

**MITCHELL INSTITUTE**  
for Aerospace Studies



# **Small Satellites: Answering the Call for Space Superiority**

**Charles Galbreath**

**Senior Fellow For Space Studies**

**with**

**Aidan Poling**

**Senior Research Analyst**



# SmallSats Can Play a Big Role in Space Superiority

---

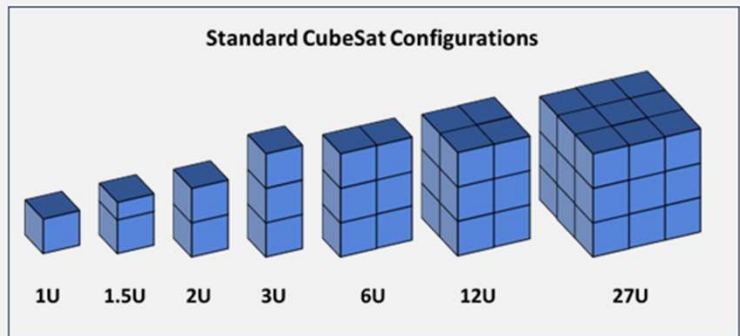
- To address Russian and Chinese offensive objectives in space, the United States Space Force must gain and maintain space superiority—achieved through tenets of Competitive Endurance
- Small satellites, or “SmallSats,” already supporting Competitive Endurance to increase resiliency, can play a much larger role across all three tenets—Deny First Mover Advantage, Avoid Operational Surprise, and Conduct Responsible Counterspace Campaigning
- Employing SmallSats enables rapid reconstitution of lost/degraded capabilities, use of defensive measures such as camouflage, concealment, and deception (CCD), greatly expanding sensor distribution, and hosting a range of defensive and offensive weapons
- The changes that SmallSats represent to satellite procurement and employment must drive a shift in thinking about how the USSF fields and operates its space architecture

**Without consistent funding and proper authorities,  
the Space Force can't fully utilize SmallSats**



# SmallSat Compared to Legacy Satellites

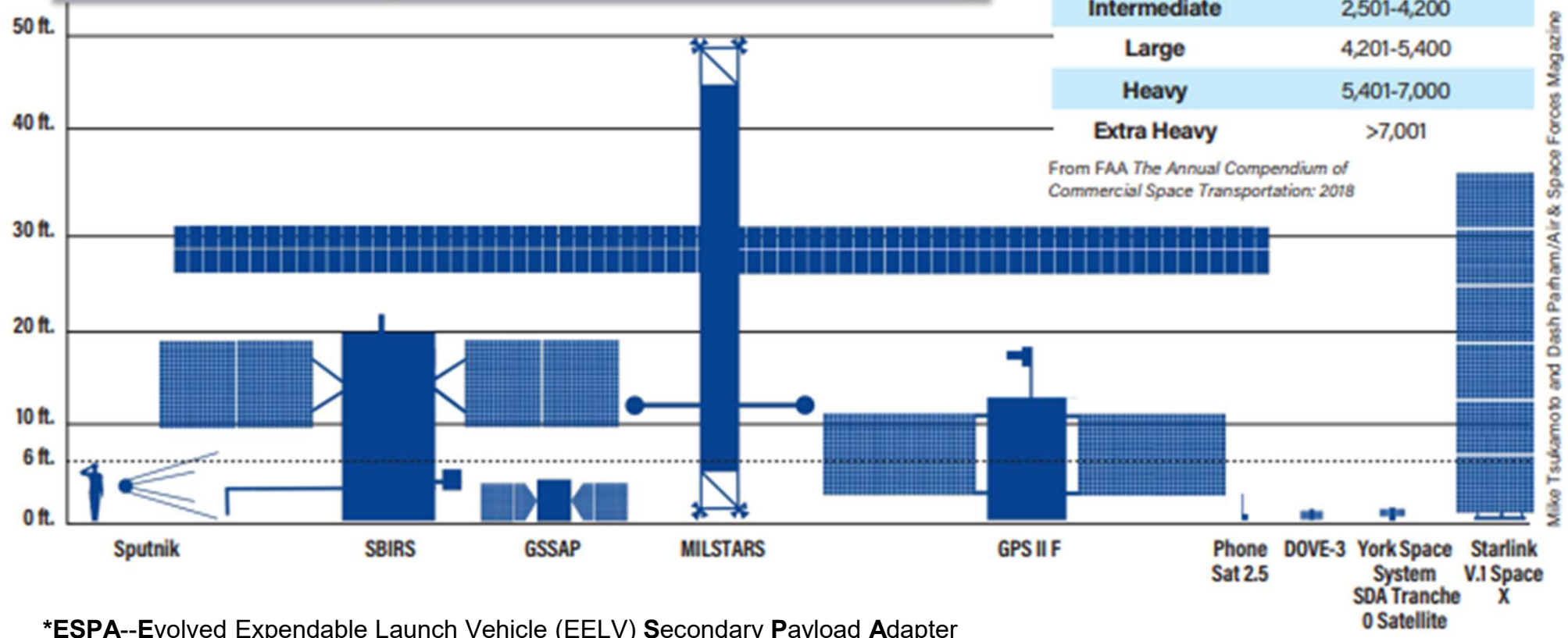
SmallSats typically weigh between 100-200 kg. Common types include CubeSats, based on 10x10x10 cm units and ESPA-class satellites weighing up to 180 kg. The standardized shape of SmallSats allows them to be launched and produced en-masse compared to larger legacy satellites.



