**3GPP TSG RAN2 #121 R2-23xxxxx**

**Athens, Greece, 27th Feb – 3rd Mar, 2023**

**Agenda Item:**  **8.8.2**

**Source: Huawei (email rapporteur)**

**Title:** **Report of [Post120][313][UAV] Interference Control for UAVs (Huawei)**

**Document for: Discussion and Decision**

# 1 Introduction

This is the report of the email discussion[Post120][313]:

* [Post120][313][UAV] Interference Control for UAVs (Huawei)

Scope: Discuss the following aspects:

- Number of triggering cells: Scenarios (e.g. inter-RAT), possible modification compared to LTE baseline (need, motivation, option, benefit/drawback). Applicability to FR1/FR2 and need for ignoring mechanism (e.g. one cell is particularly strong). Discuss need for alternative mechanisms (number of changed cell, prohibit timer etc.

- CellsTriggeredList: possible modification compared to the LTE baseline (Motivation, options, claimed benefits and possible drawbacks). E.g. numberOfTriggeringCellsForLeaving.

Output: set of agreeable proposals

Deadline: Long - Kick off: Jan 9th, Deadline for company inputs Jan, 20th. Inactive Period January 23 to 27. Comments on rapporteur summary Jan. 30th to February 3rd

All the relevant documents from previous RAN2 meetings have been taken into account, nevertheless for the sake of progress we should focus a bit, and not all the proposals submitted in the past are in the scope of this email discussion. So please do not “expand” the scope of this email discussion. Please remember to justify your answer with clear motivations, expected gains/drawback, etc. Where applicable, rather than copying a lot of explanatory text, you can reference your (or somebody else) paper if needed.

Companies are invited to put their comment in the file and change the file name in the folder according to the convention below:

File\_v00\_Rapp

File\_v01\_company1

File\_v02\_company2

…

File location:

[Directory Listing /ftp/Email\_Discussions/RAN2/[RAN2#120]/[Post120][313][UAV] Interference Control for UAVs (Huawei) (3gpp.org)](https://www.3gpp.org/ftp/Email_Discussions/RAN2/%5BRAN2%23120%5D/%5BPost120%5D%5B313%5D%5BUAV%5D%20Interference%20Control%20for%20UAVs%20(Huawei))

PS: As a reminder, I copy here the latest agreement relevant to this email discussion. The purpose of *numberOfTriggeringCells* mechanism is to limit the interference caused by too many (measurement) reports.

Agreement in RAN2#119bis:

1. As in LTE, as a baseline, events A3, A4 and A5 can be configured with the configured number of cells (numberofTriggeringCells)

Companies providing input to this email discussion are invited to leave contact information below.

|  |  |  |
| --- | --- | --- |
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# 2 Discussion

## 2.1 Applicability to the inter-RAT scenario

RAN2 should decide if the Number of triggering cells mechanism should be extended to apply to the inter-RAT scenario, i.e. event B1 and B2 triggering. How likely is that the UE will move at the border between LTE and NR? And what should we do in that case? If the Number of triggering cells mechanism is used, would this affect negatively the mobility, in particular the inter-RAT HO?

