that the new cell broadcast such information in SIB5. |
| vivo | Yes |  |
| Qualcomm | Yes | Same understanding as MediaTek. This issue was discussed in RAN2#107b. It was at least UE vendors’ consensus that the UE can’t handle SMTC in such scenario (i.e. SMTC in dedicated signalling when reselected to async cell), and it has to stop early measurements. That is the major reason why we agreed and capture below notes in 38.331:   * No UE requirements will be specified for what UE shall do upon reselection to a cell broadcasting for some frequency an SSB measurement configuration that differs from the values received in the RRC release message i.e. UE may stop early performing measurements for concerned frequency * If the UE has not received a dedicated SSB configuration, the UE does early measurements based on SIB.   As indicated by 2nd agreement above, the UE expects NW NOT to use dedicated SSB configuration in such scenario (e.g. async network deployment).  Finally, it is worth mentioning that frequency list and SSB configuration are two IEs in early measurements. It is possible that dedicated signalling only provides frequency list but rely on UE to get their SSB configuration in SIB. We should avoid mixing SSB config and frequency list in this discussion. |
| ZTE | Yes | This has been discussed before. In case the UE receives SSB configuration via dedicated signalling, the UE is not required to adjust the SSB configuration autonomously after cell-reselection to an async neighbour cell.  It implies that it is better to provide SSB configuration in SIBs in async deployment. |

## 2.2 Providing the information in non-shared network areas

The above is a strong incentive for operators to provide the *ssb-MeasConfig* in SIB5 (if not provided in SIB24 for cell reselection) rather than in dedicated signalling, if it is feasible for the operator to add all the relevant information to SIB5.

In addition, preferably, the list of frequencies in the dedicated signalling configuration should still be suitable at least after cell reselection to one of the neighbour cells of the cell in which the configuration was provided.

This means that each cell should know:

- the NR frequencies that may be available in cells that could be reselected by the UE, whether these cells have the same primary PLMN or not

- for each NR frequency, whether it can be used for EN-DC for this UE, based on its selected PLMN (assuming it would be the same in a neighbour cell)

If an operator can provide the *ssb-MeasConfig* in SIB5 or SIB24, for LTE cells not in the proximity of shared LTE cells, there is no strong motivation to use dedicated signalling to provide an NR frequency list and no coordination between cells is needed in order to configure early NR measurements using SIB5.

**Q5: Do companies agree that, besides the shared network case, if LTE cells can broadcast SIB5 the easiest solution in order to have UEs use an accurate list of NR frequencies for idle/inactive NR measurements is to not provide any NR frequency list by dedicated signalling (unlike the proposed solution for shared network areas)?**

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| **Company** | **Yes/No** | **Comments (if any)** |
| MediaTek | See Comment | We understand that non-shared network does not issue that we are discussed. Thus the frequency list could be provided by dedicated RRC message or by SIB5. For synchronous network (e.g. TDD), not sure whether providing the information in SIB5 is easier. Also, some network vendor may want to save the size of system information and thus prefer to use dedicated message. |
| Ericsson | See comment | There are different benefits with using dedicated and broadcast configuration of the frequencies. A broadcast configuration may reflect the support level in the specific cell but it is not UE specific and thus not suitable for each UE. As commented by MediaTek, it is also beneficial to keep the broadcast configuration as small as possible. With a dedicated configuration the UE can instead be configured with measurements on frequencies that are relevant for the specific UE, based on UE requirements and services. |
| BT | See comments | We agree for non-shared cells but first, the concept proximity needs to be clarified.  But also, considering the network and the environment is constantly evolving, this solution will require an extra work when planning the network. |
| vivo | See comments | The solution can avoid network coordination but may not be optimal from UE service perspectives. Thus, the solution is not preferred. |
| Qualcomm | See comment | Same issue was also discussed in RAN2#107b with the assumption of non-shared network. We understand the conclusion is that both broadcast and dedicated early measurement configuration should be feasible in spec because they had pros and cons. And it is up to NW implementation which one to use depending on specific network deployment.  Since it is quite late stage of Rel-16, we prefer not to reopen the discussion, i.e. let us focus on shared network and do not discuss what is “easiest way” for non-shared network. |
| ZTE | Yes | In non-shared deployment, we agree that it is up to network implementation whether frequency list and/or SSB configuration are provided by dedicated signalling or SIBs.  But for SIB method, considering the UE can update EMR frequency list upon cell reselection, the network only needs to configure NR frequencies which exist in the current coverage. So each LTE cell can be unaware of the NR deployment in other LTE neighbour cells (e.g. coordination among LTE cells is not needed). |