Mass Class	Kilograms (kg)
Femto	0.01-0.09
Pico	0.1-1
Nano	1.1-10
Micro	11-200
Mini	201-600
Small	601-1,200
Medium	1,200-2,500
Intermediate	2,501-4,200
Large	4,201-5,400
Heavy	5,401-7,000
Extra Heavy	>7,001

SmallSats

From FAA The Annual Compendium of Commercial Space Transportation: 2018



Mike Tsukamoto and Dash Palfam/Air & Space Forces Magazine

\*ESPA--Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter



# A Small History

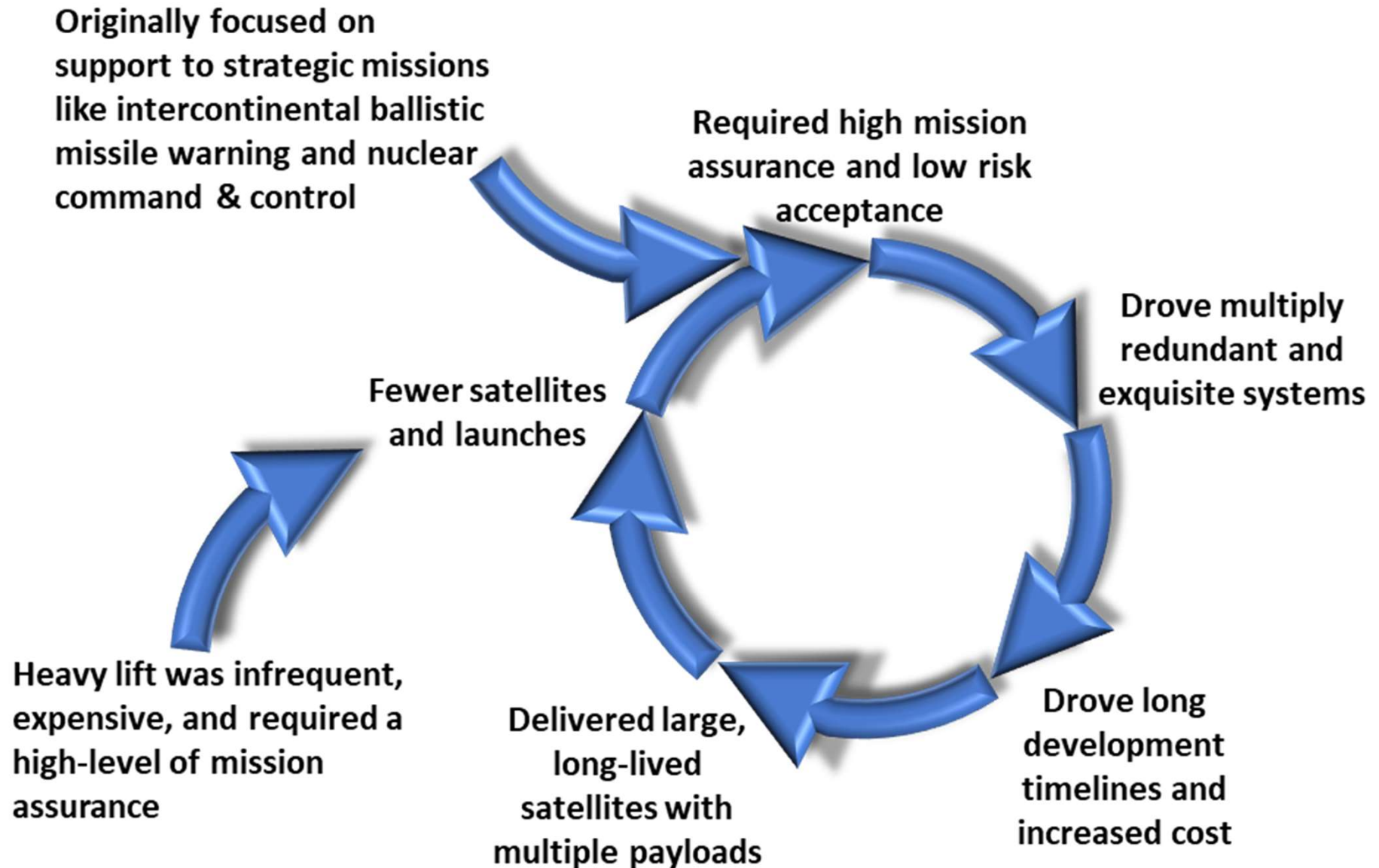
- SmallSats have been an integral element of space operations since the beginning of the Space Age
- Over the past 65 years, SmallSats remained the platform of choice for scientific payload, experiments, and even some demonstrations and prototypes
- The high-stakes implications of the Cold War and available technology drove satellites performing intelligence, missile warning, and nuclear command, control, and communications missions to larger, more reliable platforms
- This resulted in the deployment of small numbers of exquisite, highly capable, long-lived satellites
- After the Cold War, assumptions of space as a sanctuary maintained the existing paradigm of large operational systems for several decades



