**3GPP TSG-RAN WG2 Meeting #121bis-e** **R2-230xx**

**eMeeting, 17-26 April, 2023**

**Agenda item:** 7.8.2

**Work Item:** NR\_UAV-Core

**Source:** Qualcomm Incorporated (Moderator)

**Title:** Report of [AT121bis-e][306][UAV] Measurement Reporting (Qualcomm)

**Document for:** Discussion/Decision

# Introduction

During RAN2#121, based on email discussion report [Post120][312][UAV] (see R2-2300479) and report of offline [AT121][305][UAV] (see R2-2302210), following was agreed:

**Agreements:**

1. Support configuring height-dependent more-than-one configurations targeting measurement and measurement reporting enhancement. UE applies corresponding configuration based on the UE height. The proposed solutions should aim at avoiding RAN4 impacts. FFS how this would be configured (i.e. different MO configurations or different parameters FFS Exact parameters and details.

To progress further, post meeting email discussion [POST121][313][UAV] was setup (see report in R2-2302681). The report of the email discussion was discussed further and following was agreed in RAN2#121bis-e online session on Monday (yellow highlighting added):

**Agreements**

1. Height-dependent more-than-one configurations is supported on parameter/field level (i.e. different fields/values within the same MO) where different values (or value ranges) of the parameter/field applies to different height or height range.
2. For MO configuration parameters: at least the following will have ability to be configured with height-dependent more-than-one configurations/values, each for a specific height region: SSB-ToMeasure. Details on how to specify is FFS. FFS on UE behavior on L1 and L3 measurement. [additional parameters in MO configurations can be discussed in 306]
3. [CB] *For MR configuration parameters: at least the following will* *have ability to be configured with height-dependent more-than-one configurations/values, each for a specific height region: Event A4 threshold. Details on how to specify is FFS (i.e. maybe it can be achieved by combination of events). FFS other parameters to be consider. [continue this over AT email discussion 306]*
4. When height-dependent more-than-one configurations are provided, UE applies the new value once it moves to new height (or height range) similar to the case of RRC reconfiguration. Need Codes, field descriptions, etc. as in legacy specifications apply
5. If a height-specific value is not explicitly configured for certain height, whether to keep using the value that was used or consider the parameter as released (i.e. parameter/value not applicable at this height) should be looked into case by case, and can be clarified by need code, field description, or procedural text as needed. FFS details

To progress further on the highlighted parts above, following email discussion was setup:

* [AT121bis-e][306][UAV] Measurement Reporting (Qualcomm)

- Scope

 Continue discussion on additional parameters for MO configuration

 Discussions on MR configuration parameters, including how combination of events may be used

- Deadline to be set by rapporteur (proposals expected to be completed by Monday week2)

This document is the report of the above email discussion.

# Delegates contacts

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

## Proposals from Contribution vs email discussion

Following is rapporteur summary based on the input to email discussion report on the question “**Which configuration(s)/parameter(s) need ability to be configured with different configurations/values, each for a specific height region?”**

|  |
| --- |
| **Summary**: On which configuration(s)/parameter(s) need ability to be configured with different height-dependent configurations/values, the responses are diverse. The following stand out among the responses (sorted in order of more support first):* Measurement Object configuration related parameters
	+ SSB-ToMeasure: ZTE, LG, NEC, QC, DCM
	+ allowed/excluded cells: LG, NEC, vivo
	+ CSI-RS: LG
	+ max number of beams to average: Lenovo
* Measurement Reporting configuration related parameters
	+ Event A4/Ax threshold: NEC, Nokia, Samsung, DCM, vivo, Lenovo
	+ TTT: HW, CATT, Samsung, Lenovo
	+ reportAmount: E//, Samsung, Lenovo
	+ NumberOfTriggeringCells: NEC, HW, vivo
	+ No specific example: Sharp, Xiaomi, Intel
	+ reportInterval: E//, Samsung
	+ Max number of non-serving cells to be included: E//
	+ Height state scale factors: HW
 |

Following are relevant proposals from the contributions submitted in RAN2#121bis-e.

