**3GPP TSG-RAN WG2 Meeting #121bis-e** DRAFT **R2-2302681**

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

**Agenda item:** 7.8.2

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

**Source:** Qualcomm Incorporated (Moderator)

**Title:** Report of [POST121][313][UAV] Height-dependent configuration

**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, following email discussion was setup.

* [POST121][313][UAV] Height-dependent configuration (Qualcomm)

Scope: Discuss the details how the network configures and how the UE applies height-dependent configurations (i.e. which IEs/parameters can be modified, what is the expected UE behavior, etc.)

Intended outcome: set of agreeable proposals

Deadline: Long

This document is the report of the above email discussion.

# Discussion

## Which parameters need height-dependent configuration?

The first discussion point is intended to gather inputs on which parameters need height-dependent configuration. In other words, which configuration/parameters should be allowed for the UE to choose the value (form configurations provided by network) based on UE height. Note that, based on discussion during [Post120][312][UAV], for the proposed parameter needing different values/configurations each for a specific height region, following questions should be answered:

1. What happens with UE’s filters, variables, etc. when the switch between configurations happens? Is the behavior different than the one already specified e.g. for cell change?
2. Is there a mismatch between what the NW is aware of and the actual configuration the UE uses?
3. The benefit of multiple configurations versus H1/H2 reporting to the NW and waiting for the new configuration
4. Can the NW know and properly configure the LOS/NLOS boundary?

Additionally, based on the RAN2#121 discussion, moderator would like to add the following question:

1. Is there potential RAN4 impact?

**Q1: Which configuration(s)/parameter(s) need ability to be configured with different** **configurations/values, each for a specific height region?**