Technician lowering Explorer 1 satellite payload onto launch vehicle, January 1958  
(<https://explorer1.jpl.nasa.gov/galleries/explorer-1/#gallery-4>)



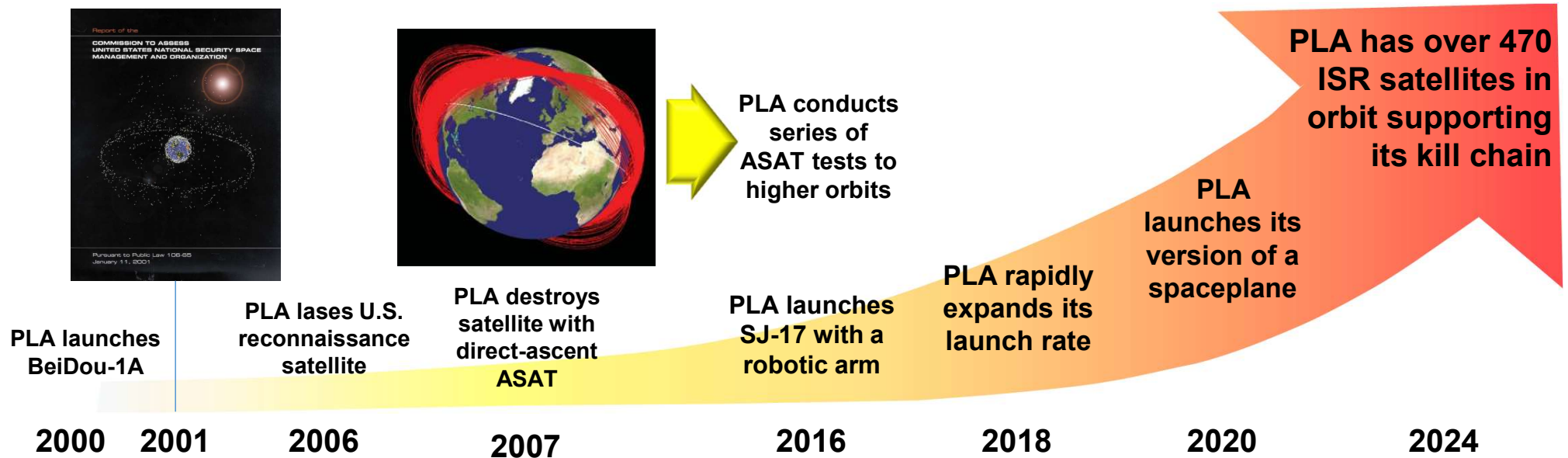
# Legacy Space Development Cycle





# Increasing Threats

- To counter U.S. Space Systems
  - Since Desert Storm, China undertook a campaign to erase the asymmetric advantage space capabilities afforded U.S. and Allied forces
- To use space to target U.S. and Allied forces
  - In the past decade, China has fielded space capabilities at a “breakout pace” to extend its power projection capability

