Perspectives on Integrating SmallSats into the DoD

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Small Satellite Portfolio
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Portfolio Objectives

• Objective 1: Determine how SmallSats can meet Air Force objectives (1kg-50kg)

• Objective 2: Workforce Development

Objectives will be met through:
• research performed at AFRL
• partnerships between AFRL and other government labs, industry, and academia
• 2+ Cubesats per year

1U (10cm x 10cm)  
3U  
6U  
6U
A History of Small Satellite Missions

Launch Date

1990 8yrs 1998 7yrs 2005 6yrs 2011 5yrs 2016 1yrs 2017 1yrs 2018

TacSat-2
370 kg
Tactical Imager
Missile Warning

MSTI-1
168 kg
MDA sponsored

MSTI-2
170 kg

MSTI-3
210 kg

MSTI-4

Warfighter-1
355 kg
Hyperspectral

TacSat-2
370 kg

TacSat-3
400 kg
Hyperspectral

ANGELS
120 kg
GEO SSA

NFIRE
Missile Warning

XSS-10
28 kg

XSS-11
100 kg

C/NOFS
395 kg

DSX
1200 kg

Research Remediation after Space Nukes

EAGLE
1000 kg

8 more CubeSats in 2019

Launch Failure

Warfighter-1
Inspectors
Launch Failure

MightySat-1
64 kg
Spacecraft Technology

MightySat-2
120 kg

Hyper-Spectral

3 CornerSat
50 kg

FASTRAC
50 kg

GEARRS 1 & 2
5 kg

CELTEE
1 kg

ARMADILLO
6 kg

ASCENT
14 kg

Prox-1
60 kg

VPM
8 kg

Oculus-ASR
75 kg

U2U
5 kg

DANDE
5 kg

SHARC
8 kg

CUSat
50 kg

DoD Space Test Program sponsorship
NRO Launch Sponsorship
SmallSat Portfolio

AFRL Missions

Small Satellite Portfolio
~<50kg

Community Interactions
- Studies
- Collaborations with other agencies

Missions
- In-House
- Industry

Parts Database
- Academia
  - STEM
  - Science and Technology Demonstrations

Large Satellite Missions
~>50kg
Critical augmentation for the AFRL Demonstration and Science Experiment (DSX) satellite
Answers key DSX physics: Can we transmit VLF across the space plasma sheath into the far-field.
Sensors to observe precipitating energetic particles induced by DSX
Satellite for High Accuracy Radar Calibration
Science/Technology Demonstration

• Demonstrate the capability to perform critical calibration of over 120 Tri-Service C-Band radars.
• Calibration is needed to meet tracking requirements of orbital objects
• Demonstrate low latency delivery of data (min vs days)
Globalstar Experiment And Risk Reduction: Rapid Technology Demonstration

- **Challenge:** Can we use commercial comm to operate AF spacecraft?  
  Potential lower cost than current AFSCN  
  60% global coverage for duplex
- **Experiment:** Characterize the Globalstar network for LEO spacecraft comm for both the Duplex and Simplex radios
Categories of Utility

Category 1: New Capabilities
- Constellations, servicing, ...

Category 2: Augmentation of current missions
- Gap filling, calibration, ...

Category 3: Rapid Technology and Science Demonstrations
- Prototyping, TRL increasing, proof-of-concept, ...

Category 4: Workforce Development
- Universities, National Labs, FFRDCs, ...

Status

Limited use
- Barely started

Moderate implementation
- Substantial, but could do more

Perspectives of CubeSat Utility: An Air Force Example

CubeSat Platform
Classes of CubeSats

- Need to integrate CubeSats into technology development roadmaps and science investigation roadmaps
  - STTRs, SBIRS
  - NAS Study: “Fly, Learn, Fly”
- SmallSats greatly increases the “dynamic range” of tools available to space architects
"New Space" needs to be more than just risk-tolerant missions, but an integration of missions of various risk postures together to meet agency needs.
USG Working to Leverage the SmallSat Platform

• There are a lot of conversations between USG agencies on how to appropriately leverage this platform
  – Large ships don’t turn instantly
  – Good representation of SmallSat-minded folks in these discussions

• There is a sincere desire to leverage the SmallSat platform without breaking what makes this platform attractive
  – Challenges include: technical, programmatic, cultural, …
  – This is a dynamic time where there will be lessons learned in implementation

• Many USG missions require a higher mission assurance
  – Still have a long way to quantify small satellite reliability
  – Architectural reliability is an exciting new capability, but work needs to be done to better understand constellation reliability

NASA hosted a Multi-Agency TIM in June to look at areas of overlap with investing in Small Satellites. More details to come at Thursday afternoon session. (POC: Dr. Merri Sanchez AFSPC, Ms. Faith Chandler NASA HQ)
Integrated Space

- We see small satellites working well with current trends toward enhancing mission assurance to DoD missions
  - Space Enterprise Vision
  - 3rd Offset
- Small Satellites provide the ability to system architects to enhance the “dynamic range” of platforms available to meet mission needs
- We need to understand how to mix cross-platform missions in a reliable method
Backup
The SmallSat Trade Space

Extension of the AI&T floor in space

Research Mission Attributes
- Mixed timeline
- Scaled mission assurance
- Multiple launch platforms
- Large Cost Range

Operational Mission Attributes
- High reliability
- Longer timelines
- DoD launches (dedicated)
What do CubeSats Really Cost?

<table>
<thead>
<tr>
<th>Capability</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td>VPM</td>
<td>$100k</td>
</tr>
<tr>
<td>Biarri</td>
<td>$1M</td>
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<td>SHARC</td>
<td>$1B</td>
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**Actual AFRL Missions**
(total cost: SV, Ground System, OPS)
(Shown on log scale to emphasize small satellite tradespace)

**Launch**
- Significant amount of low-cost access to space today
- Key challenge was dispensers/adapters (several)
- Integration costs is key cost for CubeSat launch