**Q1: Do you think that the Number of triggering cells mechanism should be extended to apply to the inter-RAT scenario, i.e. event B1 and B2 triggering?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Short answer** | **Comments** |
| Huawei, HiSilicon | No | The inter-RAT scenario should not occur too frequently compared to the intra-RAT, but more importantly if we extend the *numberofTriggeringCells* mechanism to the inter-RAT scenario we see a risk for HO failure at the cross between the two different RAT, given by the UE withholding its measurement report in some cases. |
| Ericsson | Yes  yes | But we would like to clarify that the RSRP report triggering based on number of cells is not for mobility but for interference/flying mode detection.  When triggering is based on N cells, all Ncells need to trigger before the measurement report is sent. Hence, the report is way delayed for mobility purposes! Actually, for mobility, short TTT is beneficial when UE is flying as the cell coverage gets scattered on higher altitudes.  That, said, in our view taking into account LTE and NR cells in detecting interference and/or flying mode is important. |
| Qualcomm | No strong view |  |
| LGE | No strong view |  |
| NEC | No | Agree with Huawei. |
| Nokia, Nokia Shanghai Bell | No | The purpose of multi-cell triggering for events B1 and B2 needs to be explored, but only in the context of interference control. As multi-cell triggering was designed to help with interference detection, the topic of inter-RAT mobility should be discussed separately, if necessary.  It isn’t clear whether there would be inter-RAT interference, as this would only be the case if the LTE and NR cells were on the same frequency. Additionally, DSS cells would be double counted in this scenario. |
| CATT | No strong view | If majority company support this function, we are fine. |
| Xiaomi | No strong view |  |
| vivo | No | Agree with HW and Nokia that inter-RAT interference may not occur frequently. |
| Sharp | Yes | Inter-RAT interference is real case and extension of number of triggering cell to event B1 and B2 is simple. |
| Intel | No | Agree that it may impact HO performance. |
| Samsung | No | We think that there are pros and cons of supporting the number of triggering mechanism i.e. it may be helpful for controlloing the amount of measurement reports at the expense of supporting inter-RAT mobility (e.g. inter-RAT HO). Since LTE coverage is quite larger than NR coverage, we think that seamless inter-RAT mobility support in a timley manner might outweigh the control of excessive measurement reports. We are not pretty much sure whether interference/flying mode detection is criticial in terms of inter-RAT event.  Besides, there are still remaining issues on how the number of triggering cells mechnasim in NR will be enhanced compared to LTE. In other words, we many need to further discuss whether to apply such enhancement or just copy and paste LTE mechansim to inter-RAT scenarios. Hence, we prefer not to apply the number of triggering cells mechansim to inter-RAT events (or suggest to deprioritize its applicability to inter-RAT events). |
| Apple | Yes | We share Ericsson’s view.  Besides the purpose to mitigate interference of neighbor LTE cells, another motivation is combining LTE cells and NR cells together can reduce the reporting further compared to configuring separate conditions with smaller numberOfTriggeringCells for LTE MO and NR MO |
| ZTE | Yes | Agree with Sharp that inter-RAT inference is real case. It will be useful in some deployment. If *numberofTriggeringCells* is supported for intra-RAT interference detection, we see no reason not support for inter-RAT.  The impact on inter-RAT mobility of this mechanism is same as the impact on intra-RAT mobility. |
| AT&T | No | We share Nokia’s view. Reports for LTE and NR cells can be handled separately. |

Summary: 15 companies replied. 7 No, 4 Yes, 4 No strong views.

There seem to be too many negative opinions on extending the Number of triggering cells mechanism to apply to the inter-RAT scenario, i.e. event B1 and B2 triggering, therefore the rapporteur proposes:

**P1: Do not extend the Number of triggering cells mechanism to apply to the inter-RAT scenario, i.e. event B1 and B2 triggering.**

## 2.2 Applicability to FR1/FR2

RAN2 should decide if the applicability of Number of triggering cells mechanism should be restricted to FR1 only.

**Q2: Do you think that the applicability of Number of triggering cells mechanism should be restricted to FR1 only? Why yes/why not?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Short answer** | **Comments** |
| Huawei, HiSilicon | No | We do not see a reason why the *numberofTriggeringCells* mechanism should be restricted in FR1. Ultimately this is could be left to network configuration. |
| Ericsson | No | It would be important UE considers all cell in vicinity to trigger based on N cells. |
| Qualcomm | No | If we end up defining the mechanisms, we do not see a need to restrict it to FR1 only. It is up to the network to decide and configure accordingly. |
| LGE | No | We think there is no reason to restrict the mechanism by frequency range. The network can configure an appropriate *numberofTriggeringCells* according to the frequency range. |
| NEC | No | It could be left to network configuration. On the other hand, any optimization for FR2 is not necessary, either. |
| Nokia, Nokia Shanghai Bell | No | Number of triggering cells should be an option in FR2, but it could be considered in combination with number of triggering beams. |
| CATT | No | This can be left to gNB configuration and there is no clear point to limit to FR1 only from our perspective. |
| Xiaomi | No | There is no reason to introduce the restriction. It is up to network configuration whether to configure *numberofTriggeringCells* for different frequency range. |
| vivo | No | We don’t see the need to have such restriction. |
| Sharp | No | No reason to restrict. |
| Intel | No | No reason to add such restriction. |
| Samsung | No | It should be agnostic to frequency band. |
| Apple | No | It’s not clear to us why FR2 should be excluded. |
| ZTE | No | There is not reason to have this restriction. |

Summary: 14 companies replied. 14 No, therefore the rapporteur proposes:

**P2: Do not restrict the applicability of Number of triggering cells mechanism to FR1 only. In other words, the Number of triggering cells mechanism is applicable to FR1 and FR2 (up to network configuration).**

## 2.3 Need for ignoring or bypassing the Number of triggering cells mechanism

RAN2 should decide if there is a need for ignoring or bypassing the Number of triggering cells mechanism, once configured (e.g. for the case of strong DL interference from some neighbour cells, or the UE altitude is too high/not too high, or…).