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| **Company** | **Which configuration(s)/parameter(s) need to support ability to be configured with different configurations/values, each for a specific height region?** | **For the proposed configuration/parameter, any comments to address the following questions:**  **a) What happens with UE’s filters, variables, etc. when the switch between configurations happens? Is the behavior different than the one already specified e.g. for cell change?**  **b) Is there a mismatch between what the NW is aware of and the actual configuration the UE uses?**  **c) The benefit of multiple configurations versus H1/H2 reporting to the NW and waiting for the new configuration**  **d) Can the NW know and properly configure the LOS/NLOS boundary?**  **e) Is there potential RAN4 impact?** |
| Ericsson | We prefer to alter reporting related parameters. For example, reporting interval, number of measurement reports, maximum number of non-serving cells to be included in the report. | 1. Should not impact. Only number of reports need to be accounted based on height specifically, e,g if event triggers below a height but UE’s height increases, and UE needs to follow the new count. 2. Network may not be aware of exact height of UE but that should not be an issue. For example, below a height, UE reports with certain interval and certain n of reports or cells. Network will simply receive accordingly and may even dedice the height based on the report content. 3. Interference can be limited immediately when UE crosses a height. Reconfiguration may be cumbersome and chronically late.   Not foreseen |
| ZTE | SSB-ToMeasure | We prefer to to introduce height-based SSB-ToMeasure such that UAV UE can be configured to perform measurement on different subset of SSBs in different height region. The benefits are as following:   1. It is possible for network to exclude side lobes of downtilted beams when UAV UE is flying above a threshold, especially the side lobes of downtilted beams from far away cells. The side lobes from far away cells are assumed as a negative factor on UAV Ue’s mobility performance. 2. It is beneficial for UE power saving by excluding the downtilted beam when UAV UE is flying above a height threshold. When UAV UE fly above a height threshold, it is assumed more cells will be detected. In such radio environment, to exclude the downtilted beam can reduce the measurement on beams as well as the size of measurement report.   Reply on the questions for height-based SSB-ToMeasure:   1. The UE action upon the autonomous SSB-ToMeasure switch is similar to measurement reconfiguration triggered by the NW (i.e. reception of RRCReconfiguration message with MeasConfig from the NW). There is no special impact. 2. The UE applies the height dependent configuration just as NW expected. If height information is also included in measurement report, the NW can be aware of which configuration is used for the reporting. Thus we don’t think there is mismatch between what NW is aware of and the actual configuration the UE uses. 3. Comparing the H1/H2 reporting and waiting for new configuration from NW, the height-based SSB-ToMeasure solution can save both signaling overhead and signaling delay. Then it is further beneficial for interference reduction in LOS environment. 4. For the proposed height-based SSB-ToMeasure solution, we don’t think it is related to LOS/NLOS boundary.   The network can configure the height-based SSB-ToMeasure according to network planning, i.e. which beam is uptilted and which is downtilted. Further, the network can actually “learn” how to configure it according to the beam level measurement results from other UEs.   1. For the proposed height-based SSB-ToMeasure, we assume the same SMTC is used, i.e. no additional SMTC is needed. There is no potential RAN4 impact for this height-based SSB-ToMeasure solution. |
| LGE | 1) allowed/excluded cell  2) radio resources, e.g., SSB and CSI-RS | a) Upon switching of the parameter(s), it would be simpler if UE behaves as if it receives a new reconfiguration message. Optimization can be left for later releases.  b) Height dependent parameters are configured by network, and UE reports its height based on network configuration. That is, everything is under network control and corresponding network awareness. Therefore, no mismatch issues are foreseen.  c) Considering UAV is moving fast, the height-dependent solution is beneficial to adjust the suitable parameter timely. Although, the network can re-configure UE based on the H1 and H2 event, it takes more time to reconfigure parameters and incurs frequent signalling between the UE and the network.  d) A simple bisection of areas to LON/NLOS is not suitable in real fields in particular for urban area, where environmental diversity is very high.  e) As long as the parameter switching is similar to execution of reconfiguration, we do not see any non-trivial RAN4 impact. |
| NEC | Measurements object related parameters:   * Exclude-listed cells * allow-listed cells * ssb-ToMeasure   Measurement report related parameters:   * A4 threshold * NumberOfTriggeringCells | We don’t think all details can be included in this reply, some quick comments:   * We prefer to select configuration(s)/parameter(s) which brings no RAN4 impact. * Comparing with H1/H2 reporting to the NW and waiting for the new configuration, configurations can be applied with less latency by this “height-dependent” way. * There may be mismatch, solutions can be further discussed if there are critical impact. |
| Huawei, HiSilicon | TTT  NumberOfTriggeringCells  Height state scale factors | RAN2 has agreed height-dependent multiple configuration. 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 configure each parameter for different height separately, use height state scale factor can unified all height-dependent parameter very well. It can save a lot of radio resources. 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.  We need to consider how to handle the running parameters or configurations, i.e., TTT and cellsTriggeredList if the measurement configuration has changed. For the TTT, the UE should maintain the running TTT, rather than reset the TTT, in order to send the MR immediately. For the cellsTriggeredList, if the NumberOfTriggeringCells is changed, we need to specify the UE behaviour. According to the 38.331, the UE will remove the cell in the cellsTriggeredList if the NumberOfTriggeringCells is re-configured because the measurement reporting entry needs to be removed when the ReportConfig is re-configured. However, the late report issue already existed when the NumberOfTriggeringCells was introduced in NR. The late report issue will be heavier if the UE removes the cell in the cellsTriggeredList when the NumberOfTriggeringCells is re-configured. Furthermore, the case is also different, the UE change the NumberOfTriggeringCells on its own rather than the NW re-configure the ReportConfig. Thus, the UE should also maintain the current cellsTriggeredList rather than remove the cell in the cellsTriggeredList in order to send the MR immediately too.  As for the mismatch between the UE and network, the UE can add the height into the Measurement Report when the parameter is scaled.  For question c, it can save the configuration time compared to waiting for the configuration after eventH1 or eventH2 triggers.  Whether the NW knows the LoS and NLoS boundary depends on the operator. Because the operator can measure the boundary when they distribute the base station.  There is no RAN4 impact. |
