Small Satellites
Big Business?

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Are Small Satellites Now a Big Business

- They are a “growing” business
  - They offer a value proposition that big satellites cannot
- Are they a panacea for everything we do in space?
  - Large and small space systems play a critical role in…
    - National security
    - Scientific exploration
    - Technology maturation
    - Commercial applications
  - Particularly well suited for a distributed approach to providing space-based services
  - Offer resiliency as a system, avoiding the traditional risk of a single point of failure
Imaging Advances

Hubble Space Telescope

James Webb Space Telescope
Thermal Control Advances

Heat Pipe

Loop Heat Pipe With Deployable Radiators

Miniature Devices

Passive Systems

Passive Systems

Loop Heat Pipe Deployable Radiator
Advanced Electronics

On-Board Processors

Solid-State Recorders

Credit: SEAKR Engineering
Structures—Advanced Across-the-Board

Buses

Precision Assemblies

Deployable Booms
Enabling Operationally Responsive Space

Breaking Old Paradigms and Giving JFCCs the First Realistic Opportunity for Responsive, Dedicated Space Capabilities at the Operational and Tactical Level

Space Capabilities Delivered Directly to the Operational and Tactical Warfighter

**Spacecraft:**
- Collect and process mission data
- Downlink data & geolocation product
- High-speed & narrow-band downlinks

**Tactical Ground Station:**
- Format and uplink tasking to spacecraft

**Operational Theater**
- Mission Ops Center

**CONUS**
- Tactical Ground Station

**Warfighter:**
- Send tasking to spacecraft
- Receive mission information

**SIPRNET**
Time History of Events and Macroscale Interactions During Substorms (THEMIS)

THEMIS Constellations Enabled Broad Understanding of Magnetosphere
THEMIS Highlights Flexibilities of Smallsats

Single Launch for Full Constellation

Deployment Configuration
Enabling New Commercial Space Missions

ORBCOMM
RapidEye
Space Imaging
GeoEye
Digital Globe
BNSC
**Large Satellites**

- Built for the most demanding missions (DoD, intel, etc.)
- High cost to advance state of the art
- Economics drives decision (e.g., GEO comsats)

**Small Satellites**

- Typically rely on state-of-the-art practice technology
- Achieve 80% of the capability for 20% of the cost
- Lower complexity or special purpose missions
- Near-term technology demonstrations
- Gap-filling and augmentation
Large and Small Satellite Contrasts

Large Satellite Platforms

- Extensive Requirements
- Decades Old Technology
- Long Development Schedule
- Extensive Mission Assurance
- Few Launches
- Complex Design
- Very High Cost
- Low or No Risk

10 Years and More

Small Satellite Platforms

- Good Enough Requirements
- Current Technology
- Short Development Schedule
- Tailored Mission Assurance
- Managed Risk
- Simple Design
- Modest to Low Cost
- Frequent Launches

3 Years and Less

Source: USAF
1. Increasing acquisitions of smallsat developers

2. Increasing investments in smallsat applications
   - ORS
   - LEO constellations
   - NASA acceleration of small explorer missions
   - Growing commercial imaging applications

3. International growth
Transiting Exoplanet Survey Satellite (TESS)

- Six telescopes on a small responsive-space bus
- To observe 2.5 million nearby bright stars
- Goal: To discover 1,000 new planets
The Evolution of Small Satellites

- No longer just niche applications
- Now an integral part of space architecture
- The right solution for ORS
- Commercial market accelerating

A wide path of opportunity lies before us