



Air Force Research Laboratory



Perspectives on Integrating SmallSats into the DoD

Integrity ★ Service ★ Excellence

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Small Satellite Portfolio
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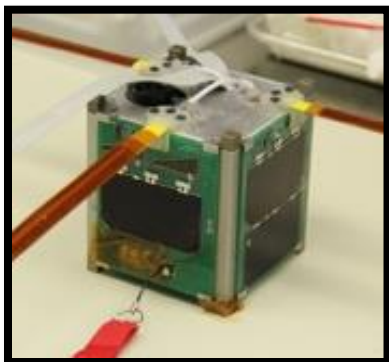


Portfolio Objectives

- **Objective 1: Determine how SmallSats can meet Air Force objectives (1kg-50kg)**
- **Objective 2: Workforce Development**

Objectives will be met through:

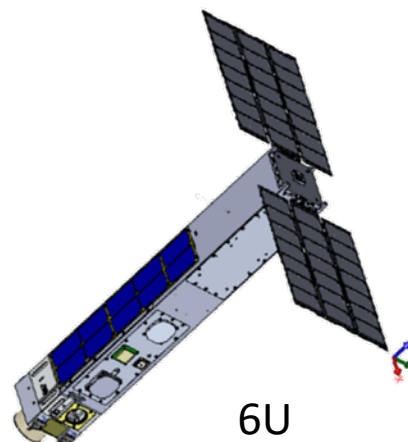
- research performed at AFRL
- partnerships between AFRL and other government labs, industry, and academia
- 2+ Cubesats per year



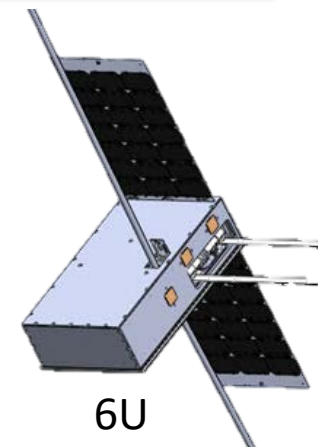
1U (10cm x 10cm)



3U



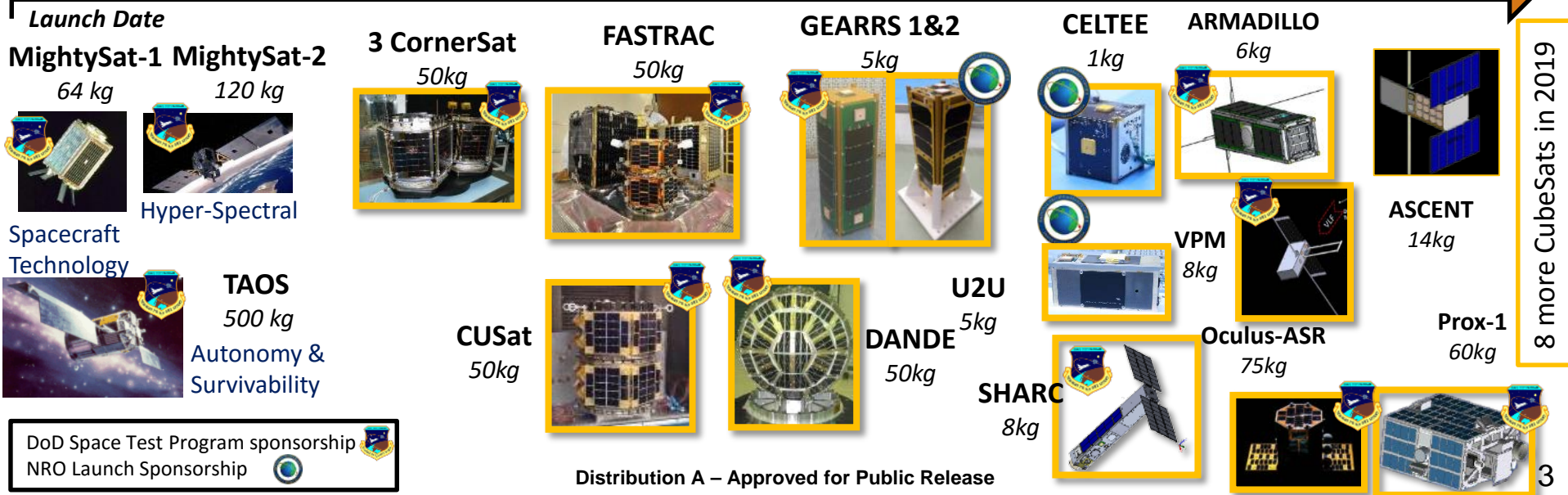
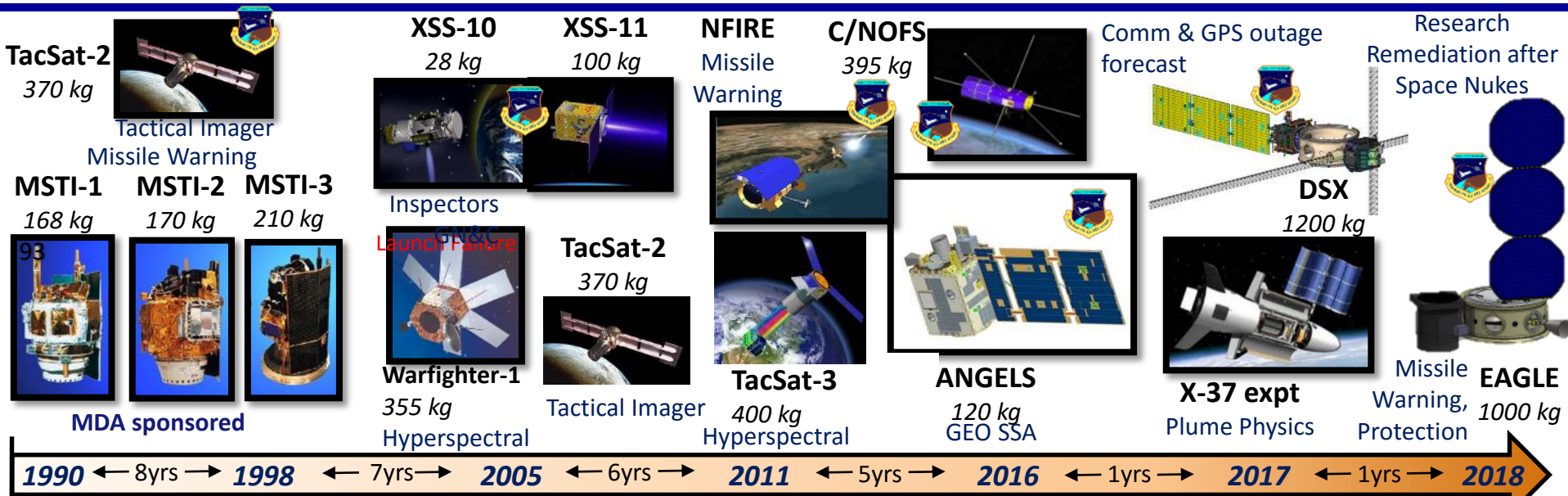
6U