| Nokia | For example, threshold for event A4 (*a4-Threshold*) | 1. UE shall not delete the content of the variables (i.e. measurement results, list of cells that triggered, etc.) 2. Both values of this parameter will be NW-configured, so difficult to say the NW is not aware what the UE may be using. We can also specify the reporting, wherein the UE updates the NW with the information on new applied parameters 3. The benefit is fast reaction to UAV UE ascending/descending (UE applies the new configuration immediately upon determining the height threshold has been reached). 4. The boundary between NLOS/LOS and LOS conditions is usually related to rooftops/building type in certain area. This should be a rather static thing, so relatively straightforward to estimate (e.g. during network planning).   We cannot definitely say there is no RAN4 impact in case there is a need to define UE requirements for the transition between those two configs. But that might also depend on which and how many parameters can be changed from one configuration to the other. In fact, we need to first clarify what is the answer to Q3 before knowing if there is a clear RAN4 impact. |
| Sharp | Parameters related to report configuration. | 1. Similar as reception of new RRCReconfiguration with measurement configuration. 2. Network may not need to know when the configuration switching happens, and measurement report can be used to know the actual configuration the UE uses. 3. Reduce signalling overhead and improve mobility performance. 4. Maybe. 5. Whether there is RAN4 impact depends on which parameters are chosen. |
| CATT | timeToTrigger in *VarMeasConfig* | 1. The legacy procedure can handle this case already, e.g. cell change; 2. In the measurement report, the measurement ID is an explicit indication to let the gNB knowing the actual configuration status; 3. Saving signalling exchange time; 4. For 6G base station, the answer is yes; 5. Not seen yet. Considering it only affects the reporting configuration. |
| Xiaomi | Some parameters in report configuration | a) Similar as legacy measurement reconfiguration.  b) Yes, network cannot know which configuration triggered the measurement report.  c) No strong benefit. UAV UE may fast change to more appropriate configurations.  d) Maybe, if NW can get the 3D-map and cell deployment.  e) There may be no RAN4 impact for these parameters in report configuration. |
| Qualcomm | SSBToMeasure | Agree with comments from ZTE above. (Not repeating for brevity.)  In our previous papers, we showed simulation results where we observed that measuring only a subset of beams based on height can save on number of measurements without significant performance degradation (see R2-2211305 and R2-2300583).  If we reduce number of measurements required by the UE, then naturally number of measurement reports will also be reduced.  Regarding the height-dependent **timeToTrigger** and **NumberOfTriggeringCells**, it seems LTE mechanism already supports configuring different value for these parameters for different height ranges. |
| Samsung | We prefer to consider triggering condition and reporting related parameters in ReportConfig, for example, but not limited to:   * Event An threshold * reportInterval * reportAmount, * timeToTrigger | Given that all the details cannot be included in this reply, our view can be summarised as follows:   1. When a switching between different configurations happens due to change of height region, UE adopts new configuration. How to cope with previous measurement results, e.g., delete or maintain, can be discussed per height-dependent configuration parameter, after we determine which parameters to consider. 2. There should not be any mismatch between UE and NW on what configurations the UE has been adopted for each measurement report. We can consider explicitly indicate which configurations the UE has been adopted by including height indication in measurement report for resolving any ambiguity caused by more-than-one height-dependent configurations. 3. Configurations can be applied with less latency. 4. It may depend on NW implementation, and this issue is not relevant to the topic of height-dependent measurement configurations. 5. We should first determine the configurations/parameters that can be configured as height-dependent. Then, we can discuss whether there is any RAN4 impact regarding the height-dependent configurations/parameters. |
| DOCOMO | * SSB-ToMeasure * Event Ax threshold | We also see benefits by setting height dependent sets of beams to save unnecessary measurements, which can reduce the measurement reporting overhead. |
| vivo | * Exclude-listed/Allow-listed cells * Ax threshold or the number of triggering cells | 1. The UE behaviour is expected to be the same as that after receiving the current measurement reconfiguration. 2. On a certain time, the network may not know which configuration is being used at the UE. But there seems no issue caused by this mismatch. 3. There maybe some delay at the UE for receiving a new proper measurement configuration at a certain height range. And this can reduce the complexity at the network as the network does not need to deduce when to reconfigure the height-dependent parameters. 4. Maybe. 5. No RAN4 impact is found. |
| Lenovo | *MeasObject*   * Consolidation threshold * Max number of beam to average   *ReportConfig*   * Threshold of event * timeToTrigger * reportAmount | 1. UE behavior is expected to be same as in legacy e.g. after measurement reconfiguration 2. Network may know which configuration is used by UE if UE report also height information. Otherwise network may not know but there seems no problem caused 3. Could save height reporting and measurement reconfiguration delay 4. Could be 5. No RAN4 impact is seen |
| Intel | ReportConifg | 1. This should not impact UE measurements behaviour. This is the main reason why we think we should add in reportConfig instead of multiple MO 2. No, since the network will configure in the reportConfig and both UE and NW will have the same view. 3. We are not sure what is the benefit so far. However, we think it is very difficult for network to configure such MO based on coverage of beams. Detail please see our contribution. 4. No. This is a well-known problem. It is very difficult for NW to determine LOS/NLOS. Even after network knows, still it is very difficult to have a correlation for height. 5. In reportConifg, there may be no/little impact. But if we do it in multiple MO, RAN4 impact will be high. |

