[94e-19-R18-UAV] - Version 0.0.5
RAN

[94e-19-R18-UAV]

3GPP TSG RAN Meeting #94e **RP-213547**

Electronic Meeting, Dec. 6 - 17, 2021

Title: Email discussion summary for [94e-19-R18-UAV

Document for: Decision

This NWM thread handles the proposed Rel-18 UAV WID submitted to RAN#94e

- **RP-212715** (draft WID) RAN2 vice-chair (ZTE)

The summary includes the following contributions:

- RP-212916
- RP-212951
- RP-213223
- RP-213329
- RP-213402

1 Initial Round

1.1 Justification

In the recent years, the global interest for uncrewed aerial vehicles based services has dramatically increased, including e.g. for multiple drone operation, personal entertainment for flight experience, cargo delivery, etc. As the basis of these applications, the capability for remote control and data transmission are key aspects for enhancements, which are of interest for service providers/operators as well as drone manufacturers.

Consequently, corresponding SI and WI based on LTE were established in previous releases, mainly focussing on aerial vehicles with an altitude up to 300m. According to the study, the feasibility and required enhancements have been verified for the support aerial vehicles via terrestrial cellular systems, e.g. in terms of UL and DL interference as well as mobility. However, since LTE was designed for terrestrial UEs, without considering aerial UEs at the very beginning, some inherent limitations, e.g. higher latency, reduced MIMO capabilities imply that some requirements for aerial services still cannot be met.

Compared to LTE, NR enables more diversified applications for aerial vehicles, with the lower latency for control and higher data rate for multi-media services.

While the advanced NR features would allow to fulfil stringent requirements, e.g. in terms of uplink UE throughput and low latency for remote control, it is clear that further improvements are needed, due to the fact that the NR system didn't take aerial vehicles into account when it was initially designed.

Feedback Form 1: Please provide feedback on the Rel. 18 UAV Justification

1 – Ericsson LM Fine.
2 – Apple AB Looks good
3 – CATT Ok.
4 – vivo Mobile Communication Co. Fine
5 – AT&T GNS Belgium SPRL OK
6 – DOCOMO Communications Lab. Fine
7 – MediaTek Inc. We are fine with the text.
8 – Xiaomi Communications Ok
9 – SoftBank Corp. Fine
10 – ZTE Corporation fine
11 – OPPO Fine
12 – Lenovo Mobile Com. Technology fine

13 – TELECOM ITALIA S.p.A. It should be clarified that the impact on the operation of ”normal” cellular deployment should not be disrupted. Moreover, considering the current fixed TDD frame structure imposed by Regulators in many countries, I do not agree that NR is fully able to fulfill stringent requirements, especially in UL. See suggested modifications below: While the advanced NR features **generally improve performance with respect to basic LTE** ~~would allow to fulfil stringent requirements, e.g. in terms of uplink UE throughput and low latency for remote control~~, it is clear that further improvements are needed, due to the fact that the NR system didn’t take aerial vehicles into account when it was initially designed. **Moreover, the interference issues that may be generated by aerial UEs have to be taken into account in order not to disrupt the operation of a network designed for terrestrial UEs.**
14 – Samsung Electronics Co. OK
15 – LG Electronics France Fine
16 – VODAFONE Group Plc The Telecom Italia addition on interference issues is very useful and important,
17 – HUAWEI TECHNOLOGIES Co. Ltd. OK
18 – Sony Europe B.V. Ok

Moderator summary:

Telecom Italia proposed the following change to the justifications to clarify the impact on the operation of ”normal” cellular deployment should not be disrupted. Change supported by Vodafone. All other companies were fine with the original justifications.

Therefore, the suggested modifications:

While the advanced NR features **generally improve performance with respect to basic LTE** ~~would allow to fulfil stringent requirements, e.g. in terms of uplink UE throughput and low latency for remote control~~, it is clear that further improvements are needed, due to the fact that the NR system didn’t take aerial vehicles into account when it was initially designed. **Moreover, the interference issues that may be generated by aerial UEs have to be taken into account in order not to disrupt the operation of a network designed for terrestrial UEs.**

1.2 Objectives

1. Specify the following enhancements on measurement reports [RAN2]:

- UE-triggered measurement report based on configured height thresholds
- Reporting of height, location and speed in measurement report
- Flight path reporting
- Measurement reporting based on a configured number of cells (i.e. larger than one) fulfilling the triggering criteria simultaneously

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed

Feedback Form 2: Please provide feedback on UAV enhancements on measurement reports

1 – Ericsson LM Fine.
2 – Apple AB Looks good.
3 – CATT It is fine.
4 – vivo Mobile Communication Co. Fine.
5 – AT&T GNS Belgium SPRL OK
6 – Qualcomm Incorporated Fine
7 – DOCOMO Communications Lab. Fine
8 – MediaTek Inc. We are fine with text.
9 – Xiaomi Communications Ok
10 – SoftBank Corp. Fine

11 – China Mobile Com. Corporation

Fine

12 – ZTE Corporation

support

13 – Deutsche Telekom AG

We are fine with these objectives, but like to add the following to the note: ”*while overall the LTE and NR solutions should be harmonised as much as possible.*” The main reason is that operators need a conistent solution for LTE and NR especially as in case of beyond line of sight flights it is not ensured that the UAV is served by one RAT rather than chaning between LTE and NR depending on location and availability of network. Also the backend systems will be the same and experience should be the same.

14 – OPPO

Fine

15 – NEC Corporation

We are supportive of this objective.

16 – Lenovo Mobile Com. Technology

Fine

17 – TELECOM ITALIA S.p.A.

Support DT

18 – MediaTek Inc.

Sorry to miss the note in the first response. We suggest following revision on the note since it is sufficient to say LTE is a starting point, NR-specific adjustment

Note: Work done in LTE is a starting point for this objective. ~~NR-specific enhancements can be considered, if needed~~

19 – Samsung Electronics Co.

OK

20 – LG Electronics France

Fine

21 – VODAFONE Group Plc

Agree with DT and TIM.

22 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon OK

23 – Orange We are supportive of this obejctive which is straightforward and also agree with DT.
24 – Sony Europe B.V. Ok

Moderator summary:

Suggest to add/modify the notes:

Note: Work done in LTE is a starting point for this objective

Note: While overall the LTE and NR solutions should be harmonised as much as possible.

2. Specify the signaling to support subscription-based aerial-UE identification [RAN3/SA2 interaction/RAN2]

Note: Work done in LTE is a starting point for this objective.

Feedback Form 3: Please provide feedback on UAV signaling to support subscription-based aerial-UE identification

1 – Ericsson LM Fine.
2 – Apple AB Looks good.
3 – CATT It's fine.
4 – vivo Mobile Communication Co. Fine.
5 – AT&T GNS Belgium SPRL OK
6 – Qualcomm Incorporated Fine
7 – DOCOMO Communications Lab. Fine

8 – Xiaomi Communications

This objective may need to be confirmed by SA, as the ”subscription-based aerial-UE identification” needs to be provided by SA.

9 – SoftBank Corp.