6U



A History of Small Satellite Missions

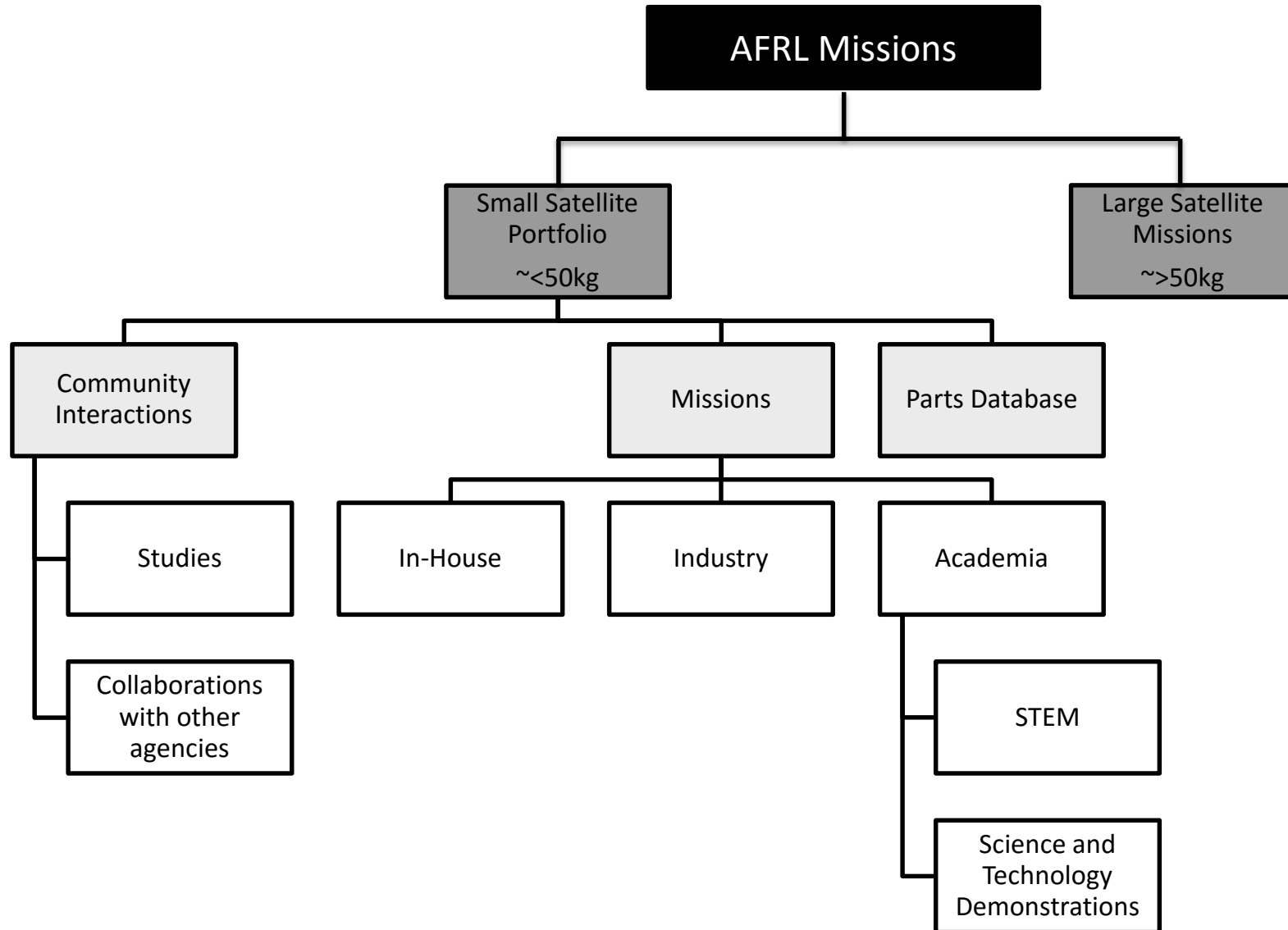


8 more CubeSats in 2019

DoD Space Test Program sponsorship
NRO Launch Sponsorship



SmallSat Portfolio

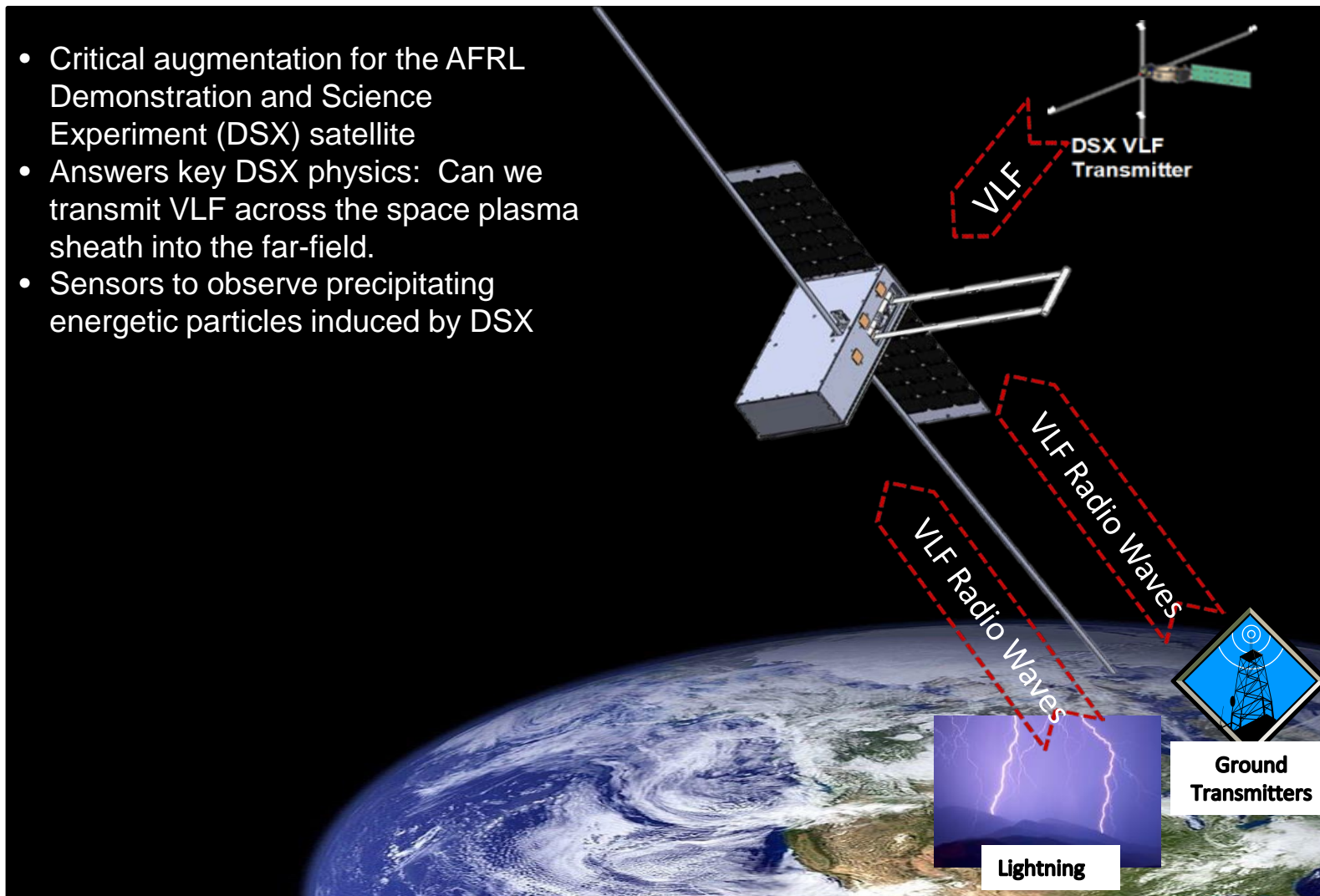




Very low frequency Particle Mapper (VPM) *Pursuing High Impact Science*



- 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



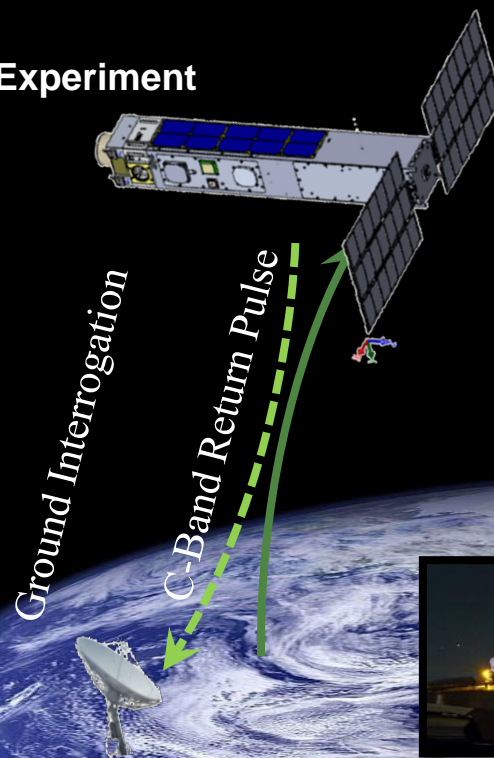