**Q3: Do you think that there is a need for the UE to ignore or bypass the Number of triggering cells mechanism, once configured, in some cases? If yes, in which cases and why?**

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| --- | --- | --- |
| **Company** | **Short answer** | **Comments** |
| Huawei, HiSilicon | Yes | As we all know, introducing the number of triggering cells mechanism can result in late handover. Thus, in some scenarios we need to skip the number of triggering cells mechanism to ensure the network obtains the measurement report in time. For example, if the number of cells in the cellsTriggeredList is smaller than the *numberofTriggeringCells* when the UAV detects the DL interference of a certain cell as being very strong (i.e. signal level above a threshold), the UAV should send the measurement report to the network immediately, to ensure the network takes the appropriate actions on time. |
| Ericsson | No | Regular events need to be configured for the UE in addition to N of triggering cells for mobility support. This was the understanding already in LTE. (For the regular event, one can consider further enhancements mobility support) |
| Qualcomm | No | UE follows what network configures (including any new mechanism that may be introduced in R18).  If there is desire and consensus for the UE to behave in a certain way, e.g. for the case of strong DL interference from some neighbour cells, then there should be corresponding procedure and configuration for that case, and UE again follows the configuration as specified (this is not same as UE ignoring or bypassing autonomously the configuration of number of triggering cells mechanism). |
| LGE | Yes | If the DL interference by a few neighbor cell is too strong, UE may face problems before sending measurement reports such as decoding failure due to interference. Therefore, in the case of strong DL interference from neighbor cells, UE should be able to report strong DL interference even when the number of neighbour cells does not satisfy the *numberOfTriggeringCells*. |
| NEC | YES | Under sort of a circumstance that a strong cell enters, for example:  - Before the number of cells in *cellsTriggeredList* is equal to or larger than *numberOfTriggeringCells*, if a new triggering cell quality is better than other cells included in the *cellsTriggeredList*,  - After the number of cells in *cellsTriggeredList* is equal to or larger than *numberOfTriggeringCells*, if a new triggering cell quality is better than other cells included in the *cellsTriggeredList*,  number of triggering cells mechanism could be ignored to avoid late measurement reporting. |
| Nokia, Nokia Shanghai Bell | Maybe | UE altitude could be used as a way to select between more than 1 number of triggering cells configuration since UEs at a high altitude will be in view of more cells than UEs at a low altitude. Whether the altitude dependency should only apply to the number of triggering cells or to an entire set of configurations, including the altitude trigger and one of A3, A4, or A5 is to be determined.  In our paper R2-2212268 we showed that by “setting A4 threshold based on average LOS conditions for altitudes below 40m, it is possible to keep the number of triggering roughly in the same range as for altitudes above 40m. This as an alternative to a bypass would provide two options that can account for the conditions at different altitudes. |
| CATT | No | The necessity to introduce this function is still unclear to us. |
| Xiaomi | No | Agree with Qualcomm.  For some case with strong DL interference or the UE altitude is too high, NW can configure measurement report without the Number of triggering cells. |
| vivo | No | If the network wants to know whether there are strong DL interference cells timely, the network can configure Ax events (e.g, A4 event with high quality threshold) in addition to N of triggering cells. So, we don’t see the need to introduce this mechanism. |
| Sharp | No | Seems appropriate existing network configuration can solve the issue. |
| Intel | No | UE should follow NW configuration. If such bypass should happen, network should simply not configure it. |
| Samsung | No | We think that UE should follow NW configuration so it is not clear to us what the question really intends to say. If there is any case for UE to ignore the number of triggering cells mechanism, it should be based on NW's configuration, not UE autonomous decision. |
| Apple | No | We think if allow this, it could be a very difficult discussion on the conditions to bypass number of triggering cells mechanism. If network would like UE to report immediately upon some conditions without waiting for *numberOfTriggeringCells*, network can configure a separate report to UE. |
| ZTE | No | Agree with Qualcomm. If existing mechanism can deal with the cases as mentioned by some companies, we should avoid complicating *numberofTriggeringCells* mechanism. |
| AT&T | No | We believe there are other mechanisms which can be employed to mitigate coverage interruptions. |

Summary: 15 companies replied. 11 No, 3 Yes, 1 Maybe.