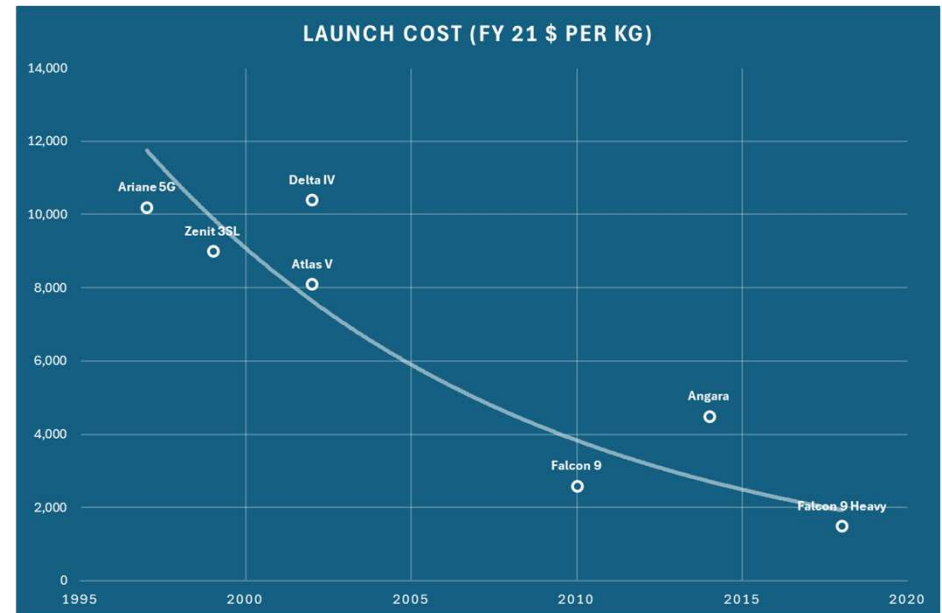
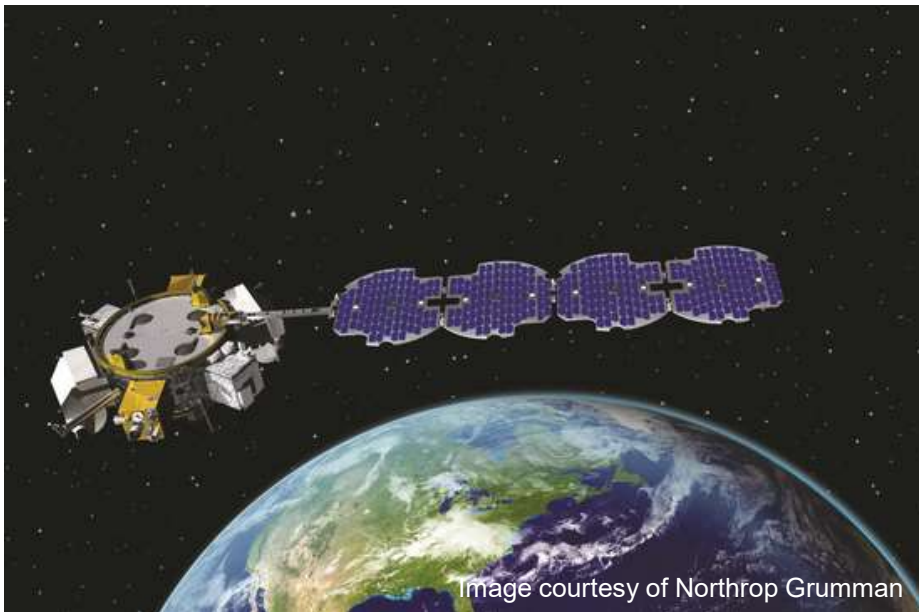


For more on the growing threat, check out: [Building USSF Counterspace Capabilities—An Imperative for America’s Defense](#) and the [Schriever Spacepower Series with Maj Gen Gregory J. Gagnon](#)