Satellite for High Accuracy Radar Calibration *Science/Technology Demonstration*

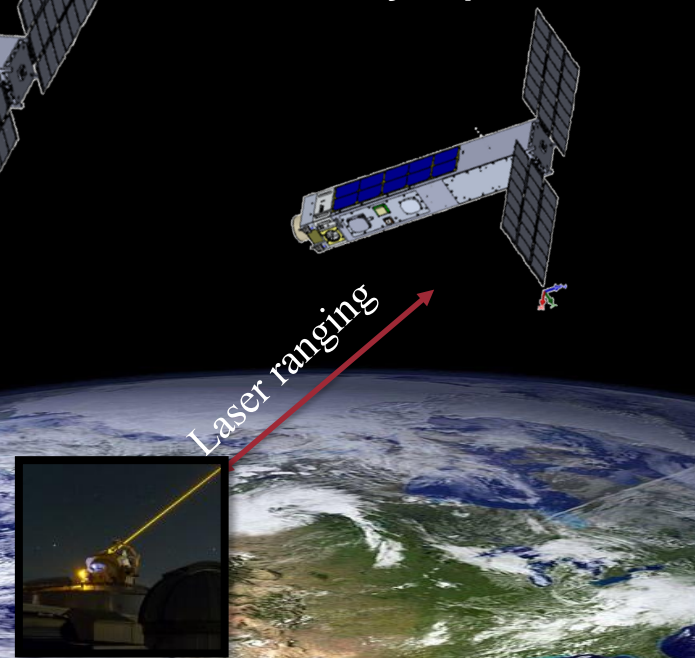


- Demonstrate the capability to perform critical calibration of over 120 Tri-Service C-Band radars.
- Calibration is needed to meet tracking requirements of orbital objects
- Demonstrate low latency delivery of data (min vs days)

Primary Experiment



Secondary Experiment