Fine

10 – China Mobile Com. Corporation

Fine

11 – ZTE Corporation

support

12 – Deutsche Telekom AG

We are fine with these objectives, but like to add the following to the note: ”*while overall the LTE and NR solutions should be harmonised as much as possible.*” The main reason is that operators need a conistent solution for LTE and NR especially as in case of beyond line of sight flights it is not ensured that the UAV is served by one RAT rather than chaning between LTE and NR depending on location and availability of network. Also the backend systems will be the same and experience should be the same.

13 – OPPO

Fine

14 – NEC Corporation

We are supportive of this objective.

15 – Lenovo Mobile Com. Technology

Fine

16 – TELECOM ITALIA S.p.A.

Support DT

17 – Samsung Electronics Co.

OK

18 – LG Electronics France

Fine

19 – VODAFONE Group Plc

Agree with DT and TI.

20 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon OK

21 – Orange We are supportive and agree with DT.
22 – Sony Europe B.V. Ok

Moderator summary:

Suggest to add the following note:

Note: While overall the LTE and NR solutions should be harmonised as much as possible.

3. [Specify needed enhancements for broadcast of UAV identification [RAN2, RAN1, SA2 interaction]]

  - Applicable to both LTE and NR

Note: This description is a placeholder for a more detailed objective to be drafted once SA2 will have concluded their study on the architectural aspects.

Feedback Form 4: Please provide feedback on UAV enhancements for broadcast of UAV identification

1 – Ericsson LM Since there are FAA requirements on broadcasting of UAV ID this is essential. Hence, we think the brackets should be removed and this objective to be part of the Rel-18 UAV item.
2 – vivo Mobile Communication Co. Agree with Ericsson to make this an objective of this Rel-18 UAV item.
3 – AT&T GNS Belgium SPRL Agree. This is a necessary objective.
4 – Qualcomm Incorporated We agree with above comments that this is a necessary objective. As indicated in the draft WID, this description was a placeholder for a **more detailed objective**. So, we provide below our view on how the details can be captured. Regarding SA2 impact, we would like to highlight that the latest approved SID in SA2 (S2-2108154) has the following text (emphasis added): *"It is necessary to study how the adoption of* ***PC5 solutions for Broadcast Remote Identification and C2 communication*** *would enable re-using 3GPP technologies for enabling this important building block in the deployment of UAVs and UAM for BVLOS and LOS.*

[...]

Moreover, the aviation industry is developing advanced requirements for Detect And Avoid (DAA) solutions in a variety of aviation groups, [...], which refer to ***UAV-to-UAV direct communication using 3GPP technologies (e.g. PC5).****"*

As such, we do not see a need to wait for SA2 on their conclusion, since they explicitly include PC5 for both remote ID and DAA. In addition, based on the simulations, it is observed that the UAVs over PC5 can reach a longer range than legacy sidelink. The comb-4 and 3 cyclic shifts of DMRS for PSCCH are the limiting factors in reaching this range.

Therefore, we suggest aligning the RAN objective with the SA2 SID, and add **details for the objective as shown below** (consequently the existing Note from Draft WID should be removed). Further, it should be clear that legacy sidelink design is a starting point, as captured by the Note below.

3. Specify needed enhancements, e.g. for broadcast of UAV identification and for broadcast/groupcast of UAV detect and avoid [RAN2, RAN1, SA2 interaction]

Adapt to UAV scenarios considering 3D range, UAV specific assistance info etc.

Support of longer-range communications for broadcast of drone identification.

− Applicable to both LTE and NR.

Note: The legacy sidelink design is a starting point for this objective.

5 – DOCOMO Communications Lab.

Fine with removing the brackets, and QC proposal also.

6 – Xiaomi Communications

We think that this might be a useful objective, but we are not sure if the corresponding Rel-18 SA SID has provided a clear scope for this objective. It seems that the Rel-18 SA package is still under discussion.

7 – China Mobile Com. Corporation

The intention of this study is to meet the FAA requirements on broadcasting of UAV ID, hence, it is reasonable to remove the brackets. Moreover, this item has been regarded as a placeholder for studying the impact of SA2. Hence, legacy sidelink design can be regarded as baseline and further study the enhancement of PC5 solutions for Broadcast Remote UE Identification.

8 – ZTE Corporation

We share the views to remove the bracket.

9 – Deutsche Telekom AG

We should leave this to SA2 first, at least this has lower priority for RAN WGs than the othe objectives.

Topics to be considered by RAN are:

- PC5 as basis for this solution (reuse of existing solutions to maximise the ecosystem)
  - LTE or NR based PC5 ?
- Consideration on the spectrum incl. control on the spectrum and resource allocation ?

- licensed ?
- unlicensed ?

10 – NEC Corporation

This objective would consume a significant number of TUs if included, and we believe objective 1 and 2 are of higher importance, therefore this objective should be deprioritized.

11 – OPPO

Fine to remove the bracket but the objective details still should be clarified by SA2 first.

12 – Lenovo Mobile Com. Technology

Fine to remove the bracket and support to clarify objective details by SA2 first

13 – MediaTek Inc.

Agree this objective should be included. We do not see the need for more details at this point, R2 can take SA2 conclusion in the discussion later.

14 – TELECOM ITALIA S.p.A.

This objective has a very large impact in general and it seems the impact on RAN4 is not taken into account.

A number of concerns:

- how a ”broadcast” transmission affects the ”terrestrial” network. in particular, as stated by Qualcomm, PC5 transmission for aerial devices could have a much larger range than in vehicular applications. and therefore much larger interference area
- which frequency bands are to used?
  - licensed? the impact on the terrestrial network should be assessed. and it is not likely operators will risk performance of commercial networks (this is a general issue with sidelink evolutions)
  - unlicensed? what about interference from other sources which could deny service?

In general the issue is already solved via Uu and does not need further activity in 3GPP.

We propose to drop it

15 – Samsung Electronics Co.

OK

16 – LG Electronics France

The current form of the objective seems fine, but any work, if deemed necessary, should be further clarified only after SA2 reaches a final conclusion.

17 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon We are ok to keep it as it is and wait for SA2 progress.

18 – Orange

This seems a bit early, the concept of re-using PC5 for drones is new in RAN and has not been studied so far. The proposed objective on ”broadcast of UAV identification” cannot be treated without the full picture of PCR for drones. We agree with DT & TIM that this raises a number of question marks, including spectrum coexistence. Our view would be to wait for SA2 conclusions, and postpone the discussion on this objective.

Moderator summary:

There is a diverse input on this objective. Half of the companies suggest to include this objective and thus removing the brackets. Others are proposing the detail of the objective to be specified. Finally a number of companies are suggesting to either delay or remove the objective.

Therefore, the moderator suggest to rephrase the objective to:

Consider whether to add an objective for enhancements for broadcast of UAV identification once input from SA2 is received

~~4. [Second priority] Study and, if needed, specify additional trigger condition(s) for CHO [RAN2].~~

4. [Second priority] Study and, if needed, specify the enhancements on beam management, with the following assumptions [RAN1, RAN4, RAN2]:

- FR1 with directional antenna at UE side
- ~~gNB uptilt beamforming~~

Feedback Form 5: Please provide feedback on UAV enhancements on beam management

1 – Ericsson LM

We believe the **CHO** objective would be both lightweight and something that could be beneficial for UAVs. However, we do acknowledge the importance of getting a WI scope which is manageable in the Rel-18 timeframe that also is well-defined. Hence, we are open to remove this objective as we think that the critical aspects to serve UAVs are covered by objective 1-3 of this WID.