# Increasing Opportunities

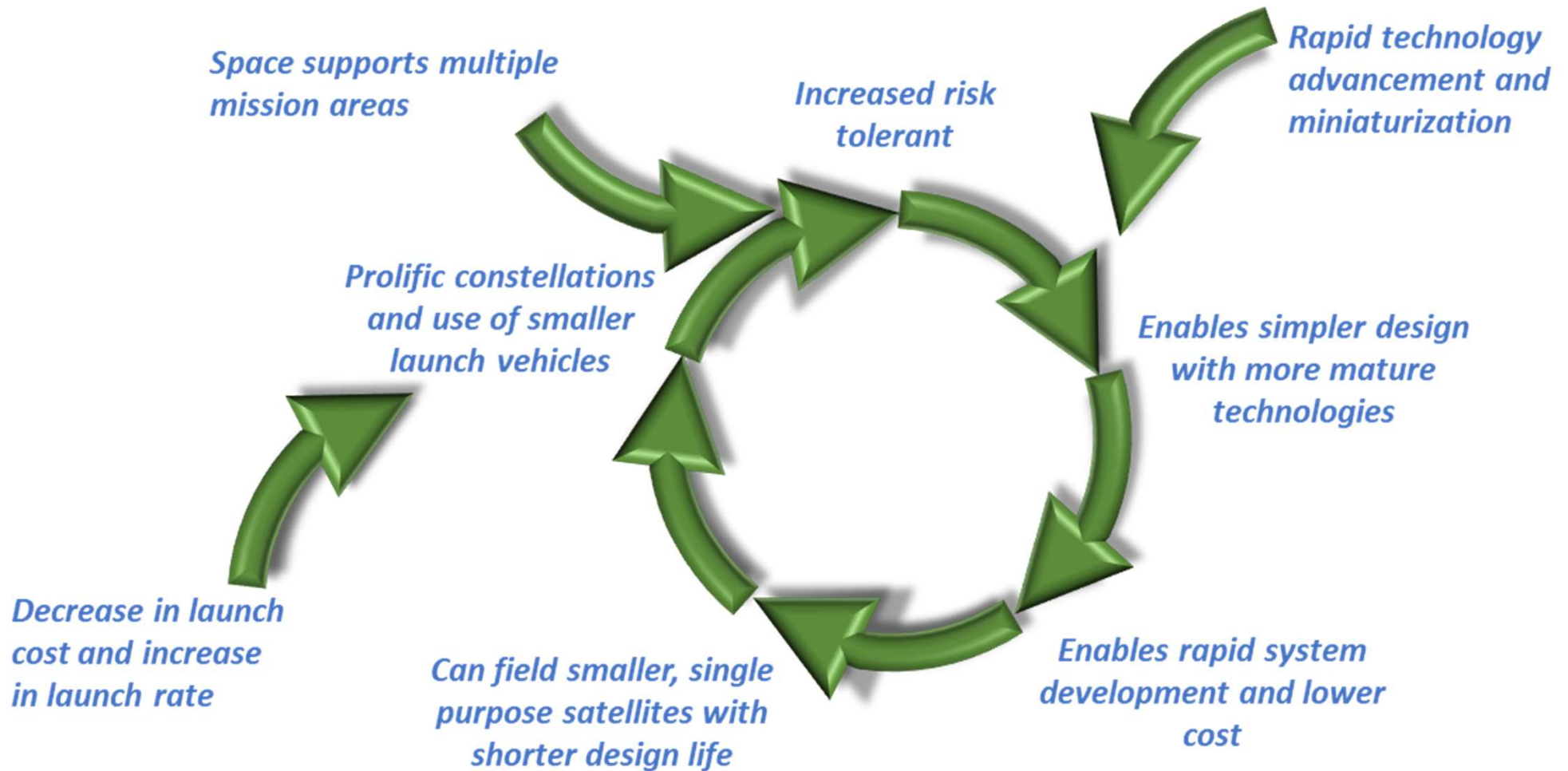
- Increasing capacity and capability of digital technology coupled with lower launch costs and increasing launch opportunities have made SmallSats operationally viable
- Long Duration Propulsive ESPA (LDPA), Starlink, and the Proliferated Warfighting Space Architecture (PWSA) are proving the utility of SmallSats