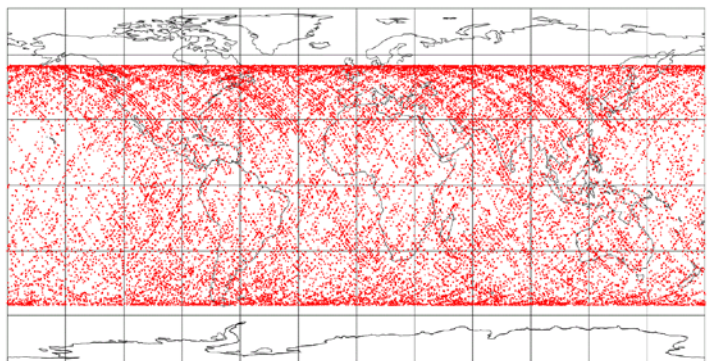


Globalstar Experiment And Risk Reduction: *Rapid Technology Demonstration*



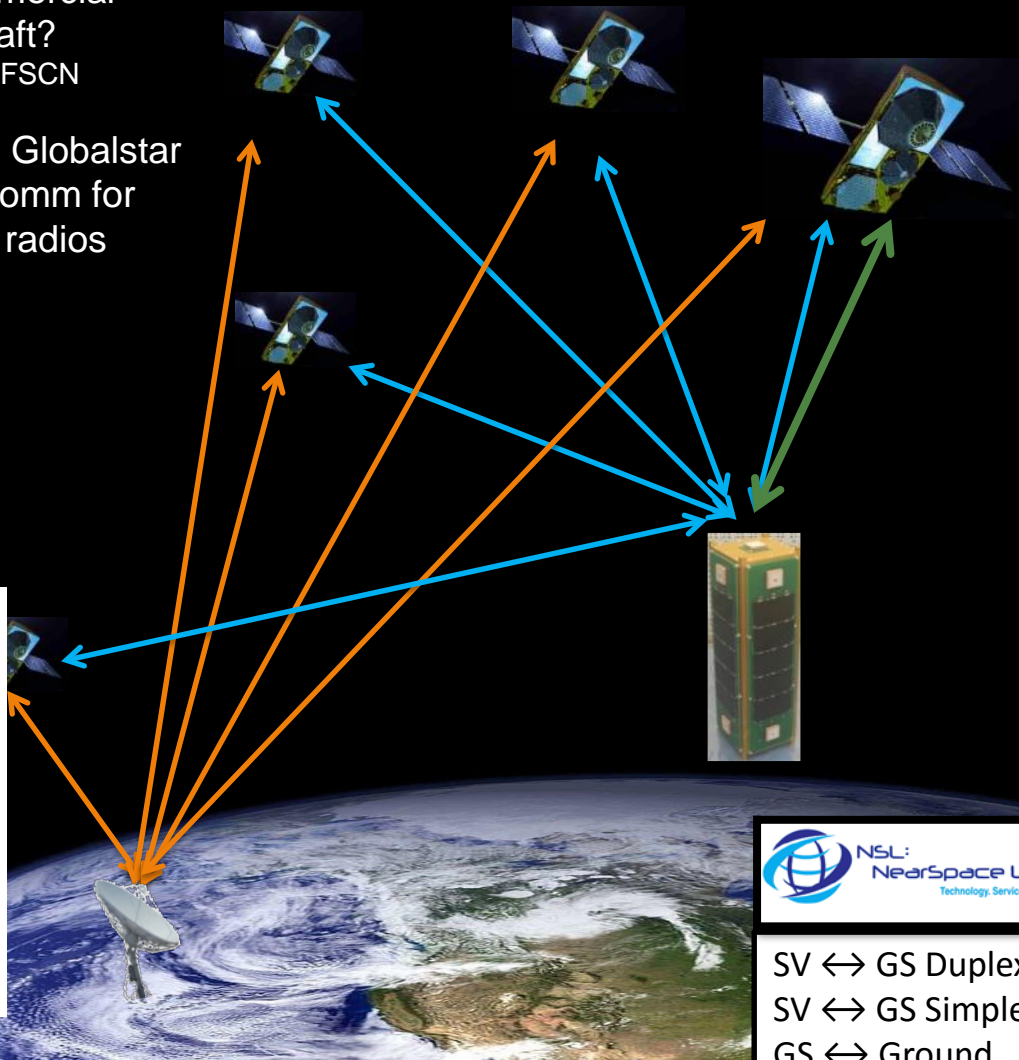
- Challenge: Can we use commercial comm to operate AF spacecraft?
Potential lower cost than current AFSCN
60% global coverage for duplex
- Experiment: Characterize the Globalstar network for LEO spacecraft comm for both the Duplex and Simplex radios