This also means that the **beam management** objective also should be dropped. The objective is unfortunately still unclear which is not a good sign as unclear objectives will consume a lot of time in the WGs. While the proposed use case for the beam management objective is drones, we believe it is rather an objective related to MIMO.

2 – Nokia Corporation

We are fine to drop the CHO handover related objective, however for the beam management we object for RAN1 that is also defining the antenna capability of a UAV (whether a UAV is having omni-directional or directive antennas in FR1), thus not really anything MIMO related, thus we see that objective should be kept to allow manage the interference a UAV causes to the network (especially when sending HD video

feed).

3 – Spark NZ Ltd

Spark NZ

There is value in lookign at beam managemnt for drones. Yes it is related to MIMO but the channels in UAV are not the same as terrestrial channels.

4 – Verizon UK Ltd

We think the objective should be kept. The example Nokia gave (UE antanna capability) maybe quite valuale already, since it demonstrates the fact that 3gpp is >100% deligent to minimize any potential interference in UAV deployment, real or preceived, in mid-band. We can keep the scope very specific .

5 – Apple AB

We are inclined to support dropping both objectives.

6 – CATT

We are fine to drop these two objectives considering the limited TU allocation.

7 – vivo Mobile Communication Co.

We are fine to drop CHO objective.

For beam management, We should keep this objective. The current beam management in NR was designed for terrestrial UE, so the study on aerial UE specific requirement on beam aspect is required and should be the scope of UAV item.

8 – AT&T GNS Belgium SPRL

We are OK to drop the CHO objective.
Regarding beam management, this objective can be considered at a lower priority after the previously stated objectives, and depending upon whether or not the scope of work can be very limited and accommodated within the TU allocation.

9 – Qualcomm Incorporated

On **CHO**, we share the same view as others: while we acknowledge the potential benefits, we are ok to exclude it to have a manageable WI scope.

On **beam management**: We support to study and specify Uu directional beamforming enhancements in FR1 for UAVs. Additionally, while we think it could be beneficial, to keep the scope manageable, we are fine to exclude "~~gNB uptilt beamforming~~".

Further, the objective already states "Study and, if needed, specify…". So, we think there is no need to indicate "[Second priority]" as the study can be done in parallel with the normative work for other objectives.

In **summary**: we support keeping the objective and removing "[Second priority]".

10 – DOCOMO Communications Lab.

As for CHO, we think it is beneficial and prefer to keep it as the second priority, but we can go with the majority.

As for the beam management, we are fine with the moderator proposal, i.e. keep directional antenna and drop uptilt beamforming.

11 – Xiaomi Communications

We are ok to drop these two objectives.

12 – SoftBank Corp.

We are OK to drop the CHO objective.

For beam management, we support keeping this objective on UE side to study as it would be beneficial to reduce interference from UAV.

13 – ZTE Corporation

We are fine to drop the CHO since additional enhancement, e.g., flight path reporting, has already been supported, which can enable the well-configured parameters for legacy CHO due to the good prediction of long-term mobility.

Regarding the BM, we prefer to keep it to improve the robustness of transmission in the UAV-specific condition, e.g., high mobility in vertical.

14 – China Mobile Com. Corporation

CHO objective, since already covered by regular CHO and NTN CHO, can be dropped from our perspective.

And for the **beam management** objective, we are tend to drop it as well. The reason is that the bullet of FR1 with directional antenna at UE side is so ambiguous to us. As the UAV as a moving UE, it is not possible to equip a fix directional antenna which can be addressed only by implementation. Hence, it seems this study still be within the scope of MIMO, and the specification on directional antenna at UE is not limited to FR2 only.

15 – Deutsche Telekom AG

Drop all second priority topics for workload resaons !

16 – OPPO

Share the similar view with CMCC. More addition, objective 1-3 are more important to consider with limited TU budget. Dropping all second priority objectives is more desirable.

17 – Lenovo Mobile Com. Technology

For CHO, we think most of work in NR NTN can be reused so the additional work load is limited. So from our point of view, we think it could be reserved. But could follow majority view if think additional work load is not acceptable

For beam management, we prefer to keep it and ok with the proposal to remove uptilt beamforming. We think UAV specific feature need to be addressed e.g. vertical speed, different coverage status in the air, planned flight path etc. In MIMO topic, UAV special scenarios cannot be addressed.

18 – MediaTek Inc.

We support to drop both items. The impact of directional antenna on BM is not clear.

19 – TELECOM ITALIA S.p.A.

As expressed above, UAV may cause serious interference to ”terrestrial” networks. Therefore we think beam management is a key aspect and should be kept in scope.

If the workload is in general too large, we suggest to drop objective 3, which requires a very large work and an ”unknown” amount of RAN4 resources.

20 – Samsung Electronics Co.

On **CHO**, we are fine to drop it considering allocated TU and the workload.

On **beam management**, we are fine to study it in Rel-18 UAV because at this point, we are still not clear about how much UAVs will cause the interference to the network.

21 – LG Electronics France

It is still unclear what kind CHO triggering conditions are exactly to be considered and why such new CHO triggering conditions are essential for UAVs. Given the lack or insufficiency of justification, we think the CHO-related objective needs to be dropped.

For the enhancements on beam management for UAVs, the justification of the enhancements is not clear yet. We do not think it is sufficient to say that UAVs' channel is different from terrestrial UEs. As the RAN chair already indicated, we should try to avoid having generic enhancement as an objective so that each WG can start their work with a concrete and specific scope.

22 – VODAFONE Group Plc

Beam management of the transmissions from the UAV is really important for reducing the interference into terrestrial networks, so we support the study of this. There is also likely to be a need for the UAV to have a direction reception capability to reduce control channel interference at the UAV.

Agree with Telecom Italia, that this objective is much more important than objective 3.

23 – TELENOR ASA

Telenor supports the comments of TIM and Vodafone. Beam management should be kept within scope.

24 – Telia Company AB

We are ok for dropping CHO, but would like to see that beam management with clear objective definition as stated by Ericsson is needed to secure not to waste time in WGs. As stated by many operators beam management plus UAVs with directional antenna (via RAN2 capability signalling) can help to reduce the interference towards terrestrial networks.

25 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon We support dropping CHO related objective.

For the Objective on “FR1 with directional antenna at UE side”, it needs further clarification what additional specification work is needed for RAN1 and perhaps RAN2, as the current text is too vague and would not help WG discussion. Furthermore, it is noted that to support directional antenna at UE side for FR1, RAN4 perhaps needs to investigate OTA testing for FR1, potential new RF requirements like spherical coverage,

EIRP etc., which in our understanding is a significant piece of work that cannot be accommodated by such a simple objective "FR1 with directional antenna at UE side". We also note that the main purpose of this WI is to port the LTE UAV functionalities into NR, while this possible objective of "directional antenna for UAV" is not essential for this WI. Therefore our view is that this objective should not be included in the WI.