|  |  |  |
| --- | --- | --- |
| **Tdoc** | **Proposal** | **Company proposal covered by summary of email discussion?** |
| R2-2303068, Ericsson | Proposal 4 Support height dependent configuration for at least the following parameters: report interval, report amount and maximum number of non-serving cells | Yes |
| R2-2303095, NEC | Proposal 1: RAN2 to consider following height-dependent configurations for measurement performing and measurement report triggering:• Exclude-listed cells and allow-listed cells• A3/A4/A5 triggering threshold• NumberOfTriggeringCells. | No except for A3/A4/A5 triggering threshold |
| R2-2303173, Nokia | Proposal 3: Implement a new height-dependent configuration for multi-cell triggered interference reporting, e.g., a new IE heightRange in EventTriggerConfig. | Unclear (is it covered by NumberOfTriggeringCells or not) |
| R2-2303255, Lenovo | Proposal 1: Following parameters can be configured per height* *MeasObject*
	+ Consolidation threshold
	+ Max number of beam to average
* *ReportConfig*
	+ Threshold of event
	+ *timeToTrigger*
	+ *reportAmount*
 | Yes except Consolidation threshold |
| R2-2303431, ZTE | Proposal 2: RAN2 to introduce height-dependent RS/beam configuration for NR UAV, e.g. multiple sets of SSB-ToMeasure associated with different height region. | Yes |
| R2-2303805, NTT DCM | Proposal3: Introduce height dependent beam configuration (e.g. SSB-ToMeasure) to avoid flying UE to catch beams from faraway cells. | Yes |
| R2-2303808, Huawei | Proposal 3: The TTT and the NumberOfTriggeringCells can be height-dependent, and they are adjusted based on HeightStateScalFactor. | Yes |
| R2-2303846, Samsung | Proposal 4: RAN2 to discuss whether network can control inclusion of all or subset of measResultServMOs in the measurement report when event H1 or event H2 triggers. FFS on network configuration details. | No |
| R2-2304176, LG | Proposal 3. To introduce Height-dependent parameters:- Beam measurement RSs are selected in accordance with height- Allowed/Excluded cell list is selected in accordance with height | Yes |

As can be seen from the table, a few proposals are new compared to the email discussion report. Based on these contributions and stated support therein, the summary can be updated as follows (NOTE that previously indicated support is not removed since companies were not required to submit contributions for the items already covered in email discussions):

* Measurement Object configuration related parameters
	+ SSB-ToMeasure: ZTE, LG, NEC, QC, DCM
	+ allowed/excluded cells: LG, NEC, vivo
	+ CSI-RS: LG
	+ max number of beams to average: Lenovo
	+ Consolidation threshold: Lenovo
* Measurement Reporting configuration related parameters
	+ Event A4/Ax threshold: NEC, Nokia, Samsung, DCM, vivo, Lenovo
	+ TTT: HW, CATT, Samsung, Lenovo
	+ NumberOfTriggeringCells: NEC, HW, vivo, Nokia
	+ reportAmount: E//, Samsung, Lenovo
	+ reportInterval: E//, Samsung
	+ Max number of non-serving cells to be included: E//
	+ Height state scale factors: HW
	+ Subset of measResultServMOs: Samsung

## Additional height-dependent parameters in MO configuration (Related to agreement#2)

RAN2 agreed that at least SSB-ToMeasure will have ability to be configured with height-dependent configuration.

2. For MO configuration parameters: at least the following will have ability to be configured with height-dependent more-than-one configurations/values, each for a specific height region: SSB-ToMeasure. Details on how to specify is FFS. FFS on UE behavior on L1 and L3 measurement. [additional parameters in MO configurations can be discussed in 306]

Following question is to address the above highlighted text from agreement#2:

**Q1: For height-dependent MO configuration parameters, what other parameters (other than SSB-ToMeasure) should have ability to be configured with height-dependent more-than-one configurations/values?**