There seem to be too many negative opinions on the need for the UE to ignore or bypass the Number of triggering cells mechanism, once configured, in some cases.

**P3: The UE shall not ignore or bypass the Number of triggering cells mechanism, once configured.**

## 2.4 Need for introducing an alternative mechanism to the Number of triggering cells one.

RAN2 should discuss if there is a need for an alternative mechanism to the Number of triggering cells ~~one~~ mechanism (need, motivation, options, benefit/drawback). In particular it has been mentioned as alternative a mechanism based on

“Number of changed cells”.

**Q4: Do you see the need for an alternative mechanism to the Number of triggering cells ~~one~~ mechanism? In particular what is your opinion on a mechanism based on “****Number of changed cells”?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Short answer** | **Comments** |
| Huawei, HiSilicon | No | For the entry condition, we think the number of changed cells is almost equivalent to the *numberofTriggeringCells*. RAN2 has been agreed to introduce the *numberofTriggeringCells* for LTE in the past and now that’s the baseline for NR*.* As a result, there is no reason to introduce the number of changed cells.  For the leaving condition, using number of changed cells may cause the wrong HO. Assume the number of changed cells is two, and cells A, B, and C are in the cellsTriggeredList and has been reported to the network. When cell A leaves the list, the UE will not send measurement report, and if the network hands over the drone to cell A at this moment, this will result in handover failure. |
| Ericsson | No | Alternative mechanism for what use? For interference detection we have this and it seems enough. For flying mode detection we have this and H events. For mobility, we have the other email discussion to consider what is needed for that. |
| Qualcomm | No | RAN2 agreed to number of triggering cells mechanism after studying and analysing various simulation results for LTE in Rel-15 and recently agreed to re-use it for NR. We do not see need and motivation to introduce alternative mechanism based on number of changed cells. |
| LGE | Yes | In LTE, the UE cannot send another measurement for that measurement ID if the number of cells satisfies the number of triggering cells. We can discuss how to continuously and efficiently notify interference after the first measurement report. From this perspective, an alternative mechanism can be useful.  Report restriction always has a trade-off relationship with handover failure. When the “number of change list” is applied to only one entry or leaving condition, the network can set an appropriate value according to the frequency characteristics or the situation the UE is in. Even, without limiting entry/leaving condition, if changes are counted by considering all added or removed cells from a list in the previous report, the environment the UE is in may be well reflected. |
| NEC | No | We do not see the need of the“Number of changed cells” mechanism as we already agreed to have “Number of triggering cells”. |
| Nokia, Nokia Shanghai Bell | Yes | We support number of changed triggering cells. In our paper R2-2210356, it was shown that numberOfChangedTriggeringCells generates 50% fewer reports compared to the LTE multi-cell triggering mechanism, and with similar performance. Additionally, numberOfChangedTriggeringCells only requires one parameter compared to two in other methods. |
| CATT | No | For the current NR UAV first version, it is too premature to find an alternative mechanism right now (we treat it as one optimization with low priority). |