26 – Orange

We fully support to keep the objective of beam management with directional antennas at UE side. Interferences are a major issue with drones "above clutter", and this probably requires "special treatment" to be operationaly viable. Besides, drones will not be constrained by the limited form factor of smartphones, therefore it is entirely conceivable to design specific directional antennas on drones.

27 – Sony Europe B.V.

We think both objectives, CHO, and Beam management are relevant, but not first priority.

Moderator summary:

The vast majority of companies suggest/supports to drop the **CHO handover** related objective

On **beam management**: This is having almost equally amount of proposals to include and to exclude. Qualcomm has drafted a compromise to reduce the scope to be be beneficial and manageable:

Study and specify Uu directional beamforming enhancements in FR1 for UAVs.

The gNB uptilt beamforming woudl be excluded in this proposal.

2 Intermidiate Round

2.1 Justification

In the recent years, the global interest for uncrewed aerial vehicles based services has dramatically increased, including e.g. for multiple drone operation, personal entertainment for flight experience, cargo delivery, etc. As the basis of these applications, the capability for remote control and data transmission are key aspects for enhancements, which are of interest for service providers/operators as well as drone manufacturers.

Consequently, corresponding SI and WI based on LTE were established in previous releases, mainly focussing on aerial vehicles with an altitude up to 300m. According to the study, the feasibility and required enhancements have been verified for the support aerial vehicles via terrestrial cellular systems, e.g. in terms of UL and DL interference as well as mobility. However, since LTE was designed for terrestrial UEs, without considering aerial UEs at the very beginning, some inherent limitations, e.g. higher latency, reduced MIMO capabilities imply that some requirements for aerial services still cannot be met.

Compared to LTE, NR enables more diversified applications for aerial vehicles, with the lower latency for control and higher data rate for multi-media services.

While the advanced NR features generally improve performance with respect to basic LTE, it is clear that further improvements are needed, due to the fact that the NR system didn't take aerial vehicles into account when it was initially designed. Moreover, the interference issues that may be generated by aerial UEs have to

be considered in order not to disrupt the operation of a network designed for terrestrial UEs.

Feedback Form 6: Objection to the changes proposed by Telecom Italia

1 – Qualcomm Incorporated Fine
2 – vivo Mobile Communication Co. Fine
3 – CATT Fine
4 – SoftBank Corp. Fine
5 – DOCOMO Communications Lab. Fine
6 – Xiaomi Communications Fine
7 – ZTE Corporation Fine
8 – Lenovo Mobile Com. Technology Fine
9 – TELECOM ITALIA S.p.A. fine, of course :-)
10 – LG Electronics France Fine
11 – MediaTek Inc. Fine.
12 – HUAWEI TECHNOLOGIES Co. Ltd. Huawei, HiSilicon We understand that the added description on interference issue is associated with the objective for beamforming enhancement. However, the existing beam management mechanism does not set any restriction on the direction of uplink beamforming and we think it works well for both terrestrial UE and aerial UE.

The added description implicitly shows that it is common understanding that there is UAV specific interference issue from beamforming perspective. However, it is not the fact. For now, the gap is still not clear to us.
13 – Samsung Electronics Co. Fine with the changes proposed by Telecom Italia
14 – Ericsson LM Agree with Huawei.
15 – Deutsche Telekom AG Fine
16 – Nokia Corporation We are fine with the proposed changes from Telecom Italia
17 – Apple AB Looks good
18 – Intel fine
19 – TELENOR ASA We are fine with the changes proposed by Telecom Italia.
20 – VODAFONE Group Plc We are fine with the changes proposed by Telecom Italia.
21 – Telia Company AB Extremely fine with updates by TIM.
22 – TURKCELL We are fine with the changes proposed by Telecom Italia.
23 – Verizon UK Ltd We agree with everyone about the intention. We are very sensitive to any wording suggesting there may be UAV specific interference issue from beamforming perspective. Beamforming further reduces already minimum interference in the generic cases and allows the UAVs to fly to anywhere. There is no interference issue to start with.

Moderator Summary:

Vast majority agrees with the justification text. Therefore, the moderator proposed to agreed on the current justification text.

2.2 Objectives

1. Specify the following enhancements on measurement reports [RAN2]:

   - UE-triggered measurement report based on configured height thresholds
   - Reporting of height, location and speed in measurement report
   - Flight path reporting
   - Measurement reporting based on a configured number of cells (i.e. larger than one) fulfilling the triggering criteria simultaneously

Note: Work done in LTE is a starting point for this objective.

Note: While overall the LTE and NR solutions should be harmonised as much as possible.

Feedback Form 7: Please provide changes (if any) on UAV enhancements on measurement reports

1 – Qualcomm Incorporated

We do not agree to removing "~~NR-specific enhancements can be considered, if needed.~~ This was previously discussed and seemed stable and among the most non-controversial items. Text from initial round is ok for us, but not the one shown above.

While the spirit of "Work done in LTE is a starting point for this objective" is pretty similar to "While overall the LTE and NR solutions should be harmonised as much as possible", if companies show strong preference, we would be fine with the addition as shown below, but NOT as separate Note (because that is not a proper sentence). So, we are fine with either of the following Notes:

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed.

or

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonised as much as possible.

2 – vivo Mobile Communication Co.

Agree

3 – DOCOMO Communications Lab.

Fine. Also agree to QC's suggestion on the note "while overall the LTE and NR solutions should be harmonised as much as possible"

4 – CATT

The same view as Docomo.

5 – Xiaomi Communications

Fine, and ok with the note updates from Qualcomm.

6 – ZTE Corporation

We are fine with the current version. Regarding the NR-specific enhancement, the NR-specific enhancement is also precluded based on the existing two notes.

7 – Lenovo Mobile Com. Technology

we are fine with note updates from Qualcomm

8 – TELECOM ITALIA S.p.A.

To manage the workload we are fine with the current proposal. Enhancements could be added in the next Release

9 – LG Electronics France

Moderator's proposal is fine and QC's further update is also fine. Think there is no real difference between them.

10 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon We are fine with the spirit but the detailed wording needs to be polished (e.g. the second note as it stands is not correct).

11 – MediaTek Inc.

We are fine with Moderator's proposal and do not agree with other variation.

12 – Samsung Electronics Co.

Moderator's proposal is quite reasonable considering work load and limited TU.

13 – NEC Corporation

We think "NR-specific enhancements can be considered, if needed" should not be removed. It means that specific enhancements for NR will be introduced only when necessary, and with LTE work as a starting point it already shows the spirit that "LTE and NR solutions should be harmonised as much as possible". Therefore, we propose not to modify the note.

14 – Ericsson LM

The following proposed note from QC is fine for us:

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonised as much as possible.

15 – Deutsche Telekom AG

Moderator's version is fine for us.

(we should trust each other and develop something which is meaningful ... then it might be implemented and used ..)