**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

Based on the above, moderator proposes to start with one parameter from each group in the above list as a starting point for further deep dive to determine spec impacts. Other parameters can be considered based on future discussion and company contributions.

**Proposal 1: 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.**

**Proposal 2: 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.**

## How to configure, e.g. different MO (measurement object) or different parameters/values (within a single MO)?

Next question is whether different configurations for different height ranges is provided to the UE as different MO configurations or done at parameter level. But before that, it is worthwhile to clarify on some comments that were raised during RAN2#121.

One of the comments raised during RAN2#121 indicated there may be restriction in current specifications that there cannot be more than one measurement objects for the same frequency with different associated parameters, e.g. different offsets and/ or exclude-lists.

For LTE, TS 36.331 has the following text:

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| 5.5.1       Introduction <<skip>>  5.   **Measurement gaps:**Periods that the UE may use to perform measurements, i.e. no (UL, DL) transmissions are scheduled.  E-UTRAN only configures a single measurement object for a given frequency (except for WLAN and except for CBR measurements), i.e. it is not possible to configure two or more measurement objects for the same frequency with different associated parameters, e.g. different offsets and/ or exclude-lists. E-UTRAN may configure multiple instances of the same event e.g. by configuring two reporting configurations with different thresholds.  The UE maintains a single measurement object list, a single reporting configuration list, and a single measurement identities list. The measurement object list includes measurement objects, that are specified per RAT type, possibly including intra-frequency object(s) (i.e. the object(s) corresponding to the serving frequency(ies)), inter-frequency object(s) and inter-RAT objects. Similarly, the reporting configuration list includes E-UTRA and inter-RAT reporting configurations. Any measurement object can be linked to any reporting configuration of the same RAT type. Some reporting configurations may not be linked to a measurement object. Likewise, some measurement objects may not be linked to a reporting configuration. |

However, the paragraph with such restriction is not included in TS 38.331:

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| 5.5.1       Introduction <<skip>>  **5.   Measurement gaps:**Periods that the UE may use to perform measurements.  A UE in RRC\_CONNECTED maintains a measurement object list, a reporting configuration list, and a measurement identities list according to signalling and procedures in this specification. The measurement object list possibly includes NR measurement object(s), CLI measurement object(s), inter-RAT objects, and L2 U2N Relay objects. Similarly, the reporting configuration list includes NR, inter-RAT, and L2 U2N Relay reporting configurations. Any measurement object can be linked to any reporting configuration of the same RAT type. Some reporting configurations may not be linked to a measurement object. Likewise, some measurement objects may not be linked to a reporting configuration. |

Additionally, following field descriptions refer to the possible scenario of multiple MeasObjectNR with the same SSB frequency:

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| ***MeasObjectNR*field descriptions** |
| ***associatedMeasGapSSB***  Indicates the associated measurement gap for SSB measuring identified by *ssb-ConfigMobility* in this measurement object. When multiple *MeasObjectNR* with the same SSB frequency are configured, the network configures the same measurement gap ID in this field for each *MeasObjectNR*. If this field is absent, the associated measurement gap is the gap configured via *gapFR1*, *gapFR2*, or *gapUE*. |
| ***associatedMeasGapSSB2***  Indicates the associated additional measurement gap for SSB measuring identified by *ssb-ConfigMobility* in this measurement object for NTN deployments. When multiple *MeasObjectNR* with the same SSB frequency are configured, the network configures the same measurement gap ID in this field for each *MeasObjectNR*. If this field is absent, the associated measurement gap is the gap indicated by *associatedMeasGapSSB*. |

On the other hand, following is captured in TS 38.331:

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| 5.5.2       Measurement configuration**5.5.2.1            General** The network applies the procedure as follows:  -     to ensure that, whenever the UE has a *measConfig*associated with a CG, it includes a *measObject* for the SpCell and for each NR SCell of the CG to be measured;  -     to configure at most one measurement identity across all CGs using a reporting configuration with the *reportType* set to *reportCGI;*  -     to configure at most one measurement identity per the node hosting PDCP entity using a reporting configuration with the*ul-DelayValueConfig;*  -     to configure at most one measurement identity per the node hosting PDCP entity using a reporting configuration with the*ul-ExcessDelayConfig;*  -to ensure that, in the *measConfig* associated with a CG:  -     for all SSB based measurements there is at most one measurement object with the same *ssbFrequency*;  *-*an *smtc1* included in any measurement object with the same *ssbFrequency* has the same value and that an *smtc2* included in any measurement object with the same *ssbFrequency* has the same value and that an *smtc3list* included in any measurement object with the same *ssbFrequency* has the same value and that an *smtc4list* included in any measurement object with the same *ssbFrequency* has the same value;  -     to ensure that all measurement objects configured in this specification and in TS 36.331 [10] with the same *ssbFrequency* have the same *ssbSubcarrierSpacing*;  -     to ensure that, if a measurement object associated with the MCG has the same *ssbFrequency* as a measurement object associated with the SCG:  -     for that *ssbFrequency*, the measurement window according to the *smtc1* configured by the MCG includes the measurement window according to the *smtc1* configured by the SCG, or vice-versa, with an accuracy of the maximum receive timing difference specified in TS 38.133 [14].  -     if both measurement objects are used for RSSI measurements, bits in *measurementSlots* in both objects corresponding to the same slot are set to the same value. Also, the *endSymbol* is the same in both objects.  -     to ensure that, if a measurement object has the same *ssbFrequency* as a measurement object configured in TS 36.331 [10]:  -     for that *ssbFrequency*, the measurement window according to the *smtc* configured in TS 36.331 [10] includes the measurement window according to the *smtc1* configured in TS 38.331, or vice-versa, with an accuracy of the maximum receive timing difference specified in TS 38.133 [14].  -     if both measurement objects are used for RSSI measurements, bits in *measurementSlots* in both objects corresponding to the same slot are set to the same value. Also, the *endSymbol* is the same in both objects.  -     when the UE is in NE-DC, NR-DC, or NR standalone, to configure at most one measurement identity across all CGs using a reporting configuration with the *reportType* set to *reportSFTD*;  <<skip>> |