| Xiaomi | Yes | In LTE UAV, if *numberOfTriggeringCells* is configured, when the number of cell(s) in the *cellsTriggeredList* is larger than or equal to *numberOfTriggeringCells* for the first time, UE shall initiate the measurement reporting procedure. However, measurement reporting will not be triggered when the number of cells always satisfies the number of triggering cells. UE cannot report the latest interference to NW.  The mechanism based on “Number of changed cells” can solve the issue without excessive measurement reports. When the number of cells added in *cellsTriggeredList* after the last measurement report is larger than or equal to *numberOfChangedCells*, UE can initiate the measurement reporting procedure.*“numberOfChangedCells”* and “*numberOfTriggeringCells”* can be configured simultaneously. And *numberOfTriggeringCells* can be configured for the first report and “*numberOfChangedCells”* can be used to trigger subsequent measurement report. |
| vivo | Yes | Firstly, we think “The number of changed cells” can be combined with “the number of triggering cells”, so “The number of changed cells” is not an alternative mechanism.  From our understanding, introducing “The number of changed cells” can solve the below two issues.   * **Issue 1:** When the number of triggering cells is equal to *numberofTriggeringCells*, the UE triggers measurement reporting. After that, the UE cannot trigger measurement reporting when new cells are added into *cellsTriggeredList* if periodic reporting is not configured. The network cannot obtain new cells timely to perform interference management and mobility management for the UAV, which may lead to RLF or HOF of the UAV. * **Issue 2:** When *reportOnLeave* is set to true for the event (A3 or A4 or A5), the UE will trigger measurement report if each of the cells in *cellsTriggeredList* fulfills the leaving condition of the event. This is also not consistent with the motivation of introducing *numberofTriggeringCells*.   The common part of two issues is the number of changed cells compared to the cells included in the *cellsTriggeredList.* So, it seems straightforward to introduce a new parameter *numberofChangedCells* to trigger RRM report. |
| Sharp | No | Enhancements to reduce measurement reports can be discussed based on the current “Number of triggering cells”. |
| Intel | No | We prefer using LTE as a baseline. If there is other enhancement, we can discuss separately. |
| Samsung | No | We understand that the necessity of having alternative mechanism stems from no subsequent measurement reports while the list of triggered cells remains larger or equal to the configured number of cells. But we think that this is the key point of controlling excessive amount of measurements reports and detecting UAV-specific interference detection via existing mechanism on the number of triggering cells. Thus, we are not convinced yet whether the concerned alternative mechanism is really needed. |
| Apple | Yes | In our contribution R2-211738, we identified one problem that for A4 event, it is not clear if network would remove and add the measurement configuration after handover. From UE side, if the measurement configuration (measID, reportConfigId) for target frequency is not changed, UE would not remove the VarMeasReportList. Therefore the consequence is the newly added entries of neighbour cells after handover cannot trigger the update of reporting. The purpose to use “number of changed cells” is to cover the case the cells in the report variant are changed from A/B/C to B/C/D to C/D/E.  The second issue identified during previous discussion is when more cells than numberOfTriggeringCells are found, UE does not trigger the report if UE has triggered reporting once.  The third motivation is to reduce the reporting frequency for ReportOnLeave.  In short, the proposal is when the addition/change/removal of neighbor cells meet the threshold, UE triggers a new measurement reporting. |
| ZTE | No | We don’t see motivation for an alternative. |
| AT&T | Maybe | We believe that either the *numberOfChangedTriggeringCells* proposal should be studied further, or that the *numberOfTriggeringCells* mechanism should be revisited, as it appears that the *numberOfChangedTriggeringCells* mechanism doesn’t adequately cover all cases. |

