NanoSat Deorbit and Recovery System (DRS) to Enable New Missions

Small Sat 2011
Introduction

• Andrews Space, Inc. founded in 1999

• **Mission Statement:** *Andrews will be a catalyst in the development, exploration, and commercialization of emerging space markets by providing innovative, entrepreneurial aerospace solutions to our commercial, civil, and military customers.*

• **Background:** Andrews has been developing aerobraking and entry descent and landing technologies to support a range of emerging markets.
NanoSat De-Orbit and Recovery System (DRS) Overview

**Design Objectives**

- Mass and Volume Efficient - < 1U and <1.5 kg
- Standard CubeSat Interface - easily interfaces with current CubeSats and spec
- High Performance at Low Cost - leverages COTS components with custom decelerator
- Modular Design - system can be used for De-Orbit or Recovery Missions
- Self Contained Design - requires only a deployment signal from s/c and does not interfere with satellite components or operation

**Payload Recovery from Orbit**

Recovery system provides survivable entry environment for CubeSat payloads.

**Expedient Satellite De-Orbit**

Provides means for CubeSat end-of-life deorbit in months instead of years.
Design Ref. Mission 1 – Expedient Satellite De-Orbit

- **CONOPS**
  - The de-orbit system is deployed for aerobraking
    - Decreases orbit altitude aerodynamically

- **Benefits**
  - Approach reduces the CubeSat orbital lifetime by a factor of 10 and/or saves potentially over 100 m/s of on-board propulsion.

A 3U CubeSat at 400km orbit altitude nominally takes 2 years to re-enter. With the CubeSat De-Orbit System deployed, it takes only 2.5 months and is equivalent to 100 m/s of delta-V.
Design Ref. Mission 2 – Payload Recovery from Orbit

- **CONOPS**
  - Spacecraft spins up and modest de-orbit burn is initiated
  - Re-entry aeroshell is inflated on orbit and re-enters the spacecraft
  - Re-entry system protects payload from heating during entry
  - DRS transmits position via satellite during entry/landing
  - Impact attenuation structure absorbs landing loads

- **Benefits**
  - Collected samples / spacecraft components are safely recovered for further analysis
  - Enables an inexpensive Corona-style missions to transfer terabytes of data

Analysis shows that the DRS can land payloads in <100km landing ellipse with course pointing and ~100 m/s de-orbit delta-V. Much smaller landing footprints can be obtained with knowledge of upper atmosphere.
**System Trades**

- Andrews evaluated multiple DRS configurations before selecting tension cone design

![Tension Cone](image)
![Pressure-stabilized cone](image)

![Isotensoid Ballute](image)

![Graph](image)
De-Orbit and Recovery System Configuration

1U De-Orbit and Recovery System for 3U Spacecraft
DRS Deployment Operations

STOWED ➡️ DEPLOYED
Development Status (1/2)

System Design

- Requirements & FOMs
- Aero & Stability Analysis
- Aerothermal Analysis
- Monte Carlo Trajectory Analysis
- System Sizing
- System Trades

Detailed Design

- Structure / Deployment Mechanism
- Payload Interface / Crushable Structure
- Inflation System
- Power System
- Decelerator

Material Test and Evaluation

- Material Rqmt Derivation and Selection
- Seam Tensile Tests
- Burst Pressure Tests
- Packaging
- Proof of Concept Model
Development Status (2/2)

EDU Fabrication

- Manufacturing Plan
- Mechanical components
- Fabric and Coating
- Inflation Tubes
- Deployable Cone
- Integration

System Testing

- Subsystem tests
- Wall Deployment
- Cone Deployment
- Decelerator Packing
Next Steps - Demonstration Spacecraft

- Andrews currently working to develop a demonstration 3U CubeSat for a suborbital or orbital re-entry test flight.
## DRS Will Enable New Missions

- Enable the recovery of nanospacecraft to enable new missions and space commerce

### DRS Capabilities

<table>
<thead>
<tr>
<th>ORBITAL</th>
<th>SUBORBITAL</th>
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</thead>
<tbody>
<tr>
<td>LEO</td>
<td>30-100 km</td>
</tr>
<tr>
<td>GTO / GSO</td>
<td>100+ km</td>
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<td>Deployed Small / Secondary Payloads</td>
<td>Sounding Rockets</td>
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<td>Hosted Payloads on Free Flyers</td>
<td>Reusable Suborbital Vehicles</td>
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<td>Payloads to GSO / LLO using SHERPA</td>
<td>Payload Recovery</td>
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<td>DragonLab Hosted Payloads</td>
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**NOTES:**
- LEO: Low Earth Orbit
- GTO / GSO: Geostationary Transfer Orbit / Geostationary Orbit
- GSO / LLO: Geostationary Orbit / Low Lunar Orbit
- SHERPA: Space Habitat for Exploration and Research Platform Assembly

**ANDREWS SPACE**