**Observation 1: In NR, currently it is possible to configure more than one measurement objects for a given frequency (but not in the same CG).**

Another comment raised was there may be different RAN4 requirements for the UE with one measurement object vs multiple measurement objects. Given that multiple measurement objects (regardless of for the same or different frequency) is already supported in NR, moderator understands no additional RAN4 requirements in terms of number of MO need to be introduced due to more-than-one configurations targeting different heights as those existing requirements apply accordingly for one or multiple measurement objects.

**Observation 2: No additional RAN4 requirements in terms of number of MO are expected due to more-than-one configurations targeting different heights.**

Note that the above observation does not concern with how the UE measures height but focuses solely on the number of measurement objects.

**Q2: Comments on the above observations, if any.**

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| **Company** | **Comment** |
| Ericsson | In one cell group, UE can be configured with only one MO per SSB frequency. This seems the baseline case for aerial operation. This seems to suggest it is easier to do the height dependency in parameter level, either within an MO or within ReportConfig, or both. |
| ZTE | Agree with observation 1. We also noticed that for SSB based measurements network can configure at most one measurement object per SSB frequency.  On observation 2, we think there is no additional RAN4 requirement in terms of different MO or different parameter values, since these MO or parameter values are applied in different height region and in different time. Autonomous switching between different Mos or parameter values is similar to a measurement reconfiguration triggered by network. |
| NEC | Agree with Observation 1. But what we are considering is slightly different from this “more than one measurement objects” case. At lease UE do not need to apply configurations for different height regions simultaneously.  For Observation 2, our view is we should target at no RAN4 impact parameters/configurations |
| Huawei, HiSilicon | We agree with the observations. |
| Nokia | Overall, we agree – the UE can already measure according to multiple measurement objects so no new requirements due to that reason are needed. However, there is a restriction of a single MO per SSB frequency. Thus, this might be a potential stopping point to enable this UAV mechanism via separate MO.  In general, we do not think agreeing on O2 is essential before we know more details. |
| Sharp | Agree with Observation 1. Not sure about Observation 2, and maybe check with RAN4 is safer. |
| CATT | Agree on the observations. |
| Xiaomi | Agree with Observation 1. For Observation 2, we need to check with RAN4. |
| Samsung | Agree with Observation 1. Regarding Observation 2, we can first identify the configurations/parameters that can be considered height-dependent, then discuss whether any potential RAN4 impact is caused thereby. |
| DOCOMO | Agree with the observations. |
| vivo | Agree on the observations. |
| Lenovo | Agree with observation 1. For observation 2, may need to check with RAN4 if there has any impact although the different MO is for different height |
| Intel | In NR, since “frequency” definition was more complicated than LTE. In addition, we have CSI-RS. However, single MO per frequency still should be the baseline for the same CG for UAV. We have discuss with our RAN4 and if multiple MO per frequency is supported, there will be high RAN4 impact. |

**Summary**: Thanks for the comments, which are good explanations for others to understand. However, no proposals are/were intended from these observations or comments.

Now, to the question above: whether to configure –

* (a) different measurement objects such that when UE moves to a different (configured) height range, a new measurement object is applicable. Or,
* (b) different parameters/fields (within the same MO), where different values (or value ranges) of the parameter/field applies to different height or height range. Or,
* (c) other option (explain in comments).

**Q3. How to configure height-dependent more-than-one configurations? E.g. different MO or** **different fields/values within same MO? Or other options.**