Summary: 15 companies replied. 9 No, 5 Yes, 1 Maybe.

There seem to be too many negative opinions on the need for an alternative mechanism to the Number of triggering cells mechanism or for adding an additional mechanism based on Number of changed cells.

**P4: Do not introduce an alternative mechanism to the Number of triggering cells mechanism. Do not introduce an additional mechanism based on Number of changed cells.**

## 2.5 Need for introducing a prohibit timer.

RAN2 should discuss if there is a need for a prohibit timer mechanism. What would be the motivation, the expected gains and drawbacks. Should this be introduced in coexistence or as an alternative to the baseline CellsTriggered mechanism?

**Q5: Do you see the need for introducing a prohibit timer mechanism?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Short answer** | **Comments** |
| Huawei, HiSilicon | Yes | We believe that the cellsTriggered mechanism and the prohibit timer can coexist. Using the prohibit timer mechanism in combination with the cell Triggered mechanism can reduce the measurement reports even further.  For example, if the prohibit timer expires but the number of cells is less than the *numberOfTriggeringCells*, the UAV will continue to refrain from sending reports*.* Otherwise, it will send the reports. Also the other way around works, i.e. the UE can follow the most restrictive conditions of the two. |
| Ericsson | Yes | This is proposed for regular mobility events originally!  This method can control the amount of measurement reporting, also at the same time it enables timely reporting when the event is triggered first time.  Preventing certain measurement results may result in a worry on decreasing mobility performance, but we have results in R2-1807257 to prove that it is not a problem. |
| Qualcomm | No | If there are too many measurement reports triggered due to certain network configuration, the correct approach is to adjust the configuration by the network instead of ‘*prohibit*’ing the reports by yet another new configuration (which are legitimately triggered by the network configuration). Prohibiting the reports also does not solve the issue of UE having to perform the measurements in the first place. |
| LGE | No | We think the prohibit timer is not suitable for reporting interference. Even the configured timer may not be suitable depending on the speed of the UE. |
| Ericsson2 |  | To QC: for mobility events, as same event is going to be triggered by new cell consecutively as UE starts to fly, it is difficult to impact that by RRC reconfiguring as that is slow. The prohibit timer would indeed be the way to impact the configuration to not trigger this way. We would be happy to elaborate better the proposal e.g. in Athens. |
| NEC | No | At least for cell entering case, we think “prohibiting” the report by a timer is not as reasonable as the *numberOfTriggeringCells* mechanism and we do not know how the network should determine the length of the timer. |
| Nokia, Nokia Shanghai Bell | No | When properly tuned, the number of changed triggering cells mechanism that has been suggested should provide a sufficient time between reports such that a prohibit timer would not be necessary. As stated in Q4, our paper showed that a prohibit timer was not needed to reduce the number of reports by 50%. |
| CATT | No | If the numberOfTriggeringCells can not be used correctly to control the amount of measurement reporting, just wondering the necessity to further introduce the prohibit timer mechanism. We think with the proposed proposal, the cost is to introduce more limitation and complexity to gNB. |
| Xiaomi | No | The CellsTriggered mechanism is enough to reduce the measurement report. The prohibit timer mechanism is not needed. |
| vivo | No | Prohibit timer is not flexible, which may lead to untimely RRM report and handover failure. |
| Sharp | No | Number of triggering cells is enough, and prohibit timer may delay measurement reports further. |
| Intel | May be | We see benefit on prohibit timer. However, the downside of prohibit timer is missing measurement report and hence delay HO resulting RLF. Therefore, adding timer stop condition in such cases will avoid that and make prohibit timer useful. |
| Samsung | Maybe no | We prefer to have common UE behaviors applicable to both LTE and NR, unless a strong motiviation is justified.  We understand that prohibit timer may be useful for timely measurement report in case the list of triggered cells is newly updated while it remains larger or equal to the configured number of cells, but it seems a minor optimization at the cost of more measurement report. |
| Apple | No | Current LTE number of cells triggering already restricts UE from frequent reporting in cases like more cells are added and cells in *cellsTriggeredList* are changed. If we follow LTE design (meaning without proposal in Q4), we don’t see the motivation to introduce a prohibit timer. |
| ZTE | No | Prohibit timer solution will complicate network implementation. It is difficult for network to determine a proper timer because the value of this prohibit timer depends on the speed of UAV UE.  Further, combination of prohibit timer and numberOfTriggeringCells mechanism may further delay measurement report. |
| AT&T | No | We have concerns that a prohibit time would have negative interactions with other proposed reporting mechanisms and the additional study that would be required to resolve these concerns. |

Summary: 15 companies replied. 11 No, 2 Yes, 1 Maybe, 1 Maybe not.

There seem to be too many negative opinions about the need for a prohibit timer mechanism.

**P5: Do not introduce a prohibit timer mechanism.**

## 2.6 reportOnLeave.

RAN2 should discuss the reportOnLeave mechanism.

Is the LTE baseline suitable/sufficient? If not, which of the following enhancements will make sense to introduce and why? Indicate possible gains and drawbacks in your view. In particular your opinion is welcome on the following:

1. Introduce a numberOfTriggeringCellsForLeaving
2. The UE should not report a cell leaving if that cell was not reported joining previously.
3. Measurement report when the number of cells in *cellsTriggeredList* becomes smaller than a threshold

