Qualcomm

RP-213453

3GPP TSG RAN#94e
Electronic Meeting, Dec. 06-17, 2021
Agenda Item: 8A.2

Views on UAVs project

5G

Background

- The moderator draft on NR UAV (RP-212715) includes the following objectives:

[…]

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.

[…]

5. [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

- In this contribution, we present our views on the aspects above.

Uu Directional Beamforming in FR1 for UAV

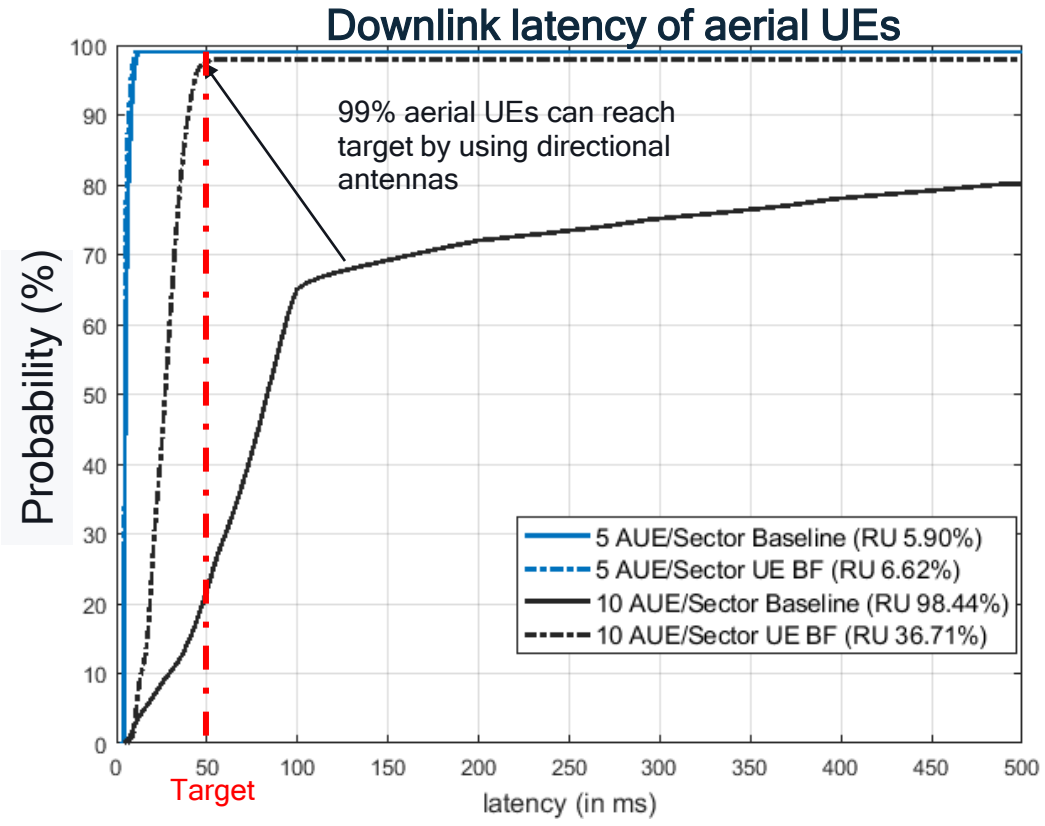
- Email discussion conclusion:
  - [Second priority] Study and, if needed, specify the enhancements on beam management, with the following assumptions [RAN1, RAN4, RAN2]