## 2.3 Providing the information in shared network areas

Within a country, if operator A is the only operator allowed to deploy cells using a certain NR frequency, it is clear that this NR frequency should be provided to all connected UEs that selected PLMN A.

Depending on agreements between operator A and operator B, in certain locations, UEs connected to LTE cells deployed by operator A and shared with operator B (i.e. PLMN A is the primary PLMN, PLMN B s also listed in SIB1) may be allowed to use a PSCell on this NR frequency.

In order to be able to provide all UEs with an NR frequency list that remains accurate after one cell reselection, there is the need to coordinate information between cells deployed by different operators. It is a difficult to characterise this in a fully general manner but we can take at least one example.

For instance, cell 1 deployed by operator A and shared with operators B and C need to know the NR frequencies possibly in use by operators B and C in the neighbour cells deployed by these operators. This means that, if operator B deploys a new NR frequency in its own network, it needs to inform operator A in case it requires updating the information provided to its subscribers by cell 1, even if this does not affect the shared cell at all.

**Q6: Do companies agree that if LTE shared cells use dedicated signalling to provide an NR frequency list for NR idle/inactive measurements, in order to there is the need for coordination between sharing operators even in case of changes only affecting the other operator (e.g. new NR frequency on non-shared LTE network)?**

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| **Company** | **Yes/No** | **Comments (if any)** |
| MediaTek | See Comment | We assume that some coordination between operators is of course necessary to have a “shared” cell. However, I don’t quite understand the example.  In case that a LTE cell 1 is shared by operator A, B, C. And an NR frequency X is also shared for all 3 operators.  Operator A has additional NR frequency Y and it decides not to share this resource with operator B and C.  Then, in dedicate message,  operator A tell its subscriber to do early measurement on Freq. X + Y  operator B tell its subscriber to do early measurement on Freq. X  operator C tell its subscriber to do early measurement on Freq. X  If operator B add new NR frequency Z and it decides not to share with operator A and C, operator B could just update its dedicate information so that  operator B tell its subscriber to do early measurement on Freq. X + Z  Perhaps there is some misunderstanding but we don’t really see problem here. |
| Ericsson | ? | The question is not clear. If an operator that is part of a shared NW e.g. deploys a new NR frequency there will anyway be a need for updates of e.g. system information throughout the network, including to cells that are shared with other operators. This will be the case also if some of the information is PLMN specific. |
| BT | Yes | Coordination among operators is required for dedicated signalling. Then, only with the coordination in place, we consider the example provided by MediaTek is feasible. |
| vivo | No | We do not see the motivation to coordinate a new NR frequency that is not allowed for network sharing, i.e., only the NR frequencies allowed for network sharing is coordinated. |
| Qualcomm | See comments | First, we also think this question is clear. If we understand correctly, the question is intended to indicate extra coordination among operators are required on (PLMN) valid frequency list provided in dedicated signaling, right? Then, we think if a new frequency is added by one operator, then such coordination is always needed for a share cell (e.g. whether adding new freq in SIB). And it is not an early measurement specific issue. |
| ZTE | Yes | Regarding the example povided by rapporteur, we agree that coordination is needed so that network can provide a “complete” frequency list that associated with the concerned operator.  Regarding the example provided by MediaTek, we understand the point is that when operator B add the new NR frequency Z, the frequency Z may not be overlapped with cell1, but overlapped with cell1’s neighbour cells (the deployment from operators are flexible). Therefore neighbour cells need to forward this information to cell 1, so that for a PLMN B UE relased in cell1, cell1 can include frequency Z in EMR dedicated frequency list, even if cell1 itself has nothing to do with frequency Z, (e.g. no cell reselection, no handover). But, this kind of coordination is complex because network has to estimate how far a UE may move during T331.  In addition, when a PLMN B UE is released in cell1, and cell 1 provides frequency X+Z to the UE via dedicated signalling, based on current spec, the UE is already required to measure frequency Z in the cell1, though there is no coverage of frequency Z at all. This is also a waste of power. |

