





AIAA Aviation Forum
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Urban Air Mobility

Command & Control Communications

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UAM C2 - FAA Aviation Forum June 2020



Urban Air Mobility (UAM) Notional Operations

NASA Glenn Research Center (GRC) has been researching the Command and Control (C2) portion of NASA's Unmanned Aircraft Systems Integration in the National Airspace System (UAS Integration in the NAS) since 2011.

GRC's UAS C2 research encompasses simulations and analysis, laboratory investigations, and test flights of a Control and non-Payload Communications (CNPC) radio designed specifically for UAS operations.

This work is in support of the RTCA Special Committee 228 (SC-228) to develop a UAS C2 Minimum Operational Performance Standard (MOPS).



NASA GRC CNPC Lab



NASA GRC S3 Aircraft CNPC Radio Flight Tests

UAM C2 - FAA Aviation Forum June 2020



NASA GRC UAS Control Room



NASA GRC's Support of RTCA SC-228

Addition of UAM C2 Communications Work:

UAM operations encounter unique C2 needs

Related to UAS but quite different

How so?

First step develop a UAM C2 Concept of Operations:

Published as NASA/TM-2019-220159

- Physical (structures, airspace, weather)
- Radio frequency (RF) considerations
- Policy/regulation challenges
- Unique to urban operations



Multipath and Blockage in Urban Environment

Regulatory questions:

- What sort of certification will a UAM pilot require?
- Where in the urban area may a UAM vehicle fly and land?
- What RF bandwidth and communications security will be necessary?
- What kinds of checking will passengers and packages be subjected to?
- and others…



Will regulations mandate corridors?

Con Ops includes six use cases of C2 UAM operations:

- Air Taxi Commuter Service
- Multi-Package Delivery
- Metro Air Shuttle Service
- Point-to-Point Package Delivery
- Life Flight Support
- Surveillance Services

Flight Operation **(Air-Taxi UAM Service)** Note: ‘‘autoprogram’ used to indicate Autopilot-like system, flight segment, programming. Commanded by PIC to Vehicle as needed.	**Operation Requiring Comm**	**Source - Dest**	**Comm System Element(s)**	**Data Type Category** Reference Appendix A, Comm Elements for Category Details										
				1 Commands	**2** Telemetry DL	**3** ATC	**4** Nav Aids	**5** Surv. Data	**6** Surv. Data	**7** Weather	**8** Video DL	**9** Air Traffic	**10** Air	**11** Vehicle
1) Beginning at 5:30 am, four ‘Airlift’ personal transport vehicles at the Steelyard Commons (SYC) transport VTOL site are prepped and ready for departure to 4 different downtown, VTOL site passenger drop off locations. Transports leave at staggered 10 min intervals from each of the four AirLift pads.	N/A													
2) A PIC is assigned to the 7:45 am flight	N/A													
3) Vehicle Prep A – vehicle at Departure VTOL site														

