

COE CST Sixth Annual Technical Meeting

**Task 306: UAT ADS-B Research and Demonstration for Commercial Space Applications:
Progress Report**

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***October 11, 2016
Las Cruces, NM***



**Center of Excellence for
Commercial Space Transportation**



Agenda

- Team Members
- Project Overview
- Current and Near-Term Activities
- Maturation plan and follow-on research plans

Team Members

- **People**

- Principal Investigators: Richard S. Stansbury; Nick Demidovich
- Students: Brandon Neugebauer, Richard P. Day, Yosvany Alonso, Dyland Rudolph, and Dominic Tournour, Kelsey Klein, Andrew "Jack" Strange
- Other faculty: William C. Barott, Massood Towhidnejad
- Other FAA:, Chuck Greenlow, John Dinofrio, Dan Lovelace, Tammy Will son

- **Organizations**

- Terminal Velocity Aerospace, LLC.
- NASA Flight Opportunities Program
 - Up Aerospace
 - Near Space Corporation
- MITRE



Goals

- Enhance tracking of vehicles as they traverse through the national airspace system to mitigate the impact of commercial space operations on routine aviation operations by leveraging existing FAA infrastructure
- Sub-goals:
 - Determine suitability for ADS-B for commercial space
 - Determine boundary conditions of system performance
 - Assess performance of prototypes on space vehicles and suitable analogues
 - Identify areas of improvement in ADS-B standard to accommodate ADS-B operations for commercial space
 - Provide stakeholders with information regarding suitability of ADS-B as a primary or secondary tracking source

MITRE UBR-TX

- UAT Beacon Radio – Transmit Only (UBR-TX)
 - Broadcasts state vector once per second
 - Supports both barometric and GPS-based altitudes
- Balloon / Rocket Flight Tests
 - 2008 Red Glare V (amateur rocket)
 - 2009 Red Glare VII (amateur rocket)
 - 2010 AFRL research balloon
 - 2010 NASA Wallops sounding rocket
 - 2012 Up Aerospace Spaceloft 6
 - 2012 Team America Rocket Challenge
 - 2013 Up Aerospace Spaceloft 7
 - 2013 Masten Xombie



MITRE[®]
TECHNOLOGY APPLIED



Past Flights:

- NSC Nano Balloon System
- NSC High Altitude Shuttle System
- Up Aerospace SpaceLoft-8
- NSC Small Balloon System w/ TVA Spacecraft

Maximum Altitude: 349,700 ft (SL-8)

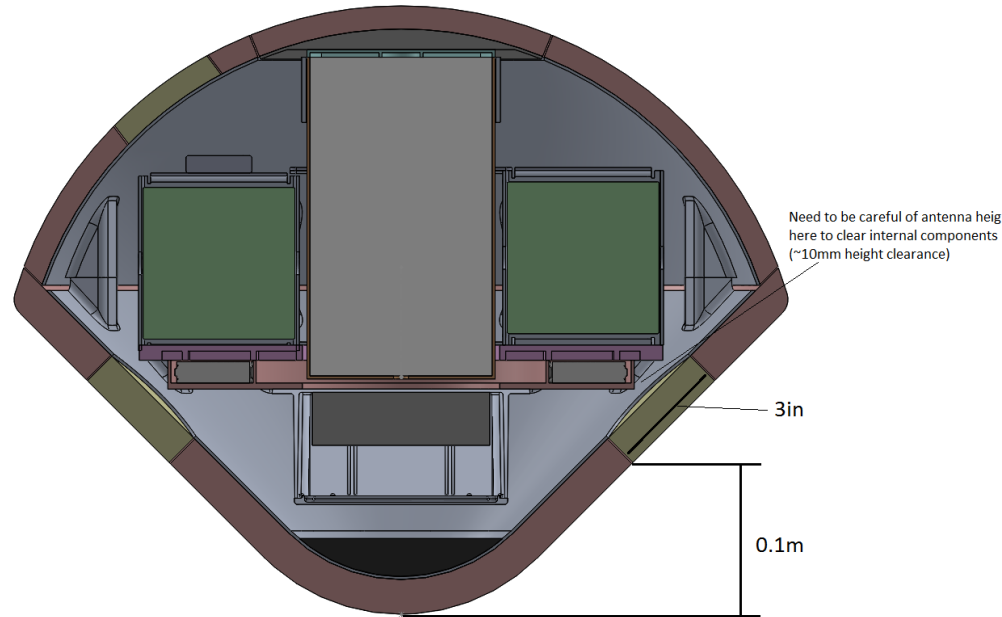
Parameter	Specification
Length	5.75" (14.6 cm)
Width	2.5" (6.35 cm)
Height	2.5" (6.35 cm)
Weight (UBR board, daughter board, GPS, battery, and enclosure)	790 g (27.9 oz)
Weight (cables, antennas, etc.)	85-300g est.
Nominal power Consumption	840mA @ 3VDC
Nominal battery capacity	7.75 Ah

**UBR-ERAU Advanced
ADS-B Transmitter
for sRLVs**

**Upgraded firmware and
GPS hardware**

Terminal Velocity Aerospace

- Integration of Advanced ADS-B Unit onboard prototype reentry vehicle
- Funded by NASA Ames
- Goals:
 - Evaluate performance of ADS-B broadcasting through experimental TPS material
 - Demonstration of UBR on new vehicle type



Terminal Velocity Aerospace Reentry Vehicle

Drop from stratospheric balloon



Technology maturation plan

- Project goal to demonstrate viability and test functional envelope of experimental ADS-B payload for sub-orbital commercial space operations
 - TRL-7, proven within its operational environment
- Additional flights needed before transition to TRL-8 (i.e. move out of prototype phase)
- Diversity of new vehicles is desirable to get operator feedback
- Exploring modified message formats with flight damaged equipment (from TVA landing) in lab research to address issues with current ADS-B message standards
 - no message type for space vehicle yet developed / approved.
- Daughterboard demonstrated ability to provide processed GPS data to vehicle at 1 HZ with TVA vehicle; exploring increasing update rate

Near-term Future Commercial Space Flights with Experimental ADS-B Payloads

- Near Space Corporation's High Altitude Shuttle System
 - Surrogate winged suborbital vehicle performing a descent into NAS (from above 60, 000 feet) – ASAP
 - HASS descended from 70Kft w/1090 MHz ADS-B in September; will incorporate lessons learned for ERAU
- SL-11 reflight with GPS through boost phase (16Gs for 12 seconds with FOP – Spring 2017

First time to pull high-g's with live data

- Mars Flyer (NASA vehicle from balloon >120Kft – 2Q CY2017
- SL-12 mixed airspace demo with UAS TBD
- Pursuing Blue Origin flight (now a NASA FOP vendor)
- Large amateur rocket to >100 miles in consideration
- Virgin Galactic SpaceShip 2 (TBD) via NASA FOP



Source: Near Space Corporation



Planned Future Commercial Space Flights with Experimental ADS-B Payloads

- Expendable Launch Vehicle
 - Currently in planning stages for first stage; preliminary discussions held
 - fly back booster
 - expendable
- Cubesat or International Space Station
 - Investigating emerging opportunities for cubesat integration
 - Preliminary discussions held for ISS flights
 - Proof of concept for on-orbit application



Source: Near Space Corporation

Questions?



Image courtesy of UpAerospace Inc.

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