## 2.4 Corrections

It was proposed, that, when SIB1 indicates multiple PLMN, e.g. PLMNs A, B and C, for each NR frequency in SIB5, SIB5 could additionally indicate whether that frequency is suitable for UEs selecting PLMN A, for UEs selecting PLN B and for UEs selecting PLMN C.

For instance, SIB5 indicates 3 NR frequencies f1, f2 and f3 and the UE has selected PLMN B. If the additional information in SIB5 indicates that only f2 is allowed for UEs selecting PLMN B, the UE knows that there is no need to measure f1or f3, i.e. the UE will only consider f2.

The only UE impact is to read the additional information within SIB5 (the UE needs to acquire SIB5 anyway). Since the information is coming from the camping cell, it is accurate while camping in this cell for sure and the UE will exactly perform the useful measurements.

On the network side, there is no need to coordinate between cells in order to provide by dedicated signalling an NR frequency list as accurate as possible while camping in any of the LTE cells around (depending on the deployment, it may actually not be possible to provide a list accurate for all camping).

**Q7: Do companies think that, when SIB1 indicates multiple PLMNs, it is useful to add for each NR frequency in SIB5 whether the NR frequency is allowed for each of the PLMNs listed in SIB1?**

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| **Company** | **Yes/No** | **Comments (if any)** |
| MediaTek | See Comment | We do not really see the need for this kind of enhancement at this stage. There may be some benefit to have PLMN indication for the early measurement targets but it is not essential. Note that we don’t have this kind of indication for the cell reselection targets and we believe that this is because it is not an important optimization.  We prefer not to add additional function in Rel-16. |
| Ericsson | No | This is an optimization that should not be added at this point in time. |
| BT | Yes | It is completely unnecessary that a UE performs measurements in frequencies which is not allowed. It results in a waste of power.  Assuming in Rel-16 operators will start to use multiple and different bands for NR while they share the LTE network, this fact shouldn’t be considered an optimization. |
| vivo | No | The issue is not so essential and can be left to future release. |
| Qualcomm | See comments | We are neutral to this enhancement. On one hand, we can see benefit of UE power saving to have PLMN-specific frequency list for EMR in SIB5. On the other hand, we have below questions:   1. In our understanding, RAN is already aware of the restriction based on the selected PLMN of the UE, i.e. which NR carrier can be configured for EN-DC for this specific UE. Then if the carrier to PLMN mapping does not change in a country, dedicated signaling seems to not quite complex. In simple word, is it an usual scenario that the carrier to PLMN mapping is not fixed in a country? 2. If it is agreed for EMR, then can we also allow it in cell reselection (i.e. the UE can also skip performing measurement for some particular frequency for cell reselection)? |
| ZTE | Yes | We think it is clear that per-PLMN indication could help UE filtering the meausred frequency list, in order to save UE’s power. The necessity of this modification depends on current LTE deployment and operator’s requirment, although at this late stage.  In addition, compare with cell re-selection, the number of measured EMR frequencies may be quite limited, so it is more necessary to consider how to avoid measuring useless frequencies for early measurement. |

# 3 Conclusion