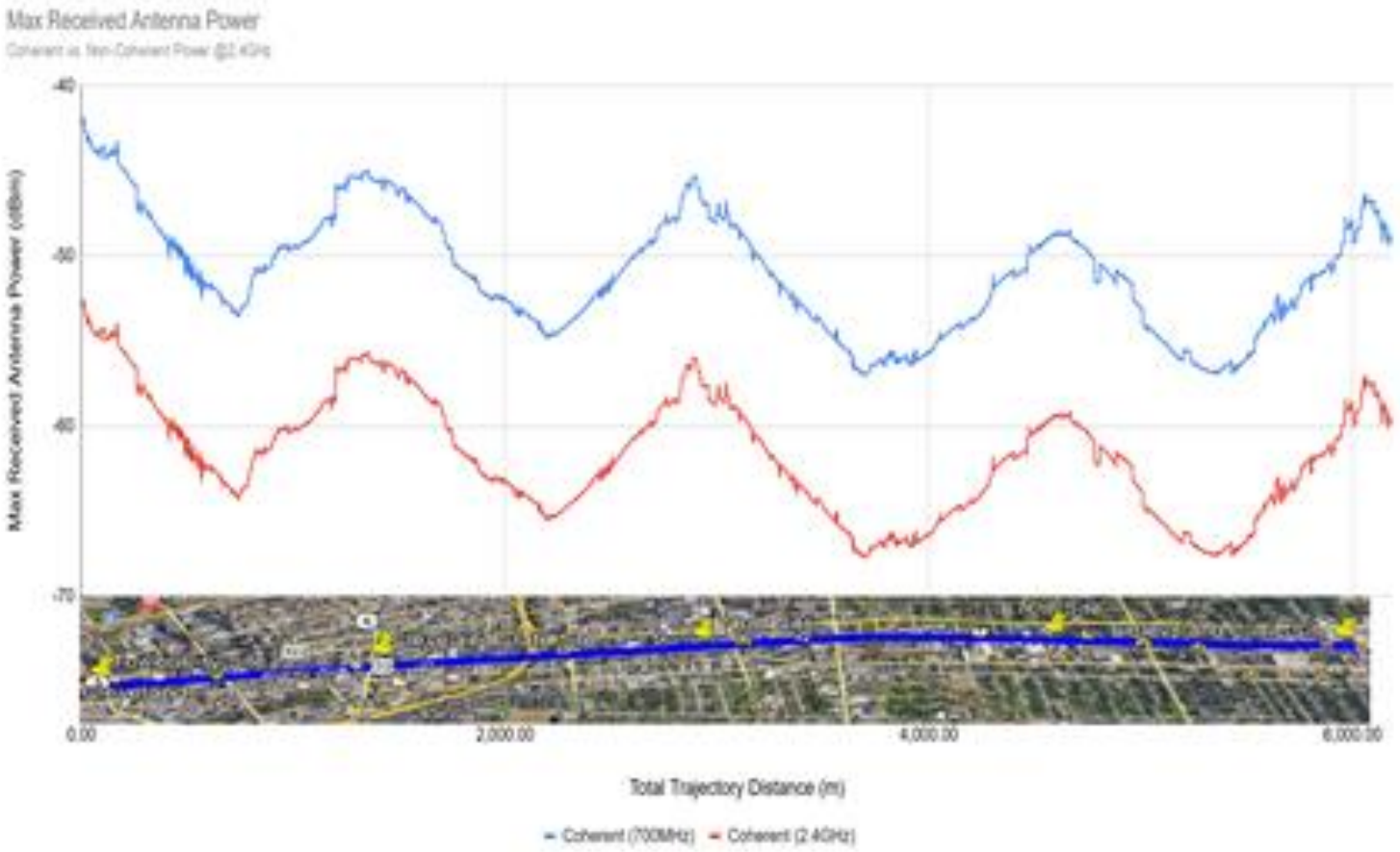
Portion of a Con Ops Use Case Table

Con Ops followed by

- UAM Wireless Communications Requirements Study
- UAM Technologies Criteria
- UAM Candidate Wireless Communications Technologies
- UAM Technology Assessment Study
- UAM Information Gaps Study
- UAM Information Stakeholders Study

Additional GRC UAM work (1)

- Communications simulations with urban models
- UAM vehicles operating at various altitudes in a designated urban corridor with C2 antennas located along the route
- Power and reception are being calculated to offer a first level numerical indication of wireless capabilities in an urban environment



Results from an Urban Communications Simulation

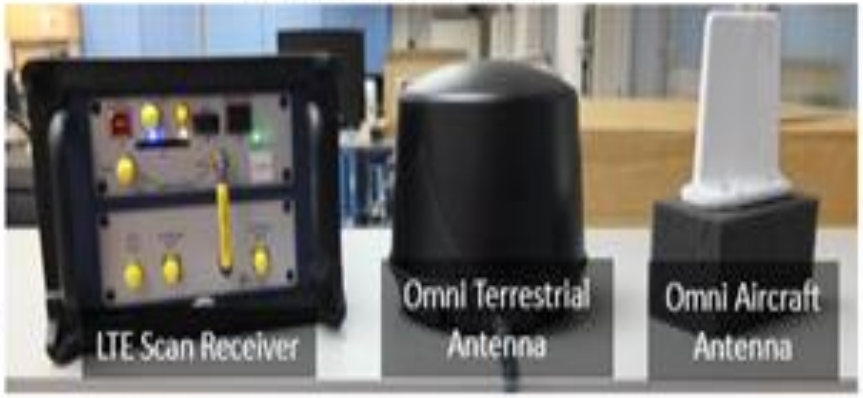
Additional GRC UAM Work (2)

- Testing of LTE communications
- "Ground truth" tests collected by a vehicle
- Measure signal availability for comparison with flight measurements
- Flight tests will measure signal availability at altitude

LTE Lab Bench



Main RF Components



LTE Lab Components



LTE Test Equipment



NASA GRC T34 Slated for LTE Flight Tests

QUESTIONS/COMMENTS?