16 – Nokia Corporation We would be fine with this ”Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonised as much as possible.”
17 – Apple AB We also think that NR specific enhancements, if needed, should not be precluded, and we should build upon LTE principles.
18 – Intel We are fine.
19 – VODAFONE Group Plc We are OK with (a tidied up version of) the original, or, the QC second note .
20 – Telia Company AB Moderator’s proposal is ok for us.
21 – TURKCELL We are fine with moderator’s proposal.
22 – Verizon UK Ltd Fine with the proposal. Also OK with QC’s note.

Moderator Summary:

Based on the feedback from Qualcomm and others, the note will be revised with the following text:

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonized as much as possible.

2. Specify the signaling to support subscription-based aerial-UE identification [RAN3/SA2 interaction/RAN2]

Note: Work done in LTE is a starting point for this objective.

Note: While overall the LTE and NR solutions should be harmonised as much as possible.

Feedback Form 8: Please provide changes (if any) for subscription-based aerial-UE identification

1 – Qualcomm Incorporated Similar to above comment, either the first Note is sufficient or the second Note can be merged to the end of the first note. But separate second Note does not seem to make sense.

2 – vivo Mobile Communication Co.

Agree

3 – DOCOMO Communications Lab.

Agree with QC

4 – CATT

Agree with QC.

5 – Xiaomi Communications

Agree with QC.

6 – ZTE Corporation

Fine

7 – Lenovo Mobile Com. Technology

Agree with QC.

8 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon We are fine with the spirit but the detailed wording needs to be polished (e.g. the second note as it stands is not correct).

9 – MediaTek Inc.

We are fine with Moderator's proposal and ok to combine two notes as long as no wording change.

10 – Samsung Electronics Co.

Same view as MediaTek

11 – NEC Corporation

Similar to the comment on objective 1, we propose not to modify the note.

12 – Ericsson LM

Agree with QC

13 – Deutsche Telekom AG

Moderator's version is fine for us.

(we should trust each other and develop something which is meaningful ... then it might be implemented and used ..)

14 – Apple AB

We need only a single note for the two objectives.

15 – Intel We are ok with merging the notes
16 – VODAFONE Group Plc ok
17 – Telia Company AB Ok for us.
18 – TURKCELL Ok

Moderator summary:

Based on the feedback from Qualcomm and others, the note will be revised with the following text:

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonized as much as possible.

3. Consider whether to add an objective for enhancements for broadcast of UAV identification once input from SA2 is received

~~3. [Specify needed enhancements for broadcast of UAV identification [RAN2, RAN1, SA2 interaction]]~~

~~Applicable to both LTE and NR~~

Note: This description is a placeholder for a more detailed objective to be drafted once SA2 will have concluded their study on the architectural aspects.

Feedback Form 9: Please comment whether to add an objective for enhancements for broadcast of UAV identification once input from SA2 is received

1 – Qualcomm Incorporated It is unclear to us what is the intent of the new formulation of the objective. (What does “consider whether” mean?) Based on responses from companies, it seems clear to us there is a very strong support to do something here instead of “consider whether to [do something]”. Instead of making the objective vaguer, we think we should go back to the text from initial phase (which was reached after multiple rounds of discussion earlier) and take the suggestions in initial phase from companies into consideration and refine the objectives and capture the specifics, e.g. as shown below: 3. Specify needed enhancements, e.g. for broadcast of UAV identification and for broadcast/groupcast of UAV detect and avoid [RAN2, RAN1, SA2 interaction] - Adapt to UAV scenarios considering 3D range, UAV specific assistance info etc. - Support of longer-range communications for broadcast of drone identification.

- Applicable to both LTE and NR.

Note: The legacy sidelink design is a starting point for this objective.

2 – vivo Mobile Communication Co.

We prefer to keep the original objective, since it has clearly indicated that RAN2 should wait for SA2 conclusion for a more detailed objective.

3 – DOCOMO Communications Lab.

We prefer to remove ”consider whether to” part. We are fine to wait for SA2. Hence we suggest ”Specify needed enhancements for broadcast of UAV identification once input from SA2 is received”

4 – OPPO

We are fine to wait for SA2 before adding any details.

5 – CATT

It’s ok for us to wait for SA2.

6 – Xiaomi Communications

It is ok for us to wait for SA2. Probably after the joint SA/RAN meeting next week, we can come up with a clearer objective.

7 – ZTE Corporation

Maybe keeping the previous version as placeholder is better. But still, we need to wait for the progress in SA2.

8 – Lenovo Mobile Com. Technology

Previous version as placeholder is better, could add condition like ”if SA2 has conclusion” in the objective as compromise

9 – TELECOM ITALIA S.p.A.

We have strong concern with the proposal from Qualcomm, since RAN4 should be involved to consider the impact of sidelink operations (bands, interference to remote BTSs, and many other issues).

As stated before we would prefer to completely remove the objective, since Uu is already addressing the problem.

10 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon We are ok with the updated objective as it is pending on SA2 output.

11 – MediaTek Inc.

This bullet does not say anything except pending on SA2 conclusion. We are not sure if we need a bullet, if so, we propose following revision.

3. If any, additional objectives from SA2 *WI code* conclusion to be added at plenary XX

~~Note: This description is a placeholder for a more detailed objective to be drafted once SA2 will have concluded their study on the architectural aspects.~~

12 – Samsung Electronics Co. We also think that previous version seems better. Anyway, we need to wait for conclusion from SA2.
13 – NEC Corporation We are fine with leaving this to SA2 first.
14 – Ericsson LM We disagree with the new wording of this objective, whose meaning is very unclear to us. And as others have said, the original objective already had a note that SA2 input is needed so no change is needed. In our view, fulfilling the FAA requirement on broadcasting remote ID is a critical and urgent task (given that the FAA rule will take effect in 2023) to make cellular technology competitive in connecting the UAVs. Therefore, we prefer the original wording without bracket.
15 – Deutsche Telekom AG We don't think this is urgent and we can wait for clear requirements to support this from SA2 (which will come if this is really needed). Complete drop as suggested by TIM is also fine for us.
16 – Apple AB We would also like to wait for SA2 progress.
17 – Intel We prefer to wait for SA2 progress or more focus objective like "Support of broadcast of UAV identification over PC5. (TBD SA2)"
18 – Futurewei Technologies This enhancement needs system-wide support, and RAN aspect can be better defined after SA2 proceeds further.

Moderator summary:

Based on general feedback and the support for inclusion of enhancements for broadcast of UAV identification, the proposal is to revert to the original text and removing the square brackets:

3. Specify needed enhancements for broadcast of UAV identification [RAN2, RAN1, SA2 interaction]

Applicable to both LTE and NR

Note: This description is a placeholder for a more detailed objective to be drafted once SA2 will have concluded their study on the architectural aspects.

4. Study and specify Uu directional beamforming enhancements in FR1 for UAVs, with the following assumptions [RAN1, RAN4, RAN2]:

- FR1 with directional antenna at UE side

Feedback Form 10: Please provide feedback if you can accept the revised compromise on UAV beam management

1 – Qualcomm Incorporated

Fine.

2 – vivo Mobile Communication Co.

Agree

3 – SoftBank Corp.

Fine

4 – DOCOMO Communications Lab.

Fine

5 – CATT

It is acceptable for us.

