3GPP TSG-RAN WG2 Meeting #121 R2-23xxxxx

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

**Agenda item: 8.8.2**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Report from [Post120][312][UAV] Mobility Control for UAVs (Nokia)**

**WID/SID: NR\_UAV-Core – Rel-18**

**Document for: Discussion and Decision**

# 1 Introduction

This is to discuss the following:

* [Post120][312][UAV] Mobility Control for UAVs (Nokia)

Scope: Discuss aspects related to mobility control, including:

- Height dependent parameter/configuration adjustment or scaling (e.g. TTT, A4 threshold etc). Discuss which parameters/configuration, options, motivation, benefits/drawbacks.

- Event combination – discuss possible event combinations (e.g. height based event and signal strength events) and motivation/benefits

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

In the next section we elaborate on the open issues for Rel-18 UAV mobility control.

# 2 Discussion

## 2.1 Height-dependent Events

Here we consider how to make use of the height/altitude which is estimated by the UAV UE and in the basic approach – used to decide if LTE-like events H1 or H2 shall be triggered. In LTE Rel-15, when the triggering condition for H1 or H2 was met, the UE was supposed to send the measurement report which could contain the RSRP/RSRQ measurements as well as the UE’s location-related information (*LocationInfo* IE) and the height information. It would be good to confirm what is to be reported in NR when event H1 or H2 is triggered.

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| **Question 1: In NR Rel-18 when event H1 or event H2 is triggered, what shall be the content of the measurement report? Please choose from the following options:**   1. **Only the parameters from *CommonLocationInfo* IE** 2. **Only the RSRP/RSRQ/SINR measurement results** 3. **The content of the report fully configurable by the network (e.g. RSRP results + *CommonLocationInfo* components)** 4. **Other** | | |
| **Company** | **Answer** | **Comments** |
| Huawei, HiSilicon | c | We think the content of the Measurement Report should include the full report so the network can obtain more information to decide on, e.g., handover. This is the same as in LTE. In principle in NR we should do something different from LTE only if there is a good reason to do so. |
| Ericsson | d | The main goal of the H1/H2 measurements is for flying mode / interference detection. As such, the height information is of the highest interest to NW. Therefore, in our view, the height information must always be in the content of H1/H2 triggered measurement report. Whether to include ***CommonLocationInfo*** and/or**RSRP/RSRQ/SINR** should be configurable by the network. The configurability is important for interference control as it controls the size of the report. We are also fine if height is also optional but in our view it should be separate from the rest. |
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Staying still in the topic of H1/H2 events, it shall be discussed if those events can be combined/configured with Ax events (e.g. A3, A4 or A5 events) and the measurement reporting is triggered only if both events are fulfilled simultaneously. Such approach was suggested e.g. in [1] to handle vertical mobility. It would be also a similar principle as was defined for Rel-17 NTN (i.e. time or location based triggering).

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| **Question 2: Do you support combining event H1 or H2 with event Ax to ensure the measurement reporting is triggered only if both events are fulfilled simultaneously? Please note, this does not remove the support for ‘standalone’ use of H1 or H2.** | | |
| **Company** | **Answer** | **Comments** |
| Huawei, HiSilicon | Yes | We think the combination of Hx and Ax can handle the vertical mobility well. Having only the Ax event makes it harder for the network to ensure the handover of the UAV UE to the target cell timely and correctly. For example, because the signal quality may decrease dramatically at the edge of the serving cell in a vertical direction (the distance between the drone and the gNB may not change or change a little when the drone moves vertically), it is hard to handover the drone to the neighboring cell in time just according to the Ax event because the signal quality is strong before the drone crosses the cell’s edge. However, if the drone considers the combination of the Ax and Hx, it can handover to the neighboring cell timely, according to the height and the quality of the cell. More details can be found in R2-2212638. |
| Ericsson | yes | In case there is consensus for the use case on combining Hn and An events, then also Hn and inter-RAT Bn events should be supported.  We could discuss also other combinations and see which ones have good use cases. For example, combining location and height might be useful for network to know if UE is approaching a no-fly zone. Or, per network implementation an area where drone UL interference causes issues for BS. In that case network can at least refrain from scheduling UL for the UE.  Finally, how the triggering is combined should be discussed. Should the condition combination H and A/B be both fulfilled during TTT, or should UE evaluate the events independently and triggering is similar to NTN CHO. |
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## 2.2 Height-dependent Adjustments

As the UAV UE can fly high above the ground level (up to 300 meters was supported in LTE Rel-15) it can experience largely varying radio conditions. This effect is especially pronounced when the UAV UE is ascending in NLOS conditions, below the rooftops. When the UAV UE flies higher, above the rooftops (in LOS conditions), it can monitor secondary lobes of distant base station’s antennas [2]. This can result in the UE attempting to HO not to the closest available cell. These circumstances have been used in several RAN2 papers to propose height-dependent actions to be taken for UAV UEs. Those include for example: parameter (e.g. TTT) scaling or using different configuration sets, depending on the altitude. Below we would like to ask the companies to express their support for such adaptations and provide additional information how these could be used and implemented.

