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

SOAREX/TechEdSat-N Team
Recent Years of Flight Experiments (2009-2015)

PhoneSat Team

Relevant Flight Experiments PhoneSat

- **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 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)
- for NASA internal use

1st NASA NanoSatellite 3U Jettisoned from the NRCSD (July 2014)

- Exo-Brake Demonstration
  - $\beta=8\text{kg/m}^2$

- Advanced Manufacturing
- COM Experiment III + GPS
- Two-tier Architecture
The image illustrates the T5/P5 Flight System Architecture and Dataflow. The diagram is divided into Ground Segment and Space Segment.

**Ground Segment**
- Sensor Display and Analysis Applications
- Iridium Data Distribution Server
- Iridium Network
- ISM-band Ground Station
- USB Video Stream WSN data
- Sensor data stream As e-mail

**Space Segment**
- T5/P5 Avionics
- POWER Board
- Crayfish GPS/COMM
- P5 Board WiFi CAM Zigbee sniffer
- Pressure Temp IMU
- 802.15.4
- XBe WSM
- Wireless Sensor Module (WSM Gen-2)
- Door and Panel Actuators Winch
- 2.4 GHz High-Rate Downlink
- Camera1 Camera2

Key components include:
- Iridium-1 Transceiver
- Iridium-3 Transceiver
- PWR Subsystem Solar Panels 8.4 V Batteries

The diagram highlights the flow of data and communication between the ground and space segments, showcasing the integration of sensor data display, WSN status display, power subsystem, and various transceivers and networks.
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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<th>TES-1</th>
<th>TES-2</th>
<th>TES-3p</th>
<th>TES-4</th>
<th>SOARE X-8</th>
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</tr>
</tbody>
</table>

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

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

S. Dutta, A. Cianciolo, R. Powell, (LaRC)

Application to larger payloads
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!