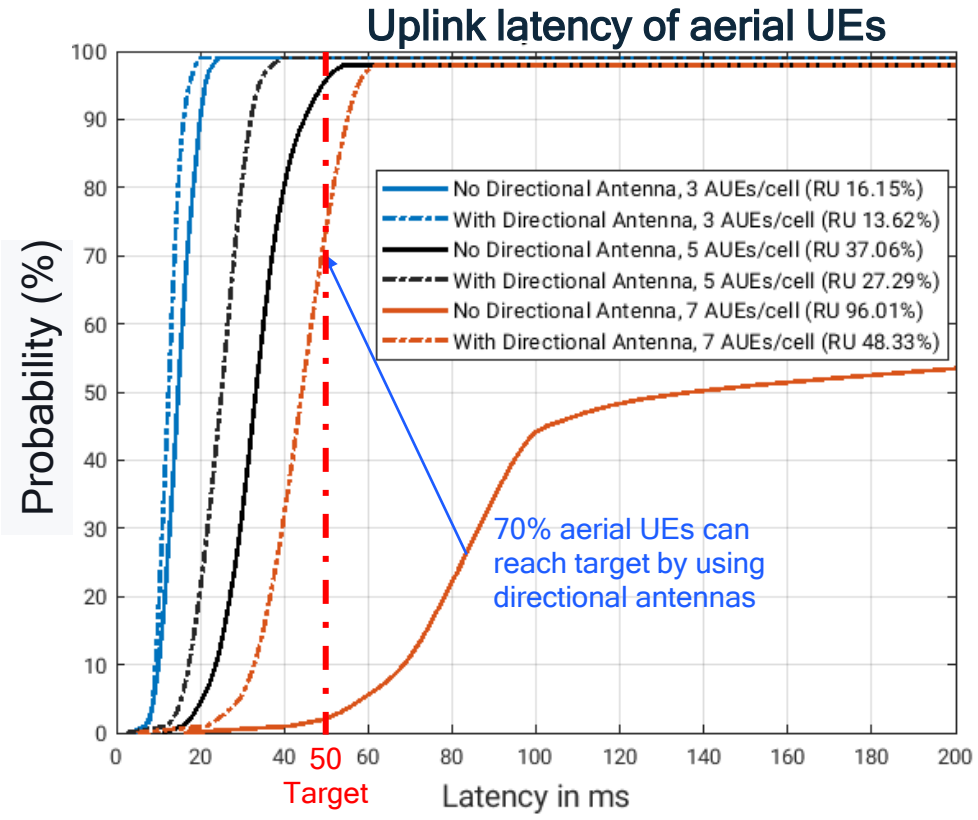
- For Rel-18 UAVs, we should focus on **Uu directional beamforming in FR1**.
  - It has been discussed during LTE study that uptilting of antennas at the BS may be beneficial.
  - Directional antennas at aerial UEs can significantly improve the system capacity and reliability (see next slides).

- **Proposal:**
  - Study and specify Uu directional beamforming enhancements in FR1 for UAVs [RAN1]
    - Focus on aerial UE beamforming by directional antennas

Impact of UAV with Directional Antennas
- Latency performance of Arial UEs -

Observation: For both DL and UL, directional antennas at aerial UEs significantly increases the capacity (UE per cell) for a target C&C traffic reliability.