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| **Question 3: Do you support allowing the UAV UE to perform height-dependent parameter scaling? If yes, please provide the details on which parameters can be scaled and in what kind of scenarios.** | | |
| **Company** | **Answer** | **Comments** |
| Huawei, HiSilicon | Maybe | We think a height-dependent TTT autonomous scaling by the UAV UE could be considered for NR UAVs. Speed-dependent TTT has been specified in LTE. When the speed of UE changes, the TTT will be scaled accordingly to adjust the reporting delay. Similarly, when the UAV UE moves vertically, the drone could adjust the TTT to ensure that it sends Measurement Reports on time, as the communication environment can change dramatically in the vertical direction. If we follow the legacy mechanism, i.e., reconfiguring the TTT when the aerial UE exceeds a certain height, the configured TTT may not be suitable due to the communication delay and the drone’s high mobility. If the TTT is running at the time UE is crossing a threshold that would trigger scaling, it could anyway conclude the ongoing operation and use the different TTT the next time a condition is triggered. Nevertheless, rather than autonomous scaling by the UE (based on some pre-configuration from the network of a scaling factor or similar), it could be more straightforward to use multiple configuration as in the following question, so we prefer the solution mentioned in Q4 instead. |
| Ericsson | yes | In our view, TTT can be scaled with height. This could be simpler option than Q4 |
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If you do not think height-dependent parameter scaling is beneficial/feasible then another question is whether the UE could be configured with more than a single configuration (e.g. RRM configuration) – each to be used within certain height region.

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| **Question 4: Do you support the option where the UE can be configured with more than a single configuration (e.g. RRM configuration) – each to be used within certain height region? Please provide the details which part of the configuration can be subject to such height-dependence and how the switching between the configurations looks like.** | | |
| **Company** | **Answer** | **Comments** |
| Huawei, HiSilicon | Yes | We think this could be useful and we prefer this solution compared to the UE “autonomous” scaling (see our answer to Q3 above). |
| Ericsson | No | This may be rather complicated to implement in specs and the complexity of the solution should be evaluated against the benefits before final decision in case there is support enough to start inspecting this option.  Another point is that the functionality will need to be discussed, that is the UE action when the switch happens. First option is that UE drops all filters(L3) and TTT and starts over when threshold to apply the second configuration is fulfilled. Hence, UE starts over all the filters and TTT. Now, how to prevent ping pong and/or delayed reporting? |
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## 2.3 Conditional Handover

As stated in several papers submitted to RAN2#120 and RAN2#119 (e.g. in [1]), CHO is claimed to be a solution to resolve a problem of vertical mobility (i.e. when the UAV UE is ascending/descending rapidly and encounters a variation of different cells’ coverage). Even though CHO is currently not in the scope of the WID [3], we would like to check the views among the companies working on Rel-18 UAV connectivity on whether UAV-specific CHO enhancements are needed as a part of Rel-18 work. Obviously, the final decision is up to RAN Plenary.

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| **Question 5: Do you see a need to pursue UAV-specific CHO enhancements as a part of Rel-18 NR work (final decision up to the RAN Plenary)?** | | |
| **Company** | **Answer** | **Comments** |
| Huawei, HiSilicon | No | Due to the time limitation and the explicit RAN plenary discussion and decision on this point when the WI was approved, we think CHO should not be discussed in Rel-18. This was already discussed and decided in RAN2 a few months ago. Only if RAN plenary discuss and decide otherwise, WGs could look into these aspects. Imagine what happened if for every WI RAN2 discusses topics that are currently not in the WI scope…. |
| Ericsson | No | Given the progress of the WI, the updated scope in RAN#98 (including details on BRID objective, which will likely require significant effort), we prefer not to add new topics to the Rel-18 WID. Hence, RAN should defer the CHO discussion to a later release. |
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In the papers submitted to RAN2, there have been different views presented regarding how CHO can be used and how it can improve UAV’s mobility. Thus, we would like to check companies’ opinions on what is the predominantly needed CHO-related enhancement for UAV UEs.

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| **Question 6: What kind of CHO-related enhancements do you see needed for UAV UEs? Choose from the following options:**   1. **Use events H1 and H2 jointly with events Ax for CHO execution triggering** 2. **Using flight path plan to prepare the UAV UE with CHO commands for multiple cells ahead** 3. **Other** | | |
| **Company** | **Answer** | **Comments** |
| C | No | We do not think this should be discussed because the CHO is out of scope now. See our answer to the previous question. |
| Ericsson | See comment | As answered in Q5, we prefer to discuss details of CHO in a later release. |
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# 3 Conclusion

This report has collected inputs on mobility enhancements for UAVs. As a result the following proposals are made:

# References

1. R2-2212638 *Further discussion on UAV measurement enhancements* 3GPP TSG-RAN WG2 Meeting #120 Toulouse, France, November 14-18, 2022
2. J. Stanczak, D. Kozioł, I. Z. Kovács, J. Wigard, M. Wimmer and R. Amorim, "*Enhanced Unmanned Aerial Vehicle Communication Support in LTE-Advanced*," 2018 IEEE Conference on Standards for Communications and Networking (CSCN), 2018, pp. 1-6, doi: 10.1109/CSCN.2018.8581827.
3. RP-223545 *Revised WID: NR Support for UAV (Uncrewed Aerial Vehicles)* 3GPP TSG RAN Meeting #98e Electronic Meeting, Dec 12 - 16, 2022