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| **Company** | **How to configure height-dependent more-than-one configurations? (a) different MO, (b) different fields/values, (c) Other option.** | **Comments and examples** |
| Ericsson | Our suggestion is to go for b) if height dependent configuration related to MO is seen useful. |  |
| ZTE | b) different fields/values | On (a) different MO:  We think this options brings unnecessary spec impact considering the limitations in current spec (Observation 1 in Q2). In addition, we don’t think it is necessary to have such flexibility to configured a whole different MO.  On the contrary, to have different fields/values (b) is much easier to analysis pros and cons, and the impact on spec can be limited within expected scope. |
| LGE | (b) different fields/values | In (a), there would be a lot of duplicated configuration parameters across measurement objects for the same frequency. |
| NEC | FFS | We need more details before making this decision. i.e., the definition of different MO, are they link to the same or different MeasID? From UE perspective, the switch is occurred between different MeasID or between different MO for one MeasID?  Also, we don’t need to exclude more-than-one report configurations at this stage. |
| Huawei, HiSilicon | B | We do not think different Mos for different heights are needed because not all the parameters included in the MO are height-dependent. If we choose the granularity of MO, it is redundant for the UE and wasteful of radio resources. Thus, we prefer solution b. The NW can configure the exact parameters in a single MO. Meanwhile, we think the height state scale factor that we proposed in Q1 is also applicable for the parameters that can be height-dependent. |
| Nokia | A or B | A is acceptable if the UE can measure according to two different Mos with the same SSB frequency.  B could mean for example configuring different ReportConfigNR Ies, each comprising different A4 configuration (with separate threshold). There has to be an indication of height-relevance of each ReportConfigNR. |
| Sharp | B | Could be different measurement identifications, different report configurations or different parameters in one IE. |
| CATT | B | Both are workable. Considering option b has less spec impact, we prefer option B. |
| Xiaomi | B | It could be different measurement Ids  Using different measurement Ids which can link of different measurement objects and different reporting configurations. |
| Qualcomm | B | Both options can work but a) would have more spec impact compared to b) as multiple companies explained above based on observation 1. |
| Samsung | B | We prefer B. Compared to A which may unnecessarily introduce duplicated fields, B is more efficient from the signalling overhead point of view. |
| DOCOMO | B | Since b has less spec impact. |
| vivo | B | Based on Q1, just few parameters are height-dependents, so b is preferred from signalling overhead perspective. |
| Lenovo | B | Option A will create many duplicated parameters since only few parameters are configured based on height. |
| Intel | FFS | Different value and parameter. But we still not support to configure more than one MO for UAV. |

**Summary**: Total responses: 15 with following distribution of support (Note: “a or b” is counted in both):

* Option a: 1
* Option b: 13
* FFS: 2

Vast majority of companies (13/15) suggest going with (b) different fields/values within the same MO (instead of different MO). Following is proposed.

**Proposal 3: (13/15) 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.**

## Expected UE behaviour when the applicable value changes due to change of height

Suppose the UE crosses a height region and the configuration/value of a parameter in the new region is as follows:

1. No change compared to the value before entering the height region
2. Not configured in the new height region
3. Different value compared to the value before entering the height region

Note that in LTE, the case of change in configuration parameter based on UE detected state exists, where the UE applies different TTT value based on its speed. The detailed UE behaviour is not specified and left up to UE. See TS 36.331 5.5.6.2.

For the case of no change of configured values, there are following options for the UE, and what UE should do may be different depending on the scenario or type of the parameter.

* Continue to perform related operations as the configured value is unchanged, or
* Reset the current action (whatever that is) since a new value/configuration means new operation even though the value is same.