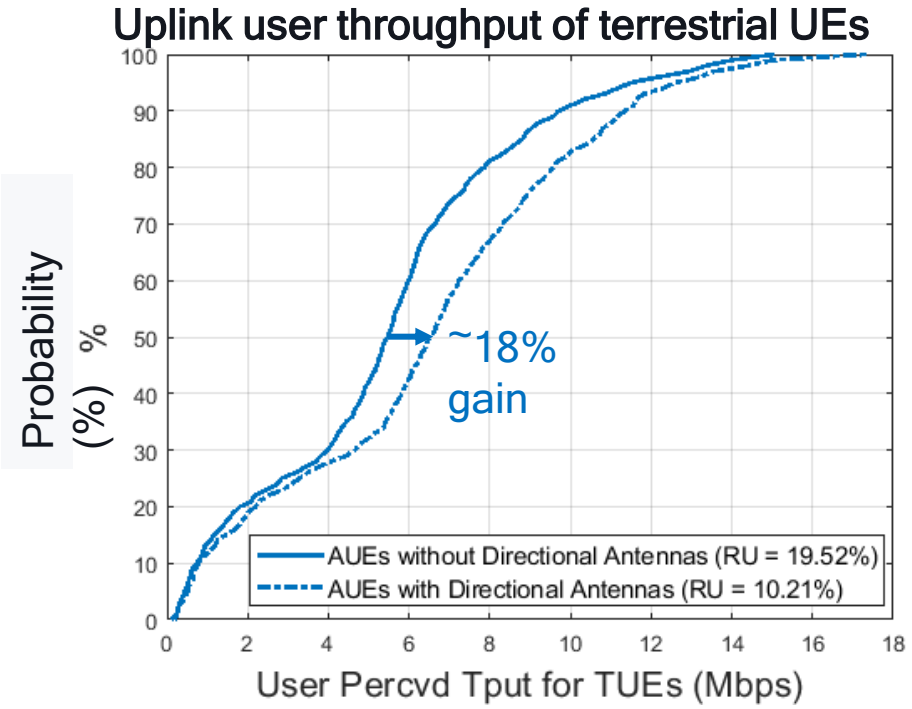


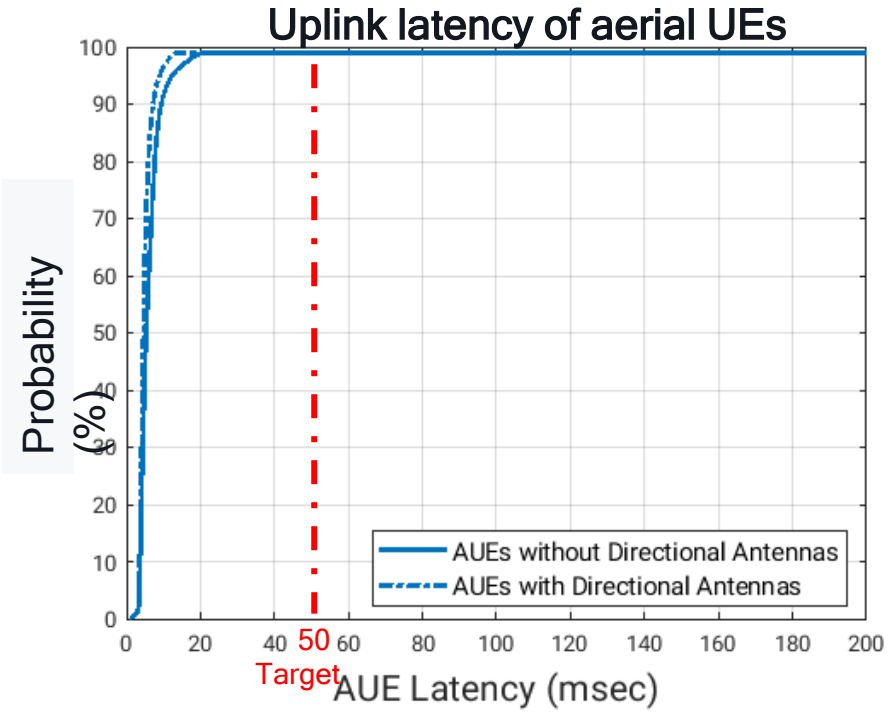
Simulation Assumptions (see more details in Appendix)

- Aerial UE distributed uniformly with height of 1.5-300 m.
- 2.5MHz dedicated for UAVs with C&C traffic (Periodic with 1.25kbytes per 100 ms)

Impact of UAV with Directional Antennas
- Terrestrial UE throughput in shared spectrum -

Observation: For UL, directional antennas at aerial UEs can increase user throughput of terrestrial UEs in the shared spectrum.





Simulation Assumptions

- 5 Aerial UEs (w/o or w/ directional antennas) and 10 Terrestrial UEs (omni-directional antennas) per cell share BW=10MHz
- Aerial UEs distributed uniformly with height of 1.5-300 m
- Traffic: FTP Model 2 with file size 50 kb at 0.01 files/s arrival rate for terrestrial UEs, C&C traffic for Aerial UEs

PC5 and UAVs – SA2 dependency

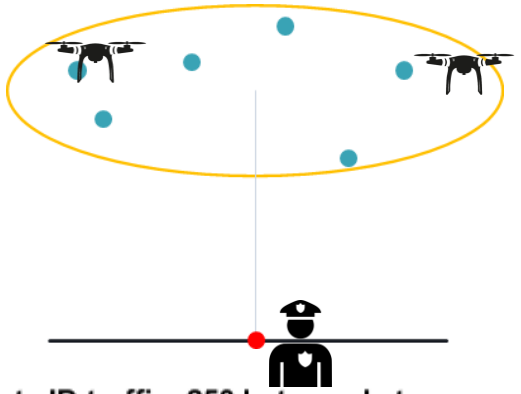
- During the previous email discussion, there were several contentious issues.
- Regarding SA2 impact, we would like to highlight that the latest approved SID in SA2 (S2-2108154) has the following text (emphasis added):

> 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).**

- Therefore, we do not see a need to wait for SA2 on their conclusion, since they explicitly include PC5 for both remote ID and DAA.
- **Proposal:** Include an objective on PC5 for remote ID and DAA, aligned with SA2 SID.

