CTIA Concepts for Testing Networked Cellular to Support Unmanned Aerial Systems

The UAS Integration Pilot Program, the NASA UTM tests (TCL3), the work of the Drone Advisory Committee, and other private research and testing all present good opportunities for CTIA UAS Working Group members (the "Working Group") to prove out the efficacy and advantages of using networked cellular for: (1) command / control links for UAS, including for operations at night and BVLOS; and (2) remote ID & tracking of UAS. The purpose of the below is to suggest common elements that Working Group members can test, measure and report when using networked cellular so that relatively uniform data can be reported back in a harmonized format to the FAA/DOT, the White House, NASA and the FCC about the advantages of using networked cellular to support UAS communications functions.

The following testing is suggested for using networked cellular for command/control and for remote ID and tracking of UAS:

Command / Control

As the majority of BVLOS UAS missions are expected to be in an autonomous mode, the "command" capability of the radio link is the main focus with the ability for "control" by a remote pilot in the event of emergency. Testing use of Networked Cellular to support "command/control" functions for small, low altitude UAS, including UAS Performance and Network Performance, should include the following:

- **UAS Performance**: In general, the reliability and availability needed to meet the UAS mission will depend on the CONOPS, but the following should be studied:
    - Received Signal Strengths (RSRP, RSRQ) -- What is the strength of the received signal at the drone:
        - at various altitudes (including on the ground – See DAC materials),
        - at various times of day,
        - over various topographies
        - in varying weather conditions
    - Handover Performance: Impact on the continuity of signal to the drone when handed off from one base station to the next
        - Handover rate
        - Time in handoff
        - Ping pong rate

- Quantify handover performance differences between ground and airborne drones

- For the link between the operator on the ground and the drone in the air, the above studies also will include evaluating latency in the link, packet error loss rate, drop outs (retainability), etc.

- Note that for the Integration Pilot Program, the SIR asks for study of the reliability, scalability, cybersecurity and redundancy of links, and mitigations that can minimize link failures. The ARC and DAC reports addressed these issues, acknowledging the viability of using networked cellular because of the reliability, scalability, cybersecurity and redundancy offered by the networks. Members can note the findings of those reports and that further testing will serve as a proving ground for what is contained in those two reports.

- **Network Performance**:
  - UAS Uplink interference in the network - Impact of uplink power control design on network interference to inform design for capacity (informs UAS business plan)

  - Network identification of airborne UAS versus terrestrial users

  - QoS and Mission Critical feature evaluation in serving an emergency situation whereby "control" of drone is required by remote pilot.

- Since Networked Cellular is based on international industry-based standards, members should ensure that testing is in concert with the work of 3GPP, an organization that is working on standards for using Networked Cellular to support drone communications functions.

Remote ID & Tracking

Testing use of Networked Cellular to support remote identification and tracking of small, low altitude UAS, should include the following testing:

- Testing of remote ID and tracking in Tier 1 and Tier 2 scenarios, as identified in the ARC Recommendations Final Report, September 30, 2017:
  - Tier 1 operations include most operations conducted under Part 107 regulations.

    - Tier 2 operations include "waivered operations" that deviate from Part 107, including BVLOS operations, operations above 400 feet and operations over unprotected persons.

- Testing of Tier 1 and Tier 2 operations will include using networked cellular to receive and decode ID and tracking data, and publishing the information to a database.

- Using Networked Cellular in combination with SIM cards and SSL/TLS certificates to validate UAV location information.

- Using Networked Cellular to provide unique IDs for UAS in the pilot program

- Providing an interface to a database that will house UAS ID and tracking information, and testing out special access and permissions to the database.

- Performance difference between TCP versus UDP

Other Testing: Data requirements -- What are the data needs of the drone for different purposes

- Command data
- Video transmission data
- Remote ID and tracking
- Sensor Data

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