**Q4: Comments on expected UE behaviour if the configuration/value of parameter in the new region is not changed compared to the value before entering the height region. And whether anything need to be specified or can be left to UE implementation.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | It can be handled by the specification that no unnecessary UE actions are needed. E.g. by the ASN1 structure, or by field descriptions. |
| ZTE | First of all, the question needs to be clarified: if the configuration/value of parameters is not changed in the new region compared to the value before entering the region, why it is configured?  For height-based SSB-ToMeasure, we think the answer to this question could be: the UE behavior related to beam measurement and cell level quality derivation will not be impacted. |
| LGE | Since there is no change of parameter values, UE continues to perform the related operations, e.g., measurement/measurement report. No special handling is needed. |
| NEC | UE should reset and switch to the new value/configuration whatever that is. Anyway NW can avoid configuring completely same configurations for different height, which makes no sense. |
| Huawei, HiSilicon | The UE does not need to change any configurations or modify any running parameters, e.g., TTT or cellsTriggeredList if the configured parameters or configurations are not changed. But we need to specify the UE behaviours when the configured parameters or configurations change. As we mentioned in Q1, we need to consider how to handle the running parameters or configurations, especially the cellsTriggeredList, if the measurement configuration has changed. For the cellsTriggeredList, if the NumberOfTriggeringCells is changed, we need to specify the UW behaviour. According to the 38.331, the UE will remove the cell in the cellsTriggeredList if the NumberOfTriggeringCells is re-configured because the measurement reporting entry needs to be removed when the ReportConfig is re-configured. However, the late report issue already existed when the NumberOfTriggeringCells was introduced in NR. The late report issue will be heavier if the UE removes the cell in the cellsTriggeredList when the NumberOfTriggeringCells is re-configured. Furthermore, the case is also different, the UE change the NumberOfTriggeringCells on its own rather than the NW re-configure the ReportConfig. Thus, the UE should maintain the current cellsTriggeredList rather than remove the cell in the cellsTriggeredList in order to send the Measurement Report immediately. |
| Nokia | This may be left up to UE implementation. On the other hand, maybe it is cleaner to specify the UE always adopts the new parameter/config, irrespective what is its value. |
| Sharp | There should be at least one parameter changed, else seems no need to configure height depended configuration. UE can just simply apply the new configuration. |
| CATT | The motivation to clarify the behaviour in NR is not clear to us. It is prefer to keep LTE solution in order not to further introduce spec impacts. |
| Xiaomi | The motivation of the case is unclear. Why network configure the same configuration/value of parameter for different height region?  However, UE don’t need to confirm whether the value has been changed when UE entering a new height region and UE should apply the new configuration/parameter/value associated with the new height region.  UE’s behaviour need to align with the case of different value compared to the value before entering the height region. Whether to reset the current action depends on the height-based parameter. |
| Qualcomm | Agree with LG’s comment: Since there is no change of parameter values, UE continues to perform the related operations, e.g., measurement/measurement report. No special handling is needed.  Also, agree with ZTE’s comment: For height-based SSB-ToMeasure, the UE behavior related to beam measurement and cell level quality derivation will not be impacted.  Note that ‘not changed’ does not always mean configured explicitly with the same value, it could be based on delta config with corresponding need codes where the previous value applies, for example. |
| Samsung | UE may continue to perform the related operations without special handling. If special handling is required, it can be specified by, e.g., procedural texts, need codes, or field descriptions. |
| DOCOMO | UE follow the spec to continue the measurements and no special UE handling is needed for this case. |
| vivo | Agree with Nokia. |
| Lenovo | If the value is not changed after height changes, we think UE behaviour is same as in legacy i.e. UE continue to perform measurement and evaluation irrespective of height. |
| Intel | Agree with CATT. And the UE behaviour also needs to ask RAN4. |

**Summary**: See below.

For the case that the value is not configured in the new height region, moderator’s view is the UE should stop the current related action and treat as if the parameter/configuration is released.

**Q5: Comments on expected UE behaviour if the configuration/ parameter in the new region is not configured. And whether anything need to be specified or can be left to UE implementation.**

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| **Company** | **Comment** |
| Ericsson | Depend on the parameter whether this would be a valid configuration or not.  Should be discussed case by case. |
| ZTE | For height-based SSB-ToMeasure, if there is no configuration for a specific height region, the UE just follow the legacy configuration/value. |
| LGE | Upon entering a new height region, it is clear that UE should stop following old parameters for the previous height range but start following the new parameter values applicable for the new height region. No tricky issue is foreseen and no risky optimization is needed. How to realize this is up to state-3 details including ANS.1 implementation. |
| NEC | It seems not a UAV specific issue. NW should ensure the mandatory configurations exist. |
| Huawei, HiSilicon | The UE should follow the last configuration or parameter if the corresponding configuration or parameter has not been configured in the new region. A UAV’s flight path is continuous, and the radio environment is similar if the height is close. For example, if the NW configures NumberOfTriggeringCells as 3 for 100m-200m but not configures it over 200m, the UE should follow the configuration in the range 100m-200m when it climbs to 220m because the radio environment is similar between 200m and 220m. |
| Nokia | It needs to be provided, if the UE shall use this functionality. If it is missing (e.g. due to an error) then the UE shall continue using the value it used so far. |
| Sharp | If delta configuration for height-depended configurations is supported, UE can follow the legacy rule e.g. need code and setup-release structure, else UE just simply applies the new configuration. |
| CATT | The motivation to clarify the behaviour in NR is not clear to us. It is prefer to keep LTE solution in order not to further introduce spec impacts. |
| Xiaomi | It depends on the type of the parameter. If the parameter is optional, UE can use current configuration without the parameter. |
| Qualcomm | If delta config is supported/used, existing rules of delta configuration (based on need codes) would apply. Otherwise, a rule needs to be specified whether to keep using the last value from previous height range or consider the value as released.  It may be case by case depending on the parameter (in such case field description can specify the behaviour, for example). |
| Samsung | It depends on NW intention that may configure UE to apply legacy field if exists, or use previous value(s), or release the parameter, which can be specified by, e.g., procedural texts, need codes, or field descriptions. |
| DOCOMO | Depends on the need code of field. If the last value is maintained, UE can just use the last value. |
| Vivo | If not configured for the new region, the expected UE behaviour is to maintain the current configuration. This could be Need S, i.e., if this filed is absent, the UE shall apply the configuration which is being used. But it seems “Need S” cannot be used for maintaining the value configured by the network for this new region, which should be Need M. |
| Lenovo | If the value is not configured when height changes, we think UE behaviour is according to the meanings of “not configured” e.g. whether not configured means no values should apply to the new height, or means value is same for all heights. |
| Intel | Agree with CATT |

**Summary**: See below.

For the case where the value in new height region is different compared to the value before entering the height region, the UE action may depend on scenario or type of the parameter.