Location of GEARRS2 for Received B1 Data Packets (2015/05/20 to 2015/07/15)



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Points plotted: 20993 of 20993 using all available TLEs for 90724



NSL: NearSpace Launch Inc.
Technology. Service. Education

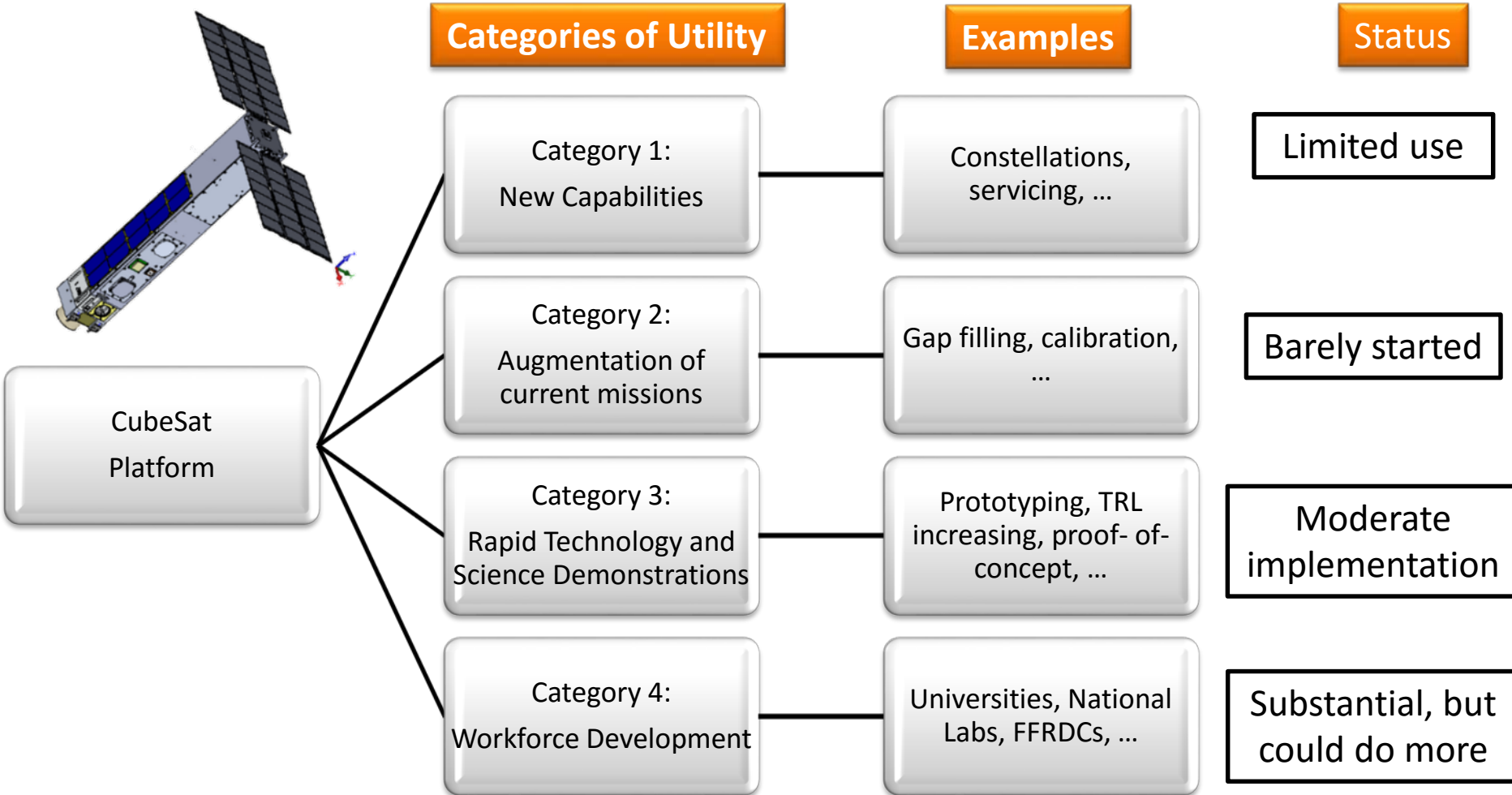
SV ↔ GS Duplex