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| --- | --- | --- |
| **Company** | **Parameter** | **Comment** |
| Ericsson | No strong view which MO parameters can be applied |  |
| NEC | allowed/excluded cells | If UAV UE is required to perform geo-fencing in airspace, performing measurement on cells in which flying is not allowed is unnecessary. In that case, associate either exclude-listed or allow-listed neighboring cells to flying altitude can limit excessive measurements for UAV UE operating at the corresponding altitude.  |
| Nokia, Nokia Shanghai Bell | No strong view |  |
| Qualcomm | No strong view |  |
| Lenovo | Consolidation related parameters | We think consolidation parameters e.g. *absThreshSS-BlocksConsolidation ThresholdNR, absThreshCSI-RS-Consolidation, nrofSS-BlocksToAverage, nrofCSI-RS-ResourcesToAverage* can be considered to facilitate quicker measurement report. For example, decrease the number of averaged beams or increase the consolidation threshold can enable consolidation results quick reach the event threshold |
| LGE | Allowed/excluded cells | By reporting measurements only for suitable cells that support UAVs, unnecessary measurement reports/UL interference can be reduced. |
| Xiaomi | No strong view |  |
| vivo | Exclude-listed/Allow-listed cells | In different height region, the UAV will see different number of neighbouring cells due to LOS path. However, not all these neighbouring cells are those that the network wants to hand the UE over. So, exclude-listed/Allow-listed cells can limit unnecessary measurements on these cells for UAV UE with the associated altitude.  |
| Samsung | No strong view | For parameters of MO, we want to ensure whether we still agree to consider only parameters that do not cause RAN4 impact. |
| Sharp | No strong view |  |
| ZTE | Consolidation related parameters | In case different SSB subset with different number of beams are configured for different height region, it may be reasonable to configure different *nrofSS-BlocksToAverage* correspondingly. And for LOS/NLOS condition, different *absThreshSS-BlocksConsolidation ThresholdNR* can also be considered to evaluate the beam quality. |
| China Telecom | No strong view |  |
| CATT | Not yet. |  |
| Huawei, HiSilicon | See comments | We do not think other height-dependent MO parameters are needed. Regarding SSB-ToMeasure, our main concern is how the NW knows the distribution of beams at different heights. For the distribution of beams on the ground, the operator obtains the distribution through network planning and optimization. If height-dependent SSB-ToMeasure is supported, then the operator needs to obtain the 3D distribution of beams. Obviously, the workload of the operator will increase dramatically.  |

## CB on MR configuration parameters (Related to agreement #3)

The proposal to “have ability to be configured with height-dependent more-than-one configurations/values, each for a specific height region” for at least the “Event A4 threshold” was based on the company inputs during [POST121][313]. The email discussion conclusion proposed “*Details on how to specify is FFS.*”

During the online discussion, it was commented that *maybe it can be achieved by combination of events* H1 and H2. Another comment was on additional parameters that should be considered.

3. [CB] *For MR configuration parameters: at least the following will have ability to be configured with height-dependent more-than-one configurations/values, each for a specific height region: Event A4 threshold. Details on how to specify is FFS (i.e. maybe it can be achieved by combination of events). FFS other parameters to be consider. [continue this over AT email discussion 306]*

Following questions cover the above comeback item from the online session.

Note: as clarified during the online discussion, *whether* to support height dependent configuration for Event A4 threshold is *not* intended to be re-discussed here. The discussion on *how* to configure, and *whether* to support other parameters.

**Q2: For height-dependent MR configuration parameters, what other parameters should have ability to be configured with height-dependent more-than-one configurations/values (other than Event A4 threshold)?**

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| --- | --- | --- |
| **Company** | **Parameter** | **Comment** |
| Ericsson | For both periodical and event triggered report configuration:* Report interval
* Report amount
* Maximal number of report cells
* stop periodical reporting above a height.
 | This controls directly the report amounts and hence controls interference.This does not impact filtering/TTT. |
| NEC | NumberOfTriggeringCells | Associate this parameter to flying altitude can achieve more flexible control of the amount of measurement reports. |
| Nokia, Nokia Shanghai Bell | NumberOfTriggeringCells | There number of relevant cells might be different in different height ranges.We support either making each type of eventXy height-dependent by adding a *HeightRange* to each on a case-by-case basis, or by adding a *HeightRange* to the *reportConfig*, which could then apply to all of the *reportConfig* configuration parameters. |
| Qualcomm | No strong view |  |
| Lenovo | * *timeToTrigger*
* *reportAmount*
 | Different TTT can be applied for different height to enable quicker reportDifferent report amount can control the number of reports thus can control the interference. |
| LGE | No strong view |  |
| Xiaomi | No strong view |  |
| vivo | NumberOfTriggeringCells | In our understanding, the number of triggering cells was introduced in LTE and the motivation is used for interference management. However, in the number of triggering cell scheme, the UE cannot report new strong interference cells when the number of the cells in cell triggered lists has been reached the number of trigger cell threshold. To solve this issue, the number of changed cells were proposed by the companies but this was not agreed. So, as an alternative way, the network may configure different the number of triggering cells for different height, and let the UE to apply the new one and reset the counter when the UAV enters a new height region. But we are ok to re-discuss which scheme is better. |
| Samsung | * reportInterval
* reportAmount,
* timeToTrigger
 | What we want to clarify first is that the Proposal 4 of our paper R2-2303846 (mentioned in the proposal summary above) is not related to this email discussion; the control of inclusion of measResultsServMOs is related to the topic of measurement triggering for joint event Ax and Hx.For Q2, we propose to consider reportInterval, reportAmount, and timeToTrigger, to control the amount of reports that are transmitted, for controlling the amount of interference to other cells/UEs, taking the height-dependent wireless channel conditions into account. |
| Sharp | No strong view |  |
| ZTE | No strong view |  |
| China Telecom | No strong view |  |
| CATT | Time to trigger | Similar as speed based mechanism, we raise this parameter to further discussion. |
| Huawei, HiSilicon | TTT,NumberOfTriggeringCells,Height state scale factors | We believe that NumberOfTriggeringCells and TTT parameter can be height-dependent. Besides, we think that height state scale factors can be defined for these height-dependent parameters. Similar to the IE SpeedsStateScaleFactors, height state scale factor can be applied when the UE is in a medium or high height state and used for scaling a height-dependent parameter. Compared to configuring each parameter for different heights separately, using the height state scale factor can unify all height-dependent parameters very well. It can save a lot of radio resources, especially when so many parameters are proposed. We assume, for example, that TTT and NumberOfTriggeringCells are height dependent. The NW needs to configure multiple sets of these two parameters for the legacy mechanism, e.g., TTT value1 for 100m, TTT value2 for 200m, TTT value3 for 300m, and N1 for 100m, N2 for 200m, and N3 for 300m. However, if the height state scale factor is applied, the NW only needs to configure TTT value0 and N0 and scaling factors 1, 2 and 3 for 100, 200 and 300 meters, respectively. The UE autonomously scales the TTT and N by multiplying the scaling factors according to the altitude. The result can be round up or round down if the parameters are integer. As we can see, the more parameters that are height-dependent, the more radio resources can be saved by using height-state scale factors. |