**Q6: Do you see the need to enhance the reportOnLeave mechanism? Please comment on the possible enhancements listed above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Short answer** | **Comments** |
| Huawei, HiSilicon | b | Solutions a) and c) may cause the wrong HO, like the number of changed cells. See for example our comments in the papers that we submitted in Q4 for more details.  For solution b), we think this mechanism should work (i.e. be introduced) only when the number of cells in the CellsTriggereddList is greater than *numberOfTriggeringCells.* When the number of cells is smaller than *numberOfTriggeringCells* should follow the current mechanism, i.e., the UAV sends a report to the network when a cell leaves. In this way we do not see any technical drawbacks and some useless measurement reports can be avoided. |
| Ericsson | See comment | If numberOfTriggeringCellsForLeaving means a measurement report is triggered when the number of cells in the list goes below this value it seems ok to consider. |
| Qualcomm | b + c | Motivation for a) is not convincing enough to justify the additional complexity/work to introduce the new procedures. |
| LGE | a | For option b, if the leaving condition is applied only to the cells included in the previous measurement reports, it is difficult to notify the interference continuously. The leaving condition can be a complement to sending measurement reports when measurement reports cannot be sent due to the number of triggering cells condition. Therefore, to inform the interference continuously, the UE must be able to report the interference regardless of whether the cell has been previously reported.  For option c, we think, even if there are more cells than a certain threshold, a report is required if large interference is measured or there is a large change in the list.  Therefore, we think ‘option a’ seems to be reasonable to report the interference continuously while preventing an excessive report. |
| NEC | Slightly prefer b |  |
| Nokia, Nokia Shanghai Bell | a | If the number of changed triggering cells mechanism, which we prefer, from Q4 is adopted, the report on leave mechanism would be redundant since the list of triggering cells can change by having cells leave condition, which would trigger a report.  a) Based on our simulations, out of the three choices, this option produced the best accuracy (percentage of cells report which receive UAV interference of at least 3dB above noise) while reducing the number of reports compared to LTE.  b, c) These options produced fewer reports compared to LTE, but with a lower accuracy than both numberOfChangedTriggeringCells and option a. |
| CATT | b | We reckon that the reportOnLeave mechanism introduced in LTE is not appropriate, hence the first step for NR UAV is to fix this issue firstly. |
| Xiaomi | b | Solution b) can update the interference and measurement results in time, thus avoiding the wrong HO. |
| vivo | See comments | See our comments in Q4, we prefer to introduce the number of changed cells. |
| Sharp | b | This option is based on existing method and is simpler. |
| Intel | b |  |
| Samsung | b | When the reportOnLeave and numberOfTriggeringCells are configured for a certain event, we think that the main intent of reportOnLeave is to make network which cell(s) are removed in the cellTriggeredList by comparing the latest received measurement report associated with the configured event. Hence, b is OK to us but details can be further discussed. |
| Apple | a | Please check our detailed reply in Q4. |
| ZTE | b | Reporting on leave for the cell not in CellsTriggereddList is not useful for network.  On a: the measurement report due to leaving CellsTriggereddList will be reduced. However, it also delay the measurement report. It is unclear whether timely report for cell leaving is necessary.  On c: similar to option a, the measurement report will also be delayed. It is unclear whether it is acceptable. |

Summary: 14 companies replied. Companies generally think that something can be improved in this area, and are interested in the following enhancements: a) 3, b) 9 (of which one was “slightly prefer”, c) 1.

There seems to be not much support for option a) and c), while there is quite some support for b), therefore the rapporteur proposes:

**P6: The UE should not report a cell leaving if that cell was not reported joining previously.**

## 2.7 Use of “beams” vs “cells” for interference control.

RAN2 should discuss the possible use of “beams” vs “cells” for interference control. Will this increase the number of reports, and therefore the interference, or rather the opposite? How would that work? What are the possible gains and drawbacks?