SV ↔ GS Simplex

GS ↔ Ground

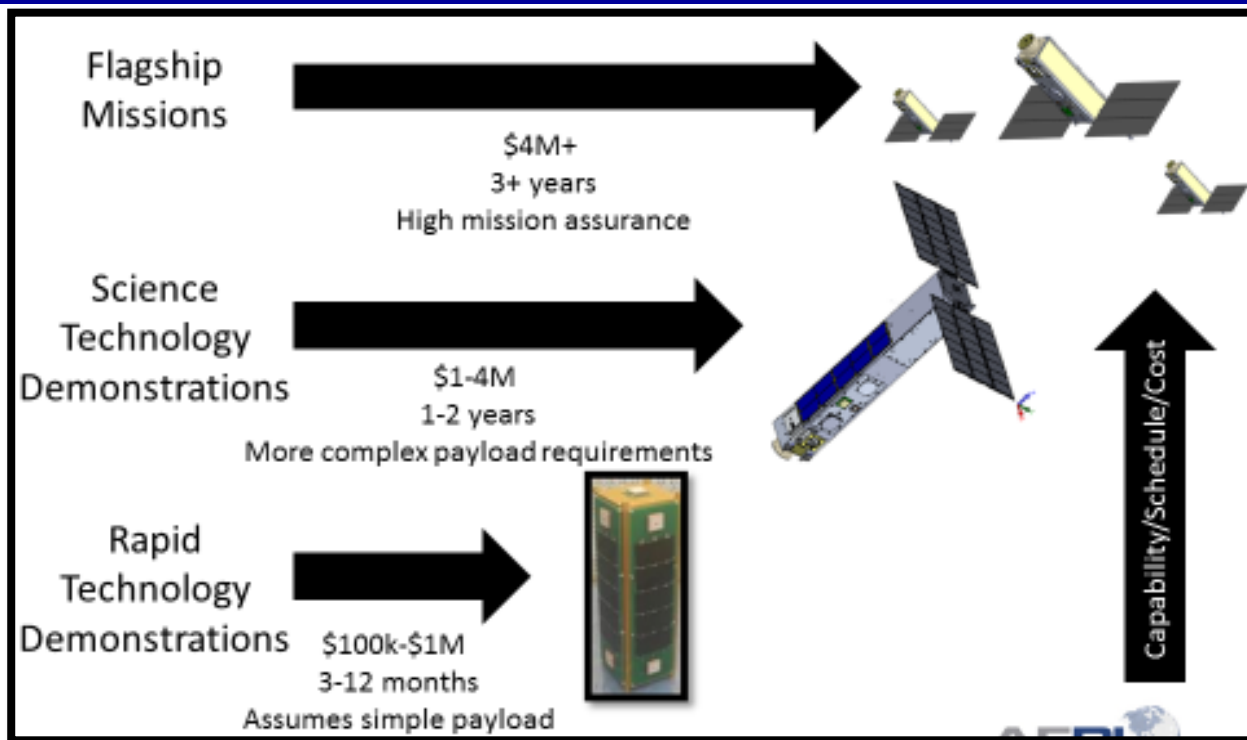


Perspectives of CubeSat Utility: An Air Force Example





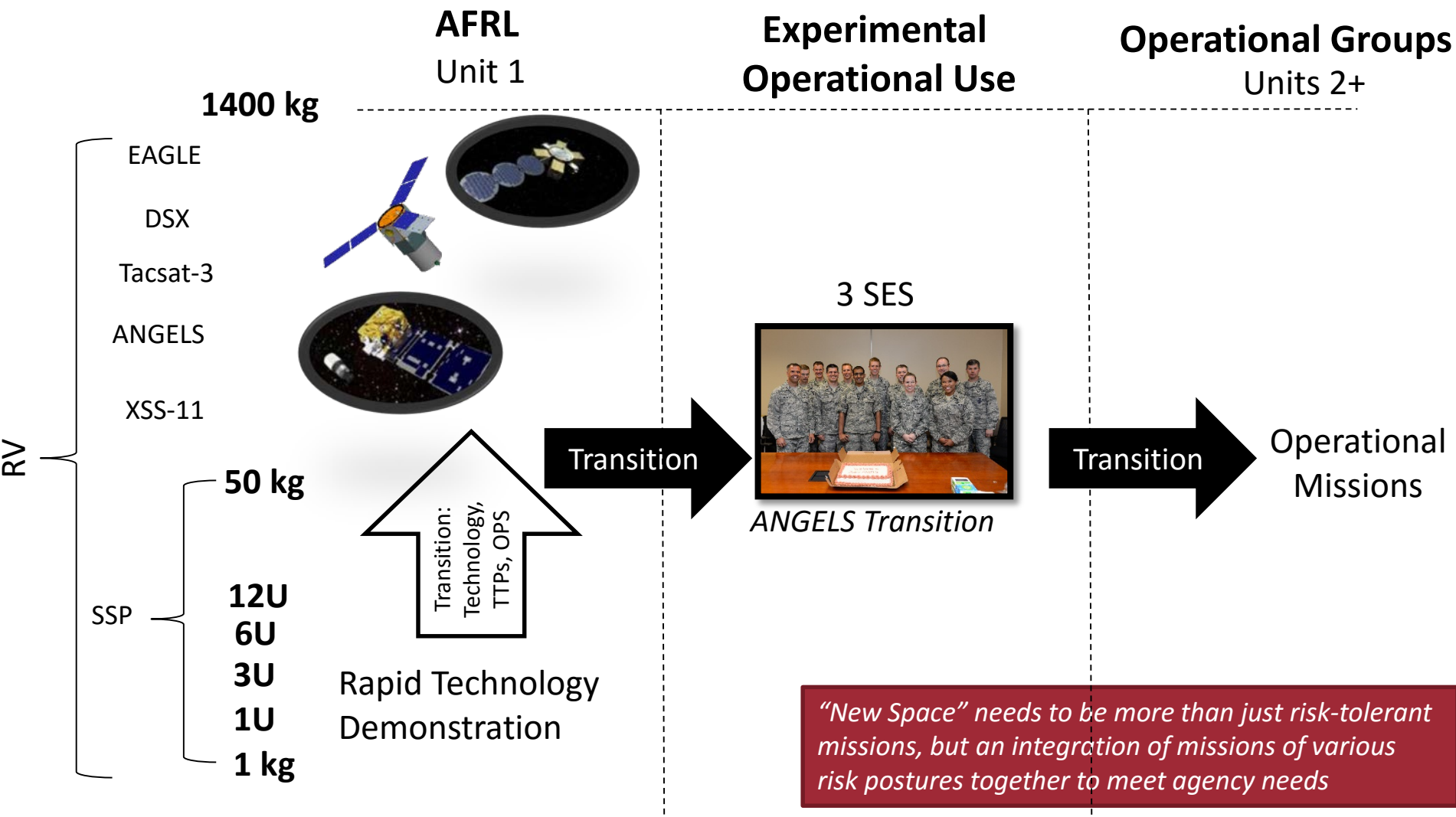
Classes of CubeSats



- **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**



Rapid Prototyping Example





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