**Q3: Company comments on how to specify the MR configuration parameters (e.g. whether it can be achieved by combination of events).**

(Note: include comments on how to specify height dependent Event A4 threshold as well as parameters proposed in Q2)

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | UE could be configured with H1 and A4 for above a high and H2 and another A4 below a height.  |
| NEC | If what we need is switching MR parameters based on current height events, then height dependent Event A4 threshold can be achieved by combination of events. But if we want associate MR parameters to a certain height range (higher than threshold height A and lower than threshold height B), we don’t think it can be covered by current height events. |
| Nokia, Nokia Shanghai Bell | One possible implementation would add a *HeightRange* field, shown in Figure 1, to the *EventTriggerConfig*, shown in Figure 2, which would configure a minimum height, maximum height, and a hysteresis. To configure two height regions, one region would only configure *heightMax*, and the other would only configure *heightMin*. To configure more than two height regions, those height regions in between the lowest and the highest would configure both *heightMax* and *heightMin*. The conditional presence related to these requirements is specified in Table 1. Hysteresis, a delta using the same units as the height, could be configured in all cases to prevent ping-ponging between height regions, e.g., a UE would only trigger a report for an event in the new height range after it surpassed the hysteresis into the new height range.HeightRange::= SEQUENCE {heightMin INTEGER (W..X) OPTIONAL, -- Cond Height-Range-MinheightMax INTEGER (W..X) OPTIONAL, -- Cond Height-Range-Maxhysteresis INTEGER (Y..Z) }*Figure 1: Proposed HeightRange IE**Table 1: Proposed HeightRange IE Conditional Presence Definitions*

|  |  |
| --- | --- |
| **Conditional Presence** | **Explanation** |
| *Height-Range-Min* | This field is mandatory present if heightMax is not present, else optionally present. |
| *Height-Range-Max* | This field is mandatory present if heightMin is not present, else optionally present. |