PC5 and UAV – RAN1 aspects

Based on our evaluations, **UAVs can reach a range of 1000m+,** assuming non-ideal but correct channel estimation at the receiver.

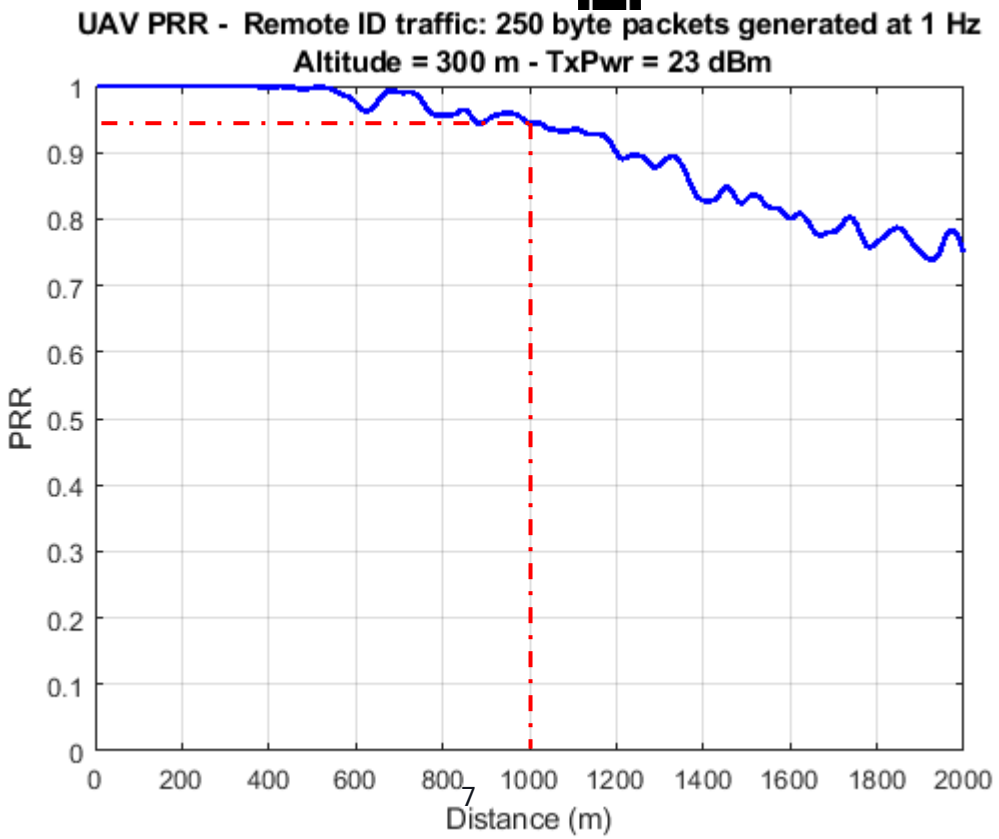


- We have identified that the DMRS for PSCCH is the limiting factor in reaching this range. Without this limitation, we can exceed 1km range at 95% PRR.
  - See appendix for simulation assumptions.

- Due to **comb-4 + 3 cyclic shifts**, there is an ambiguity in channel estimation if the range exceeds 1/12th of the OFDM symbol duration.

- RAN1 should introduce **minimal changes in PSCCH DMRS** to remove this ambiguity.

- Simulation details are shown in the annex.



PC5 and UAVs

- In view of the arguments made in previous slides, we propose the following

- **Proposal:** Modify the objective on PC5 as follows:
  - Specify enhancements for PC5, e.g. for broadcast of UAV identification and for broadcast/groupcast of UAV detect and avoid (RAN2, RAN1, SA2 interaction)
    - Adapt to UAV scenarios, such as 3D zone, UAV specific assistance info
    - Support of longer-range communications for broadcast of drone identification (specifically, enhancements to NR PSCCH DMRS)
    - Applicable to both LTE and NR.
    - Note: The legacy sidelink design is a starting point for this objective.