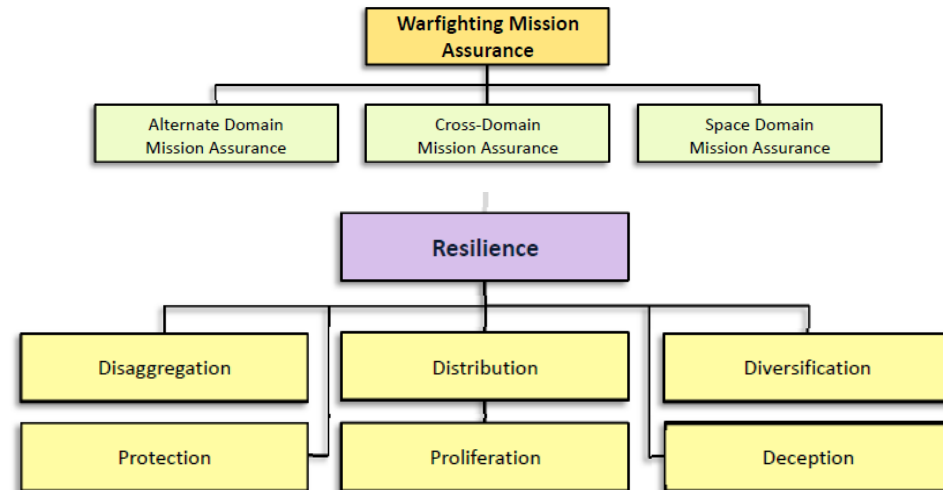
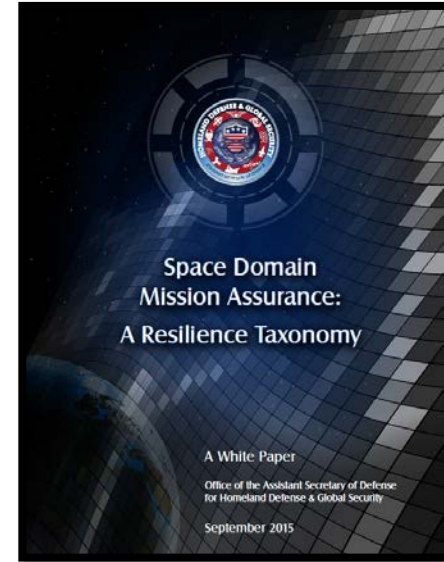
NASA hosted a Multi-Agency TIM in June to look at areas of overlap with investing in Small Satellites. More details to come at Thursday afternoon session.
(POC: Dr. Merri Sanchez AFSPC, Ms. Faith Chandler NASA HQ)