6 – Xiaomi Communications

Agree

7 – ZTE Corporation

The current wording ”Uu directional beamforming enhancements” is ambiguous, and may imply how to ”construct the beam for implementation” for Uu instead of general enhancement to the BM. The following updated version is preferred:

- Study and specify **enhancements of Beam management for directional Uu** in FR1 for UAVs, with the following assumptions [RAN1, RAN4, RAN2]:
  - FR1 with directional antenna at UE side

8 – Lenovo Mobile Com. Technology

Fine

9 – TELECOM ITALIA S.p.A.

fine

10 – LG Electronics France

We think the scope and the actual necessity of specification work are still unclear in the current text. If it is difficult to converge to more detailed scope on this objective, we may at least put the specification work up to the result of the study, i.e., we propose to modify the objective

- “Study and if necessary specify …”

11 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon As commented by companies in initial round, the justification of the enhancement is not clear. The assumption of directional antenna does not make any difference from the perspective of beam management, comparing with the existing uplink beamforming mechanism.

Again, as mentioned in initial round, the introduction of directional antenna at UE side for FR1 requires lots of RAN4 work, which is not aligned with current TU allocation. In fact, RAN4 perhaps needs to investigate OTA testing for FR1, potential new RF requirements like spherical coverage, EIRP etc.

Keeping the main purpose of this WI and the TU allocation limitation in mind, we think this objective should be dropped.

12 – MediaTek Inc.

First, there is no justification on the benefit of RAN to know UE equipped with directional antenna; second, there is no clear scope on the functional or procedure impact of directional antenna, e.g. which part of BM is impacted; third, no understanding on potential R4 work to specify a new antenna architecture. Considering the immature proposal, we do not agree to add this bullet.

13 – Samsung Electronics Co.

We understand concerns from other companies regarding potential high workload especially in RAN4 and lack of justification of the enhancement. On the other hand, we also understand that there is strong demand from the market and we are fine to study this aspect in order to check whether interference issue is serious or not.

14 – Ericsson LM

This objective has gotten less and less clear the longer the discussion goes. We don't understand what this objective is requesting the WGs to do. Beam manament is also applicable to FR1 already today. There is no restrictions on that the UE must be on the ground for beam management to be used.

We cannot accept having this objective unless we can explicitly and clearly say what is hiding behind this.

15 – Nokia Corporation

The use case and benefit for network knowing if UAV had directivity capability or not should be obvious. For a UAV above event, like a stadium, if network knows there are directive antennas, once can consider connecting a site outside the stadium (thus reducing the interference) while if UAV has only omni-directional antenna then no other option than connect the closest (best) site (cell). This is known to create a lot of interference to many sites in the network.

For the RAN4 aspects of directive antennas, as there are product already in the market for other use cases, like FWA with directive antennas, so hard to see why this would suddenly become a show stopped in case if a UAV with directive antennas and only that would require OTA etc work.

Foreseen work in RAN1 thus only to help with antenna related capability signalling (If directive antenna in place + a few key parameters like antenna gain).

16 – Deutsche Telekom AG

Not clear what this objective is about ... any antenna is directional in the one or other way. Nokia sceanrios is a very very specific one .. we do not need a standard for such a scenario ...

We propose to drop this objectives in the interest of workload coming from the unclear formulation. Thanks.

17 – OPPO

Based on previous discussion, we don't think companies have a common understanding on the justification for this objective. It's hard for us to accept a unclear objective without knowing what enhancements are behind, in our view, so prefer to not have this objective for this release.

18 – TELUS

Agree

19 – TELENOR ASA

Agree.

20 – Intel

We think that beam management may not be the most important WI for the first UAV release for NR. It may occupy a lot of discussion time and hence prefer to delay to later release. However, if we can narrow the scope down which can focus on the discussion, we are open to it. Without clarification on the expected solution and assumption on antenna set for this item there is a risk that RAN1 will not be able to complete the work in the allocated TUs (especially considering low number of TUs for RAN1 UAV in the Rel-18 package provided by RAN leadership RP-213469). Also, the impact on RAN4 RF/RRM should be clarified given no planned TU allocation for this WI in RP-213469.

21 – VODAFONE Group Plc

agree

22 – Futurewei Technologies

The actual work scope defined by this objective is not clear. And the impacts on RAN1/2/4 seem to be not well understood. The use case given by Nokia is quite a corner case. We are not convinced this needs to be included in the WID.

23 – Telia Company AB

We agree and support Nokia view of network understanding the UAV antenna capability.

24 – TELEFONICA S.A.

Agree

25 – Nokia Corporation

Perhaps it it would help to solve uncertainty if in the WID we mention RAN2 specs only (I see only 38.306 and 38.331 would be impacted) and not RAN1 specifications. RAN1 role could be clarified more clearly to be only about UE capability signaling (in terms of UAV antenna capabilites) and after that RAN2 to work on related RRC signaling.

26 – Verizon UK Ltd

Same as Telia - "we agree and support Nokia view of network understanding the UAV antenna capability."

27 – Orange We support Nokia's view. Network knowledge of the UAV antenna capability will be useful.
28 – TURKCELL We agree and support Nokia view of network understanding the UAV antenna capability.

Moderator summary:

Based on the support for UAV beamforming capabilities and the comments from multiple companies, the revised text proposal for the objective is:

4. Study and specify UE capability signaling to indicate UAV beamforming capabilities and necessary control signaling, with the following assumptions [RAN1, RAN4, RAN2]:

- FR1 with directional antenna at UE side

3 Final Round

The proposed justification and objectives based on the discussions in the initial and intermediate round are including as proposed text for the WID in the final round.

3.1 Justification

In the recent years, the global interest for uncrewed aerial vehicles based services has dramatically increased, including e.g. for multiple drone operation, personal entertainment for flight experience, cargo delivery, etc. As the basis of these applications, the capability for remote control and data transmission are key aspects for enhancements, which are of interest for service providers/operators as well as drone manufacturers.

Consequently, corresponding SI and WI based on LTE were established in previous releases, mainly focussing on aerial vehicles with an altitude up to 300m. According to the study, the feasibility and required enhancements have been verified for the support aerial vehicles via terrestrial cellular systems, e.g. in terms of UL and DL interference as well as mobility. However, since LTE was designed for terrestrial UEs, without considering aerial UEs at the very beginning, some inherent limitations, e.g. higher latency, reduced MIMO capabilities imply that some requirements for aerial services still cannot be met.

Compared to LTE, NR enables more diversified applications for aerial vehicles, with the lower latency for control and higher data rate for multi-media services.

While the advanced NR features generally improve performance with respect to basic LTE, it is clear that further improvements are needed, due to the fact that the NR system didn't take aerial vehicles into account when it was initially designed. Moreover, the interference issues that may be generated by aerial UEs have to be considered in order not to disrupt the operation of a network designed for terrestrial UEs.

3.2 Objectivies

1. Specify the following enhancements on measurement reports [RAN2]:

- UE-triggered measurement report based on configured height thresholds
- Reporting of height, location and speed in measurement report
- Flight path reporting
- Measurement reporting based on a configured number of cells (i.e. larger than one) fulfilling the triggering criteria simultaneously

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonized as much as possible.