**Operational SmallSats come at the opportune time to move away from “big, fat, juicy targets”**



# SmallSat Development Cycle



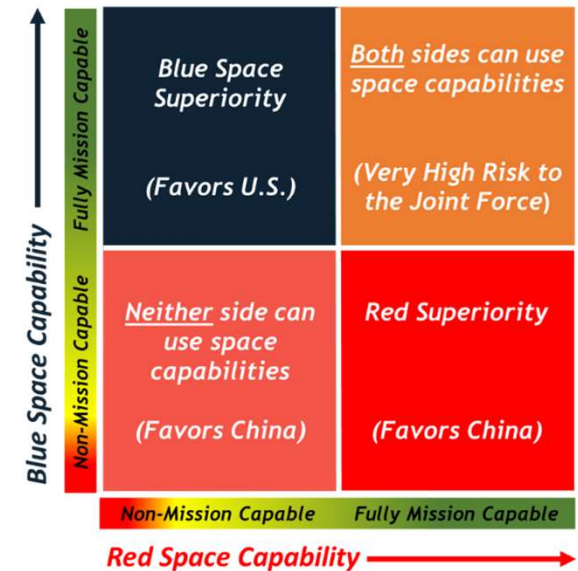
**SmallSats can be as transformative for space activities as assembly lines were to the Industrial Revolution**





# Competitive Endurance and Need for Space Superiority

- In competition or conflict, the United States must have the ability to gain and maintain space superiority
- Assuring the advantages of space is a critical element of integrated deterrence
- The theory of Competitive Endurance identifies three lines of effort needed to secure a space advantage and promote stability
- Deny First-Mover Advantage seeks to decrease the incentive to a potential adversary from taking the first offensive action
- Avoid Operational Surprise creates a clear understanding of potential threats to friendly space capabilities, regardless of domain origin
- Conduct Responsible Counterspace Campaigning will protect friendly space capabilities and defend fielded air, land, and maritime forces from adversary space-enabled attack





# SmallSats to Deny First Mover Advantage

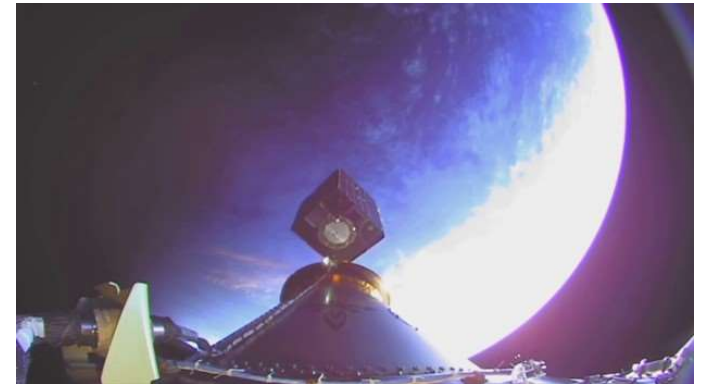
---

- Continue proliferation activities already underway
- Utilize camouflage, concealment, and deception (CCD) techniques
  - Expand on the inherent advantage of being a smaller target to further decrease an adversary's ability to find, fix, and track
  - Employ low-reflectivity materials and paints to reduce signature
  - Deploy SmallSats in clusters to obfuscate missions
- Deploy multi-orbit diversified architecture
  - Leverage the affordability and versatility of SmallSats to further improve mission assurance
  - Deploy SmallSats to a mix of LEO, MEO, GEO, xGEO, and others to support the same mission
- Advance use of rapidly deployable SmallSats to augment and/or reconstitute existing capabilities



# SmallSats to Avoid Operational Surprise

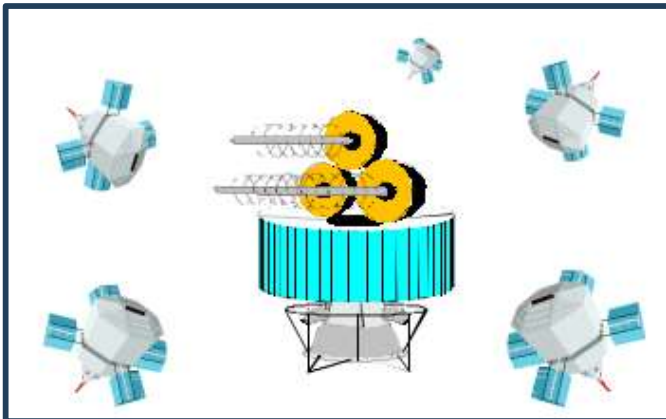
- Expand space domain sensing architecture
  - SmallSats can affordably proliferate space domain awareness sensors to cover greater volumes of space and in key regions
  - Victus Nox and Victus Haze are proving the potential to rapidly deploy sensors to respond to emerging threats
- Expand the ability to monitor air, land, and maritime threats
  - SmallSats can provide ubiquitous coverage of the Earth to monitor air, land, and maritime threats to space capabilities