E.g., if the changed parameter is a timer value, and,

* the new value is such that the timer would not have expired, then the expiration time should be updated based on new value (considering the actual start time); ongoing operations may continue but the expiry of the timer is extended or shortened according to the new value.
* the timer would have expired with the new value (shorter value), then treat it as if the timer just expired.

Such details can be left to UE implementation, similar to what was done in LTE for different TTT value for different UE speed.

**Q6: Comments on expected UE behaviour if the configuration/value of parameter in the new region is changed compared to the value before entering the height region. And whether anything need to be specified or can be left to UE implementation.**

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| **Company** | **Comment** |
| Ericsson | Depends on the exact parameter. It may be ok to leave some changes to UE implementation but where feasible, explicit specification is preferred to limit varieties in UE behaviour. |
| ZTE | For height-based SSB-ToMeasure, UE just applies the corresponding configuration/value of parameter in new region, and then performs measurement as the current spec handling. Spec needs to capture this and nothing else is foreseen. |
| LGE | Upon entering a new height region, it is clear that UE should stop following old parameters for the previous height range but start following the new parameter values applicable for the new height region. No tricky issue is foreseen and no risky optimization is needed. How to realize this is up to state-3 details including ANS.1 implementation. |
| NEC | For non-timer-based parameters, we think it just like receiving new RRC reconfigurations and some current procedures can be reused, i.e., measurement object removal/addition/modification. |
| Huawei, HiSilicon | See our comments in Q4 |
| Nokia | We agree it depends on the exact parameters considered. In case of A4 threshold:  - we think the UE may stop evaluating according to the previous value;  - preferable: if any of the measured cells meets the new criteria, the TTT for this cell might be kept running if it was started before.  - simpler option: allow the TTT to run even for the cells that may not meet the new criteria (in order to keep the UE implementation simpler), but their TTT was started before new config was applied. |
| Sharp | Similar as reception of new RRCReconfiguration with measurement configuration. |
| CATT | The motivation to clarify the behaviour in NR is not clear to us. It is prefer to keep LTE solution in order not to further introduce spec impacts. |
| Xiaomi | Similar to Q5, it also depends on the type of the parameter. Reusing LTE solution (i.e. UE implementation) may be ok. |
| Qualcomm | For non-timer-based parameters, it is just like receiving new RRC reconfigurations and current procedures/behaviours apply.  For timer parameters, it should continue but the new value effectively shortens or extends its value (from the original start time), which means the timer may be ‘expired’ immediately if the new value is shorter than the elapsed time. |
| Samsung | Upon change of the height region that results in different configuration/value, UE just applies the new configuration/value. We can further discuss whether the UE should maintain or delete previous measurement results, depending on which configuration/parameter has been changed, case by case. |
| DOCOMO | It depends on the exact parameters. Basically, UE follow the parameters in the new height region. |
| vivo | Similar as reception of new RRCReconfiguration with measurement configuration. |
| Lenovo | UE behaviour is same as in legacy procedure of RRC reconfiguration e.g. apply new value immediately. |
| Intel | Agree with CATT. |

**Summary**: Thanks for the comments in above 3 questions. Reading through the comments, while they are very insightful, in moderator’s understanding, they can be roughly summarized as follows:

* 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.
* If a height-specific value is not explicitly configured for the new height which the UE just transited to, whether to keep using the value that was used (e.g. same value for all heights) or consider the parameter to be released (i.e. parameter/value not applicable at this height) should be looked into case by case, and can be clarified in field description, need codes or procedural text if needed.

**Proposal 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.**

**Proposal 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.**

## Any other items?

Please list any other aspects related to the discussion on height-dependent configuration that is not covered by above questions.

**Q7: Any other items?**

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| **Company** | **Comments** |
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# Summary

Based on the above discussion, following is proposed as summary. Note: P3 is placed first being the least controversial one and may help for discussion on the remaining proposals.

How to configure (different MO or different parameters)

**Proposal 3: (13/15) 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.**

Which IEs/parameters can be modified

**Proposal 1: 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.**

**Proposal 2: 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.**

Expected UE behavior

**Proposal 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.**

**Proposal 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.**