2. Specify the signaling to support subscription-based aerial-UE identification [RAN3/SA2 interaction/RAN2]

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonized as much as possible.

3. Specify needed enhancements for broadcast of UAV identification [RAN2, RAN1, SA2 interaction]

Applicable to both LTE and NR

Note: This description is a placeholder for a more detailed objective to be drafted once SA2 will have concluded their study on the architectural aspects.

4. Study and specify UE capability signaling to indicate UAV beamforming capabilities and necessary control signaling, with the following assumptions [RAN1, RAN4, RAN2]:

- FR1 with directional antenna at UE side

Feedback Form 11: Please add any concerns related to WID text on NR support for UAV (Uncrewed Aerial Vehichles)

1 – Intel For (4): Propose to remove RAN4 work given it is unclear what is required at this point. We can send RAN4 LS in case of any implementation aspects.
2 – Qualcomm Incorporated We thank the moderator for the hard work of handling this discussion. While we have our reservations in some items and further comments in other items like everyone else, for the sake of progress and compromise given the extent of discussions so far, we are fine to go ahead and approve the WI with the latest form of the justification and objectives. Thank you.
3 – CATT The latest version is ok for us.
4 – LG Electronics France We really appreciate the moderator's hard work so far.

We have one small suggestion to add ”if necessary” on objective 4, given that the objective is starting from a study phase which will then determine whether any new signaling is needed or not:

- Study and if necessary specify UE capability signaling

5 – vivo Mobile Communication Co.

The latest version is ok for us.

6 – Xiaomi Communications

The latest version is ok for us.

7 – Samsung Electronics Co.

As we said multiple times, we are not sure at this point regarding how much interference situation in UAV mentioned by Nokia would be serious as compared to normal cellular networks. So, we are fine to study it but we think that whether or not to have normative work to support such aspect will be dependent on the outcome of the study. Having said that, we propose to take ’if needed’ back in Objective 4.

Another point is that ’necessary control signaling’ in Objective 4 is not clear to us, especially whether it means DCI, MAC-CE, RRC or any combination of them. When we checked companies’ responses, Nokia was the only company proposing ’RRC signaling’. So, we would like to put RRC signaling in Objective 4 rather than to use too broad terminology of control signaling.

In summary, Objective 4 needs to be changed as

4. Study and **if needed**, specify UE capability signaling to indicate UAV beamforming capabilities and necessary ~~**control**~~ **RRC** signaling, with the following assumptions [RAN1, RAN4, RAN2]

- FR1 with directional antenna at UE side

8 – Deutsche Telekom AG

We are not not convinced that Objective 4 is needed as indicated already earlier. At minimum we support adding ”if needed” or ”if neccessary” as also suggested by Samsung and LGE.

With the Objectives 1 - 3 we are fine.

If the condition on Objective 4 is considered Deutsche Telekom is happy to be listed as co-signing company.

Thanks to the moderator handling this discussion !

9 – DOCOMO Communications Lab.

The latest version is ok for us.

10 – Nokia Corporation

We are are fine with the suggested ”if needed” addition and also the being specific with the ”RRC signaling” is good as suggested by Samsung.

11 – MediaTek Inc.

We thank moderator's good efforts. However, we must say we cannot accept Objective 4 in its current wording, especially when the impact of "directional antenna" on network performance and requirement is not clear, we cannot consider spec impact only when those become clear.

4. Study ~~**and specify UE capability signaling to indicate**~~ UAV beamforming ~~**capabilities and necessary control signaling**~~, with the following assumptions [RAN1, RAN4, ~~**RAN2**~~]:

- FR1 with directional antenna at UE side

12 – OPPO

Really thanks for the effort by the moderator, but we are still not convinced by the justification of objective 4, it's still not clear what enhancement is involved, only reporting additional UE capability does not make much sense; to make progress, we can accept to add 'if needed' for objective 4.

13 – Ericsson LM

We agree with others that still it is not clear what objective 4 will result in. But, we would be fine with Samsung's wording but if we also clarify that corresponding FR2 signalling is the baseline. Meaning we would be OK with this wording:

Study and if needed, specify UE capability signaling to indicate UAV beamforming capabilities and necessary control RRC signaling, where the corresponding RRC signaling for FR2 is baseline

14 – TELECOM ITALIA S.p.A.

We cannot agree on objective 3 as is, especially as clearly indicated by multiple companies is to define / use sidelink.

As commented by many companies, it is not clear which band should be considered fro this sidelink operation and there is no reference to study impact on interference towards remote base stations (in addition to BTSs in the vicinity).

This activity requires a huge effort in RAN4, while RAN4 is not even mentioned in the objective.

As is **we are raising sustained objection** to the approval of this activity for the following reasons:

- the effect of broadcast transmission has a severe impact on interference towards base stations, including remote BTSs. The topic is not even addressed in the current proposal, and definitely need RAN4 involvement
- The workload due to this objective is not manageable
- there are already existing solutions (e.g. based on Uu) to provide this service

15 – Deutsche Telekom AG

To Ericsson: We are also not convinced about this objective 4, but why do you propose to limit it to FR2 ?

To TIM: We agree there are already technologies which work, i.e. using Uu. We also do not see that this requires broadcast in licensed spectrum. The current FCC requirement talks about WiFi or BT, hence for us it is not pre-judged that this broadcast of UAV ID uses 3GPP technologies. Hence we propose to change the Objective 3 to "study and specify, if needed, control for UAV identification broadcast [R2, SA2]" ... maybe this addresses your concerns ?

16 – ZTE Corporation

We also think objective 4 is unclear and not sure about the benefits of introducing signaling to indicate UAV beamforming capabilities. MTK's suggestion can be the general way to go under the current situation.

17 – TURKCELL

We're fine with the moderator's latest version. Samsung's text proposal can be added to it.

18 – NEC Corporation

We are supportive of current WID text.

19 – TELECOM ITALIA S.p.A.

Thanks to DT for considering the objection.

A possible solution would be the following:

In addition to existing techniques based on Uu or non 3GPP technologies, study and specify, if needed, control for UAV identification broadcast **in unlicensed band** [R2, SA2].

Unless this objective is solved we still make a sustained objection to the approval of this activity

20 – Nokia Corporation

For the objective 3 the main issue was to wait for SA2 conclusion. And if we are going to do it over the air, I would assume as pointed out by DT that we would not use licensed spectrum for that but unlicensed (as with Wi-Fi or BT), so if we capture that somewhere (minutes perhaps), this hopefully addressed concern on that?

21 – SoftBank Corp.

We are fine with the moderator's latest version. In objective 4, proposal by Samsung looks good.

22 – LG Electronics France

We really appreciate the moderator's hard work so far.

We have two small suggestions:

a) we suggest adding "if necessary" on objective 4, given that the objective is starting from a study phase which will then determine whether any new signaling is needed or not:

- 4. Study and if necessary specify UE capability signaling,

b) The same logic can apply to objective, i.e. the following changes are suggested:

- 3. Specify, if necessary, relevant ~~needed~~ enhancements for broadcast of UAV identification

We are also fine with DT and TI's revision on this.