# SmallSats to Conduct Responsible Counterspace Campaigning

- Deploy bodyguard and hunter-killer SmallSats
  - Proposed in 1996's "Air Force 2025"
  - Current technology and threat make this concept acutely relevant
  - SmallSats could leverage a range of temporary or permanent counterspace payloads supporting defensive/offensive missions
- SmallSats could deploy with larger satellites to maintain awareness and respond to threats to high-value assets



- SmallSats could patrol key orbits or follow adversary satellites to enable options for future leaders

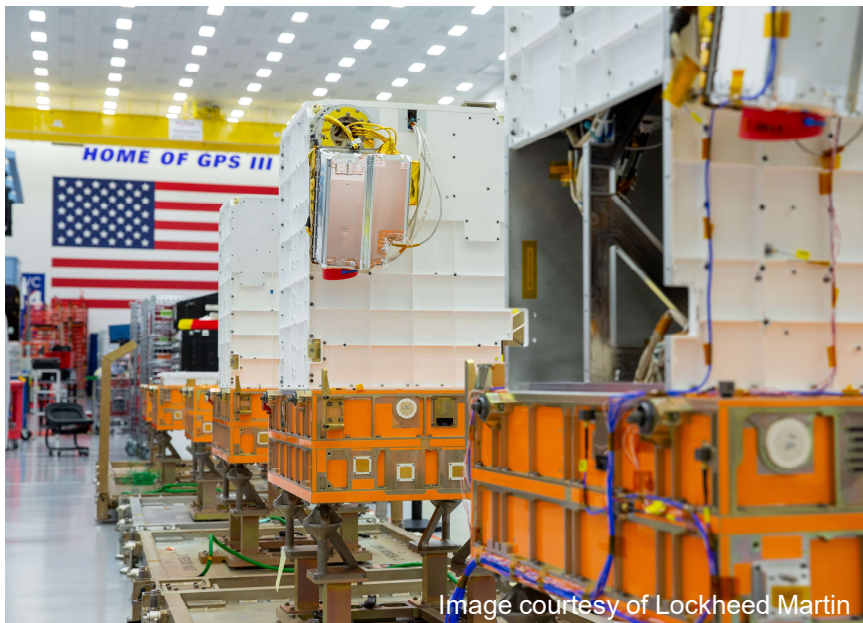
**SmallSats can create dilemmas for a potential adversary and support our deterrent posture**



# Improving Adoption of SmallSats (1 of 2)

- Acquisition

- Large block buys of highly versatile buses
- Secured/stable funding for multiple generations of a system
- Increase funding tied to Competitive Endurance
- Support Industrial Base adjustments to SmallSat production
- Continue to develop and scale launch capabilities and capacity





# Improving Adoption of SmallSats (2 of 2)

- Operations
  - Develop/adopt tactics, techniques, and procedures tailored for operations of large numbers of SmallSats
  - Increase cyber awareness and defenses
  - Improve satellite tracking precision
- Sustainment
  - Prioritize architecture sustainability
  - Assure supply chain reliability and depth
  - Make management, disposal, and reconstitution part of the strategy—non-LEO SmallSats may require servicing to extend operational life or aid in disposal



**Decision-makers must understand the full potential of SmallSats as well as their limitations**



# Summary and Conclusion

---

- SmallSats have long been an integral part of space activities
- Lower launch costs and digital technology now make SmallSats operationally relevant to address increasing threats
- SmallSats can support all tenets of Competitive Endurance and help deliver space superiority
  - Uniquely enable reconstitution; augmentation; camouflage, concealment, and deception; diversification, proliferation; and defensive operations
- Low cost and rapid timelines make SmallSats a highly flexible and scalable tool to create dilemmas for an adversary
- Adjustments to space acquisition, operations, and sustainment can further advance the adoption of SmallSats

**Consistent funding and proper authorities will be critical to realize the full benefits of SmallSats**



---

[www.mitchellaerospacepower.org](http://www.mitchellaerospacepower.org)