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





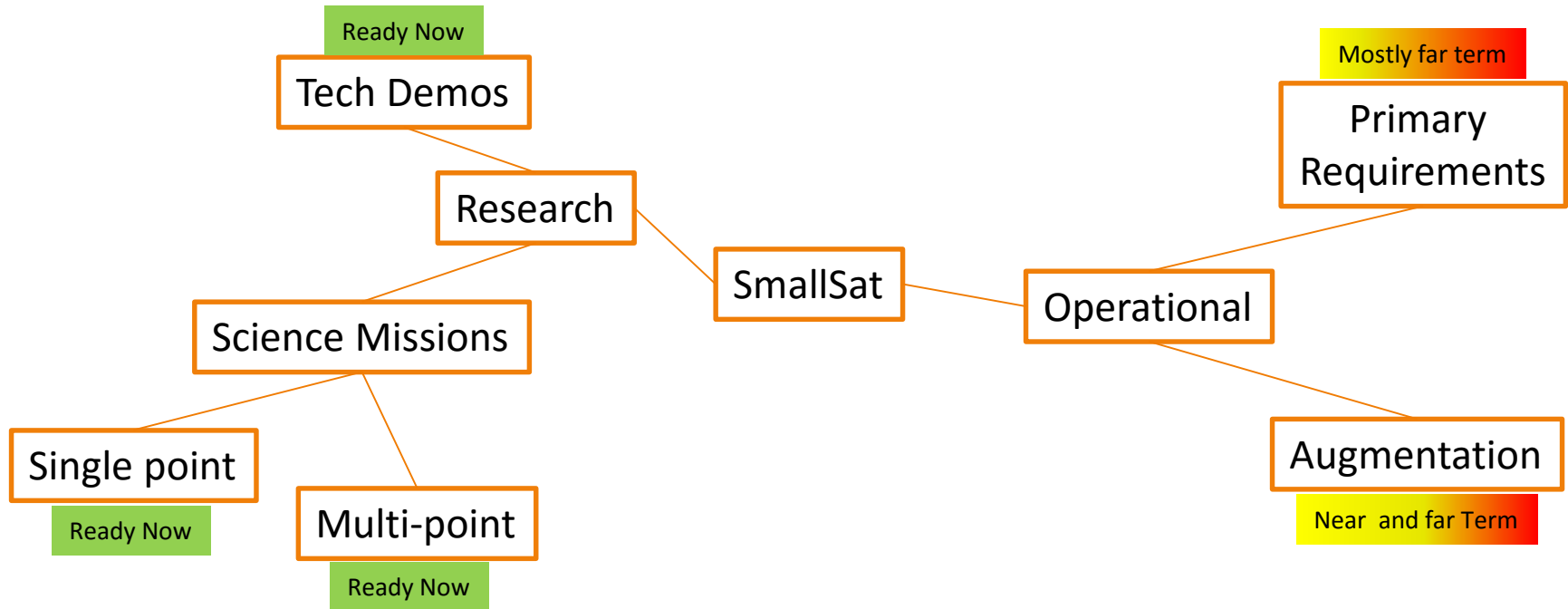
Backup



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

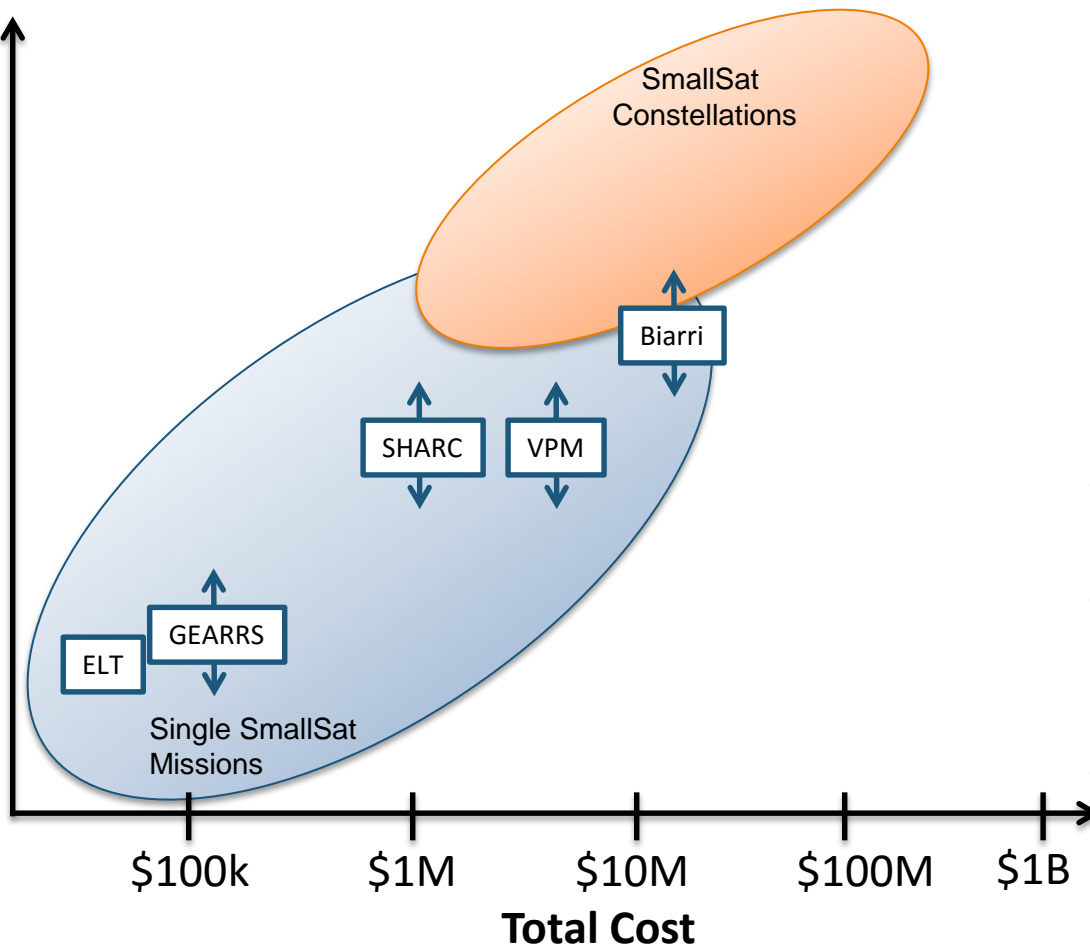
Operational Mission Attributes

- High reliability
- Longer timelines
- DoD launches (dedicated)



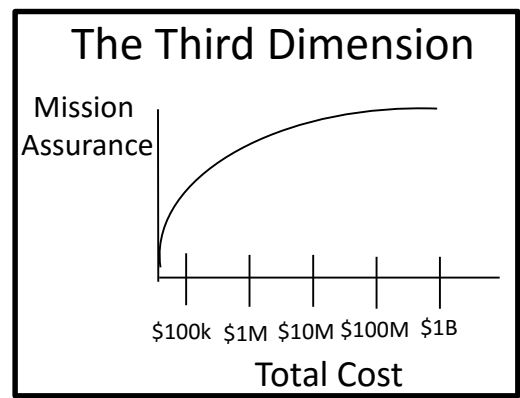
What do CubeSats Really Cost?

Capability



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