6 Flights +1(SOAREX8) +PhoneSats 1-4

SOAREX/TechEdSat-N Team
Relevant Flight Experiments PhoneSat

Recent Years of Flight Experiments (2009-2015)

- **Intimidator-5**: July 29, 2010
- **Balloon**: June 9, 2011
- **SpaceLoft-6**: Apr 5, 2012
- **PhoneSat 1a, 1b, 2.0 Antares A-ONE**: Apr 21, 2013

PhoneSat Team

- **PhoneSat 2.4 ORS-3 Minotaur 1**: Nov 20, 2013 (still in orbit)
- **PhoneSat 2.5 CRS-3 Falcon 9**: Apr 18, 2014

- **EDSN Super Strypi**: Oct 29, 2015
- **Nodes Orb-4 Atlas V**: Dec 3, 2015
- **SOAREX-8 Terrier/Black Brant**: July 7, 2015
- **SOAREX-9 (WFF)**: March 3, 2016
Status of Analysis TES-3 and TES-4

TES-3/TES-4 Flight Test Data

*Active work in progress to refine models based on flight data – including uncertainty analyses (F10.7; geometric variables)
TechEdSat-4

- Improved Cartridge Design (Ease of integration/test)
- Teflon Nosecap
- Iridium/GPS Antenna (Improved location; TES-3p)
- COM/CNTR Boards (Improved)
- Extruded Structure Design (TES-3p)
- Solar Panels, PWR Board (Improved)
- RBF Pin (TES-3p)
- Canon BP930
- ISS-supplied x2 (TES-3p used 1)
- Aft-Cover (TES-3p)
- Exo-Brake and Deployment System (TES-3p)

- 1st NASA NanoSatellite 3U Jettisoned from the NRCSD (July 2014)
- Exo-Brake Demonstration
  - $\beta=8$ kg/m^2
- Advanced Manufacturing
- COM Experiment III + GPS
- Two-tier Architecture
T5/P5 Flight System Architecture and Dataflow

Ground Segment

- Sensor Data Display and Analysis Applications
- Iridium Data Distribution Server
- Sensor data stream as e-mail
- USB Video Stream WSN data
- Iridium Network

Space Segment

- T5/P5 Avionics
- POWER Board
- Iridium-1 Transceiver
- Iridium-3 Transceiver
- P5 Board WiFi CAM Zigbee sniffer
- 2.4 GHz High-Rate Downlink
- Camera1 Camera2
- Iridium-1 Transceiver
- 802.15.4
- Pressure Temp IMU

Monitoring and Analysis Applications

- Sensor Data Display and WSN Status Display

ISM-band Ground Station

Wireless Sensor Module (WSM Gen-2)

Iridium Messaging

ISM

PWR Subsystem Solar Panels 8.4 V Batteries

Door and Panel Actuators

Winch

Ground Segment

- T5/P5 Flight System Architecture and Dataflow

Iridium-1 Transceiver

Iridium-3 Transceiver

P5 Board WiFi CAM Zigbee sniffer

Camera1 Camera2

Iridium-1 Transceiver

802.15.4

Pressure Temp IMU

Wireless Sensor Module (WSM Gen-2)
TES-5 Science/Mission Objectives

- Establish improved uncertainty analysis for eventual controlled flight through the Thermosphere (perform detailed comparison to the TES-3 and TES-4 with respect to key Thermosphere variable uncertainty).

- Improve prediction of re-entry location.

- Provide the base technology for sample return technology from orbital platforms.

- Provide the eventual testing of independent TDRV-based planetary missions

- Provide engineering data for an On-Orbit Tracking Device that could improve the prediction of jettisoned material from the ISS (per discussions with the TOPO group).

TES-5/P-5 Flight Unit (READY to Integrate)
## Frequency Coordination

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- for NASA internal use
De-Orbit/Targeting Interest…

Sample Return/Re-entry Targeting
With Modulated Exo-Brale:
Validation – it WORKS!

Application to larger payloads

S. Dutta, A. Cianciolo, R. Powell, (LaRC)
What is Next?

ISS Sample Return

SPQR-Small Payload Quick Return
- 3 stage concept
- On-demand sample return
- COM IV experiment
- EDL test platform

Atromos: Nano-sat Mission to the Surface of Mars
- Mission Attributes – local climatology and surface characterization of areas not accessible to large missions (most of Mars!)
- Self-stabilizing re-entry probe (TDRV-Tube Deployed Re-Entry Vehicle)
- EDL Technique for small probes
- Dual probe demonstration 2018-2020
Summary

• TES-N/Phone-N series has helped to train ~40 individual now at NASA, SpaceX, Boeing, Lockheed and …Start-ups!

• Several ‘Firsts’ for ISS-deployed experiments

• Numerous Technologies Advanced
  • COM [LOW data rate up/downlink – Iridium; MEDIUM and HIGH data rate]
    ✓ Commanding the nanosat via EMAIL
  • Fabrication
  • De-Orbit Systems (Exo-Brake – MODULATED!)
  • Evolving 2-tier Architecture
    ✓ Arduino/Intel-Edison-Linux based platforms

• Pioneered Safety Processes for ISS Satellite Jettison

• Future Work leads to ISS Sample Return, Advance Re-entry Development ….. And Mars!