23 – Ericsson LM

@DT: Clarification for our comment on Objective 4: We don't propose that this should be done for FR2. We think that there are beam management techniques defined for FR2 which can be used as baseline when addressing objective 4. But we still assume that objective 4 is for FR1.

24 – Nokia Corporation

Suggestion from Ericsson is fine from our perspective as reasonable was moving forward (capturing the most concerns raised), understanding FR2 has large number of capabilities not needed here, so we of course need only a few capability parameters for this case in FR1

We also assume this ”FR1 with directional antenna at UE side” is retained to be clear the work is about FR1

25 – Ericsson LM

After reading the comments from TIM, we are open to soften this. But we do not see the need for the mentioning of ”existing techniques”. We dont understand what the WGs would actually be asked to do based on this ”existing techniques”-wording. We think it is quite clear that if we go the direction proposed by TIM; we should simply say that the WGs should ”study and specify, if needed,”

We dont think the objective is limited to unlicensed though. FAA does not have a requirement that this should only be in unlicensed spectrum. And limiting it to only unlicensed does not reduce the work load.

To summarize, we would be fine if objective 3 is phrased like this:

Study and specify, if needed, control for UAV identification broadcast [RAN2, RAN1, SA2 interaction].

26 – AT&T GNS Belgium SPRL

Agree with moderator’s objectives 1 and 2. For objective 3, we are OK with Ericsson’s suggested proposal above. We also don’t think the objective is limited to unlicensed band. For objective 4, we agree with comments from Nokia and Ericsson above.

27 – Telia Company AB

We are supporting the moderator’s latest version objectives 1 and 2. Seems that more work and alignment is needed for objective 3 and 4, but maybe we have a solution in the evening GTW, hopefully. Good work!

28 – Verizon UK Ltd

We are fine with the latest version.

29 – Qualcomm Incorporated

For objective 4, we are fine to add ”if needed” as suggested by many companies, but do not see a need to restrict to ”RRC signalling” at this early stage. That should/would be clear during the ”study” phase what needs to be specified, if any.

30 – Futurewei Technologies

We are fine with current version of objectives 1 and 2. We support Ericsson’s modification of objective 3 and moderator’s modification of objective 4 based on Samsung’s and LG’s comments.

31 – Qualcomm Incorporated

For objective 3, as already indicated, even though we wanted to add more specifics because SA2 objectives are already clear, for the sake of compromise, we are fine with the current wording to keep this is as a placeholder to be updated based on SA2 outcome. If companies still want to massage the wording, we would be fine with LG’s suggestion above, i.e.: 3. Specify, if necessary, relevant ~~needed~~ enhancements for broadcast of UAV identification. There is no need to go into details about Uu vs PC5, 3GPP vs non3GPP or licensed vs unlicensed at this stage.

32 – HUAWEI TECHNOLOGIES Co. Ltd.

Huawei, HiSilicon

1. Technically, based on the existing BM/HO framework, it is not clear what additional control signaling is needed. If the signaling is related to antenna gain, the gain of directional antenna can be "captured" in the measurement result values as of today. The measurement results of the cell in the dedicated direction of the antenna can be better than others. We did not get clear answer what is missing from signaling perspective. If the intention is to let UE report beamforming gains as UE capability, this requires the UE to reveal implementation details and is difficult to be standardized per different implementations. To be more specific, it is hard to quantize the gain of directional antenna from the perspective of specification. The antenna gain varies in the different directions, and for one direction there is uncertainty of reported gain.

2. The potential RAN4 work load should be carefully taken into account, because if the performance of direction antenna is guaranteed the EIPR (maximum, minimum, drop EIPR), spherical coverage and other requirements need be specified and the corresponding OTA testing is also needed, which lead to huge amount of work.

3. We observed that some other companies are also not completely convinced regarding objective 4 and thus we do not believe this objective should be accommodated in Rel-18.

33 – Nokia Corporation

For Huawei comment. There are already products out there for FR1 which have directive antennas, use them for measurements etc. without any RAN4 work. With UAV simply reporting details this UE capability for the network, how this requires suddenly RAN4 OTA work to be possible? (and some companies suggest even to remove RAN4 here). Interference from UAVs for a cellular network is well known issue, due to large number of cells visible for a flying UAV .

34 – Qualcomm Incorporated

In response to Huawei regarding objective 4: What control signaling is needed is to be studied. Although it is details for the WGs to discuss, no intention to let UE report antenna gain. Referring to FR2 BM frame structure, potentially we need control signaling e.g., spatial relations for directional antenna in FR1. Also, we can put RAN4 in [ ] now if that helps alleviate the concern.

35 – VODAFONE Group Plc

Thanks for the work on this. V002 is looking good - but some of the above suggestions might improve it further.

4 Conclusions

The proposed justification and objectives based on the discussions in the initial, intermediate, and final rounds are including as proposed text for the WID in the final round.

4.1 Justifications

In the recent years, the global interest for uncrewed aerial vehicles based services has dramatically increased, including e.g. for multiple drone operation, personal entertainment for flight experience, cargo delivery, etc. As the basis of these applications, the capability for remote control and data transmission are key aspects for enhancements, which are of interest for service providers/operators as well as drone manufacturers.

Consequently, corresponding SI and WI based on LTE were established in previous releases, mainly focussing on aerial vehicles with an altitude up to 300m. According to the study, the feasibility and required enhancements have been verified for the support aerial vehicles via terrestrial cellular systems, e.g. in terms of UL and DL interference as well as mobility. However, since LTE was designed for terrestrial UEs, without considering aerial UEs at the very beginning, some inherent limitations, e.g. higher latency, reduced MIMO capabilities imply that some requirements for aerial services still cannot be met.

Compared to LTE, NR enables more diversified applications for aerial vehicles, with the lower latency for control and higher data rate for multi-media services.

While the advanced NR features generally improve performance with respect to basic LTE, it is clear that further improvements are needed, due to the fact that the NR system didn't take aerial vehicles into account when it was initially designed. Moreover, the interference issues that may be generated by aerial UEs have to be considered in order not to disrupt the operation of a network designed for terrestrial UEs.

4.2 Objectives

1. Specify the following enhancements on measurement reports [RAN2]:

- UE-triggered measurement report based on configured height thresholds
- Reporting of height, location and speed in measurement report
- Flight path reporting
- Measurement reporting based on a configured number of cells (i.e. larger than one) fulfilling the triggering criteria simultaneously

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonized as much as possible.

2. Specify the signaling to support subscription-based aerial-UE identification [RAN3/SA2 interaction/RAN2]

Note: Work done in LTE is a starting point for this objective. NR-specific enhancements can be considered, if needed, while overall the LTE and NR solutions should be harmonized as much as possible.

3. In addition to existing techniques based on Uu or non 3GPP technologies, study and specify, if needed, control for UAV identification broadcast in unlicensed band [RAN2, SA2].

Applicable to both LTE and NR

Note: This description is a placeholder for a more detailed objective to be drafted once SA2 will have concluded their study on the architectural aspects.

4. Study and if necessary, , specify UE capability signaling to indicate UAV beamforming capabilities and necessary control RRC signaling, where the corresponding RRC signaling for FR2 is baseline [RAN1, RAN2]:

- FR1 with directional antenna at UE side