Summary of proposals

- We propose to modify the draft WID adding the following objectives:

  - Specify enhancements for PC5, e.g. for broadcast of UAV identification and for broadcast/groupcast of UAV detect and avoid (RAN2, RAN1, SA2 interaction)
    - Adapt to UAV scenarios, such as 3D zone, UAV specific assistance info
    - Support of longer-range communications for broadcast of drone identification (specifically, enhancements to NR PSCCH DMRS)
    - Applicable to both LTE and NR.
    - Note: The legacy sidelink design is a starting point for this objective.

  - Study and specify Uu directional beamforming enhancements in FR1 for UAVs [RAN1]
    - Focus on aerial UE beamforming by directional antennas.

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Thank you

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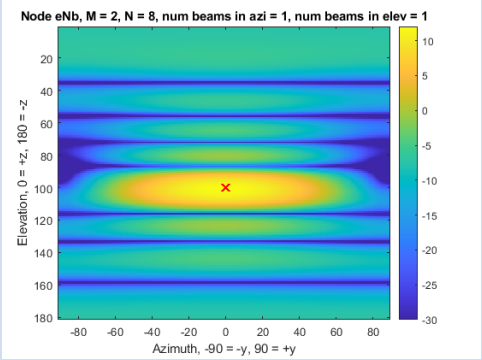
Annex: Aerial UEs with Directional Antennas

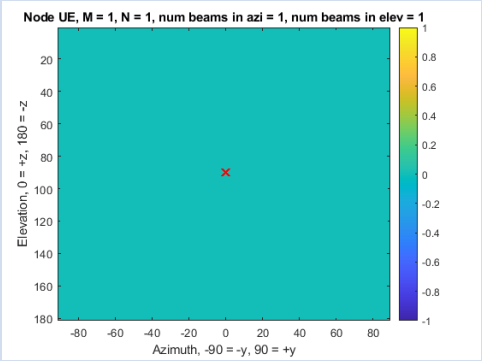
w/o UE beamforming (baseline)

- gNB: one beam at $\theta_{elev} = 100^o$ (downtilt)
- UEs: omni-directional antenna

gNB



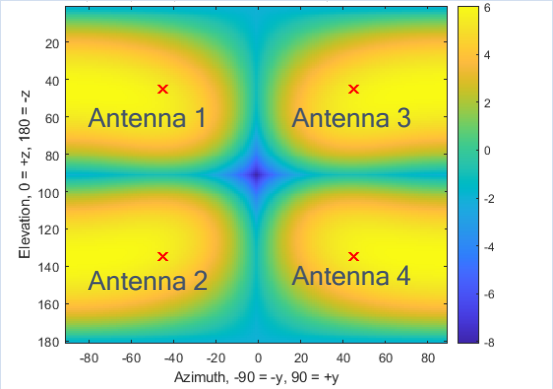
UE



w/ UE Beamforming

- gNB: same as Baseline
- UEs: With 4 directional antennas pointing at $(\theta_{azi}, \theta_{elev}) =$
  $(-45,45)$, Antenna 1
  $(-45,135)$, Antenna 2
  $(45,45)$, Antenna 3
  $(45,135)$, Antenna 4

(simulated as 4 analog beams)



Simulation Assumptions

Parameters	Values
Scenario:	UMa-AV with ISD 500 m
Carrier Frequency	2 GHz
BS Antenna configuration: (M, N, P)	$(8,1,2)$
Aerial UE height distribution	Uniformly distributed from 1.5m to 300m
Cell association	Based on RSRP from CRS port 0
Wrapping method	Geographical distance-based wrapping
Tx power (gNB, UE)	46 dBm, 23 dBm
Traffic for C&C	Periodic with 1250 bytes per 100 ms
Carrier frequency	2 GHz
Bandwidth	10 MHz carrier
Duplexing scheme	FDD