EventTriggerConfig::= SEQUENCE {eventId CHOICE {Cut for brevity eventA4 SEQUENCE { a4-Threshold MeasTriggerQuantity, reportOnLeave BOOLEAN, hysteresis Hysteresis, timeToTrigger TimeToTrigger, useWhiteCellList BOOLEAN }, ...},Cut for brevityreportAddNeighMeas ENUMERATED {setup} OPTIONAL, -- Need ReventHeightRange HeightRange,...}*Figure 2: EventTriggerConfig Excerpt with Event Height Range IE Added*Because the height range is configured for separate *ReportConfigs*, the *numberfOfTriggeringCells* and the associated *cellsTriggeredList* would be independent per height range. This means that, unlike the approach that combines two events, there is no conflict with TTT, and there is no conflict with other configuration parameters in the *reportConfig* being mismatched. It is FFS for how the two configurations could be aligned, e.g., enforcing non-overlapping height ranges. |
| Intel | We are ok with Nokia approach as long as the UE procedure is clear when the UE enter the height range and leaving the height range, does TTT stops? Corresponding procedure will need to be added. |
| Qualcomm | One way of achieving this would be using combination of events as explained by Ericsson.Other way would be to add height ranges as explained by Nokia. We slightly prefer to use combination of events as that enables reuse of the existing methods. We can go with additional specification only if needed (but no strong view).  |
| Lenovo | The combination of events, in our understanding means when both events fulfilled, the measurement report is triggered. We think this is not so suitable to enable height dependent event threshold, which is to use different threshold to trigger the event when UE is in different height range.  |
| LGE | We prefer to use combination of events. It seems that the UE behaviour where the Ax event is triggered according to the height is the same. |
| Xiaomi | We prefer to use combination of events. |
| Vivo | If we will introduce height-dependent MO configurations, we don’t see the need to introduce a different method to support height-dependent MR configuration, i.e., the combination events. We prefer to only introduce a unified solution for both. Based on the current specification, we suggest to use ToAddModList and ToRemoveListstructure for height-dependent MO/MR configuration, that is, in each entry the height specific parameters (Event A4 threshold) are linked with the related height region. In the current measurement configuration procedure, the network can modify the configuration for each MO and MR. And upon one MO or MR is reconfigured, the UE shall remove the measurement reporting entry for the related *measId* from the *VarMeasReportList* and stop the periodical reporting timer or timer T321 or timer T322, whichever one is running, and reset the associated information (e.g. *timeToTrigger*) for this *measId*. Now we are going to introduce something like conditional modification of MO and MR.  |
| Samsung | We prefer a more fundamental discussion of height-dependent configuration method rather than focusing on that of a specific parameter. It seems possible to specify an A4 event for a specific height region defined by H1 or H2 event, through combining them, but such ignalling method is only applicable to triggering event configurations and not to any other parameters. We can discuss the configuration method after determining the parameters of interest. |
| Sharp | Combination of events seems not easy to associate parameters to height range, and is not be applicable for height-dependent parameters in MO configuration. To have a unified method, adding height range for height-dependent parameters is generally fine. Based on that, how to avoid ping-pong can be further discussed. |
| ZTE | RAN2 has already agreed combination of events. Per our understanding, separate measurement report configuration in different height region can be implemented by either combination of events or height-dependent field values of measurement report. Thus we wonder whether we need two different mechanism for same purpose?Combination of events can reuse existing method as much as possible then will reduce the work effort otherwise. As to height range issue, it can be achieved by combining Ax event with H1 and H2 events respectively. For example, if a report configuration (e.g. A4 threshold) is applicable to height range (100~200), we can have a combination of event A4 with event H1 (threshold=100), and a combination of the same event A4 with event H2 (threshold=200).As to the ping-pong issue as mentioned above, we think it can be avoided by reusing h1-Hysteresis and h2-Hysteresis which will be defined for H1/H2 event. eventH1-r15 SEQUENCE { h1-ThresholdOffset-r15 INTEGER (0..300), h1-Hysteresis-r15 INTEGER (1..16) }, eventH2-r15 SEQUENCE { h2-ThresholdOffset-r15 INTEGER (0..300), h2-Hysteresis-r15 INTEGER (1..16) |
| China Telecom | We slightly prefer to use the combination of events. With this approach, traditional measurement events can be reused without affecting the measurement behaviour of the UE. No new events have to be defined. Simply add a parameter to the measurement configuration that evaluates all combined events independently for the duration configured for those events (e.g. during respective TTT values).The combination of the event A4 and the events H1/H2 could be specified as explained by Ericsson. |
| CATT | For event A4, combination can be used. For others, need to discuss one by one based on the situation. |
| Huawei, HiSilicon | We also think height-dependent event A4 threshold is needed. The combination of event A4 and event H1 or H2 is used to trigger MR and event H1/H2 is triggered when the UAV is above/below the threshold. If the NW needs to configure different A4 thresholds for different height ranges, it cannot use combination event to describe it.  For example, if we use combination events to describe the height range, i.e., event A4 with event H1 (threshold =100m) and event A4 with event H2 (threshold = 200m), when the UE is ascending through 100m and event A4 is also triggered, the MR is sent to NW. The question is, how does the NW understand this MR? This MR is triggered because the height of the UE is above 100m or below 200m？ |

# Summary

Based on the above discussion, following is proposed as summary.

TBD