**Q7: Do you see the need to use of “beams” instead of “cells” for interference control?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Short answer** | **Comments** |
| Huawei, HiSilicon | No | In NR, the measurement report is still based on the measurement result at the cell level, even for the beamforming cell. Thus, using beams for interference control cannot improve the performance of interference control. We see that this could cause additional work in RAN2 for no real benefit. |
| Ericsson | No | It’s a bit unclear what is meant by “interference control”. In general, in NR the measurements are done at beam level and the measurements can be used to calculate a cell-level quantities. In our view, using cell-level RSRP is appropriate for the event of numberOfTriggeringCells. |
| Qualcomm | See comments | The question is a bit confusing. The beam level measurements can be used to calculate cell-level quantities, and such cell-level value is appropriate for the evaluation of event trigger conditions for numberOfTriggeringCells. However, if beam level reporting is considered, then separate trigger condition e.g. numberOfTriggeringBeams would be needed.  Note that we showed previously that naturally there will be more measurements when there is more than one beam per cell (compared to one beam per cell). So, if report trigger mechanisms depend on number of ‘beams’, for example, instead of number of ‘cells’, there will be more reports triggered.  We observed that measuring only a subset of beams based on height can save on number of measurements without significant performance degradation. Consequently, we propose that to reduce the number of beam measurements (and measurement reporting), RAN2 should introduce height threshold for measurement of a subset of beams. See R2-2211305 [1] for details. |
| LGE | No | We can consider two scenarios:  Scenario 1. A Cell quality does not satisfy the report condition, but some beams exceed the threshold of the report condition.  Scenario 2. A Cell quality satisfies the report condition, but some beams are weak.  In the case of scenario 1, if the target cell is a neighbor cell, the UE will not perform a handover to the corresponding cell. Even if one or two beams are good, if the cell quality is not satisfied, it cannot be considered a good cell. So, the UE does not need to send a measurement report for mobility. If the target cell is a serving cell, the purpose of the measurement report may be beam control. However, the beam can be controlled by the existing procedure such as CSI-RS report. So, the UE does not need to send a measurement report for beam control.  In the case of scenario 2, if the cell quality satisfies the report condition, it means that there are beams that satisfy the threshold and can be considered as a good cell. Thus, the weak beams should not affect the measurement report. If the cell quality based on beams (whose beam quantity is higher than absThreshSS-BlocksConsolidation or absThreshCSI-RS-Consolidation) satisfies the report condition, the UE should send the measurement report for mobility. |
| NEC | No | In NR, the triggering of the measurement report is still based on cell-level measurements, so in our view this “beam-level interference control” requires at least beam-level triggering of the measurement report, which may bring much higher burden for RAN2 works. |
| Nokia, Nokia Shanghai Bell | See Comments | Beams could be reported when a multi-cell report is triggered. Or the cell and beam level measurements could be used in combination. We do not support triggering on beams only. |
| CATT | No | We share the same view as Huawei. |
| Xiaomi | No | Because cell-level measurement results are calculated based on beam-level measurement results, the signal strength of beam can indirectly affect the measurement results of cell-level. Hence, using cell-level measurement results is enough for NR UAV and using beam-level measurement results for interference control is not needed. |
| vivo | No | Agree with Huawei. |
| Sharp | No | Agree with Huawei. |
| Intel | No | We don’t see the benefit using beam instead of cell. Beams can be reported to the NW but for triggering condition, it is still unclear to us how it is benefit. |
| Samsung | No | Though there is difference of deriving cell measurement quantity between LTE and NR, network can do control how to derive NR cell measurement quantity by appropriate setting of numberOfTriggeringCells and existing parameters (e.g. nrofSS-BlocksToAverage and absThreshSS-BlocksConsolidation), if needed. Thus, we do not see any need to use 'beams' instead of 'cells' for interference control. |
| Apple | No | The question is not very clear to which mechanism it refers. We suppose it is about introducing numberOfTriggeringBeams as a condition for UE to initiate measurement report. Our understanding is this is not needed as the beam number is not a necessary factor to identify the cells from which UE receives signal. In order to not miss any cells in interference mitigation, numberOfTriggeringBeams should not be considered.  Else if it is about reporting beam related measurement results, we think it is already possible so nothing new is needed. |
| ZTE | No | We share similar view as above companies on that cell level measurement are derived from beam level measurement results.  And we also think when UAV flies above a height threshold, UAV only needs to measure a small number of beams of a cell, as indicated by Qualcomm. Thus using beam for interference control is unnecessary. |

Summary: 14 companies replied. 12 No, 2 Maybe.

There seem to be too many negative opinions about the need to use of “beams” instead of “cells” for interference control and the possible use of a “numberOfTriggeringBeams” mechanism.

**P7: Do not introduce the use of “beams” instead of “cells” for interference control. Do not introduce the use of a “numberOfTriggeringBeams” mechanism.**

# 3 Conclusions and Proposals

~~[To be added later by the rapporteur]~~

Based on the opinions expressed by the companies that participated, the rapporteur has the following proposals:

**P1: Do not extend the Number of triggering cells mechanism to apply to the inter-RAT scenario, i.e. event B1 and B2 triggering.**

**P2: Do not restrict the applicability of Number of triggering cells mechanism to FR1 only. In other words, the Number of triggering cells mechanism is applicable to FR1 and FR2 (up to network configuration).**

**P3: The UE shall not ignore or bypass the Number of triggering cells mechanism, once configured.**

**P4: Do not introduce an alternative mechanism to the Number of triggering cells mechanism. Do not introduce an additional mechanism based on Number of changed cells.**

**P5: Do not introduce a prohibit timer mechanism.**

**P6: The UE should not report a cell leaving if that cell was not reported joining previously.**

**P7: Do not introduce the use of “beams” instead of “cells” for interference control. Do not introduce the use of a “numberOfTriggeringBeams” mechanism.**

# 4 References

~~[you can add if needed]~~

[1] R2-2211305, Measurement and reporting enhancements, Qualcomm Incorporated, RAN2#120, Toulouse, France, Nov 14-18, 2022