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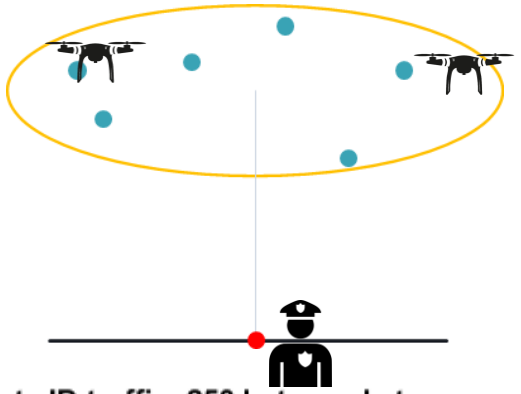
Annex - Long-range remote ID for UAV

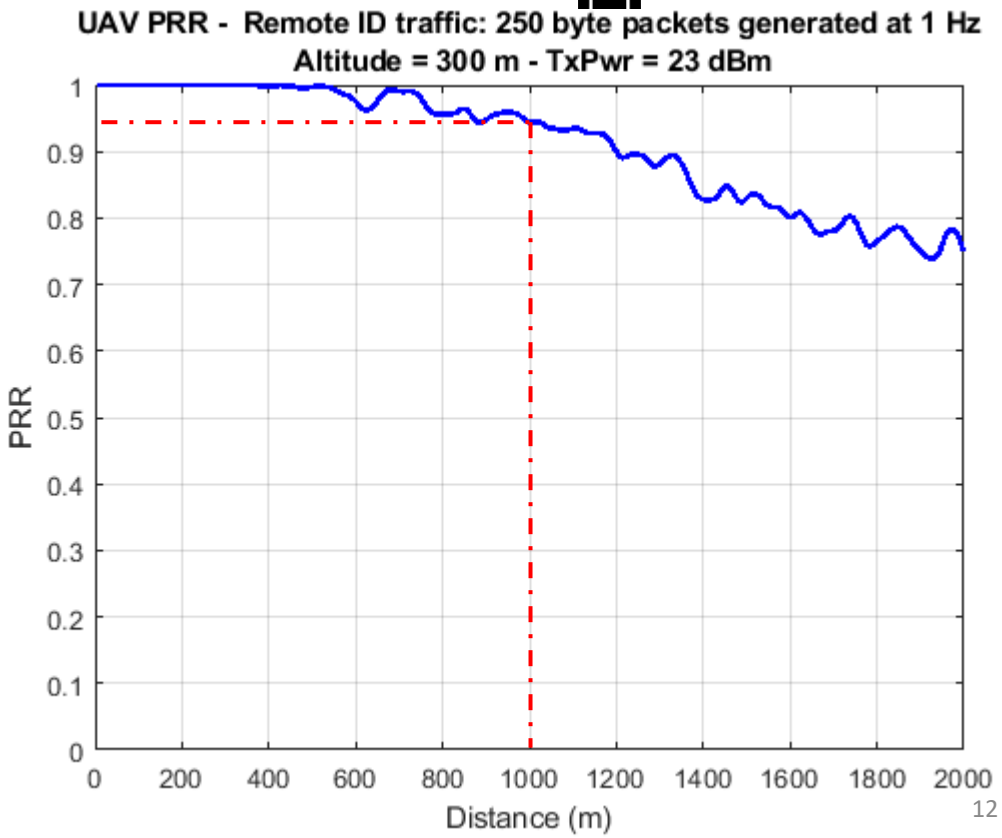


Observation: 95% UAVs flying high can reach a range of 1000m+, assuming non-ideal but correct channel estimation at the receiver.

For Sidelink link budget simulation:

- **UAV Drop:**
  - 40 UAVs per sq. km. uniformly distributed inside a disc of 2000m radius at a fixed height 300m above the ground.
  - Terrestrial UE (law enforcement) has to receive broadcast ID sent by UAVs, located on the ground right below the center of the disc.

- **Trajectory:**
  - UAV moves at constant speed (160km/hr) at the constant height in a straight line (with wrap-around at the border).
  - Initial horizontal direction selected randomly.

- **Channel Model:**
  - LOS channel for high-altitude UAVs.
  - AWGN channel and the pathloss for the UMa scenario given as

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