Purpose

- Describe Innovation, Science, and Technology risk reduction through the NanoSat Testbed Initiative (NTI)
- Introduction to the University Nanosatellite Program (UNP)
NTI Overview

• Objective: Reduce development risk for missile defense future architectures
  • Keep pace with rapidly evolving threats
  • Inform system acquisition

• Approach
  • Develop transformational technology and algorithms
  • Demonstrate the technology on-orbit using small, affordable platforms
  • Engage with DoD, Services, NASA, industry, and Universities to leverage space expertise, investments, and to employ best practices

• Enabling Technology
  • Secure communications (Laser and Radio Frequency)
  • Cognitive systems
  • Radiation hardened, high-speed processors
  • Small SWaP components
  • Robust large format focal plane arrays (FPA)
  • Efficient cooling
  • Deployment mechanisms and antennas
NTI Technology Maturation

- Execute maturation tests where ground tests & short flight experiments are insufficient
- Raise component Technology Readiness Level (TRL) to 6 or higher
- Directly applicable to MDS components (kill vehicles, battle management, command and control, communications, space sensors)

NTI Solution:
- Testbed in a space environment
- Leverages emerging low-cost small satellite technology (Class D), expanding launch capacity, and automated satellite operations

Technology Insertion Process

<table>
<thead>
<tr>
<th>Advanced Technology Development</th>
<th>Program of Record Development</th>
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<tbody>
<tr>
<td>Technology Readiness Level (TRL) 1-3</td>
<td>TRL 7 - 9</td>
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<tr>
<td>Small Business, Industry Partners</td>
<td>Element Transition</td>
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<tr>
<td>Proof of Concept</td>
<td>System Proven in Mission Operations</td>
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<tr>
<td>Prototype Demonstration in Relevant Environment</td>
<td>+ in some cases, operational environment is possible</td>
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<tr>
<td>TRL 4 – 6+</td>
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</tbody>
</table>
NTI: Current Mission Content

CubeSat Networked Communication Experiment

- CubeSat Networked Communications Experiment (CNCE-1)
- Autonomous Mesh Networking
  - 2 CubeSats(3U) Software Defined Radio (SDR)
  - Performance Metrics under non-optimal orientation
  - Rad Hard Processor
- High Assurance Communication
  - 2 CubeSats(3U)
  - High Assurance Internet Protocol Encryption
  - Software Defined Radio
  - Rad Hard Processor

Nanosat Testbed Operations Center (NTOC)
MDA

Space Test Program
Virgin Orbit

CubeSat Based Laser Communications Experiment

- CubeSat Based Laser Communications (CBAS-LaCE) Block 1
- Optical Inter-Satellite Link
  - 2 CubeSats(6U)
  - Low SWaP, non-gimballed
  - Free-Space Optical communications payload
  - Partnership with NIWC
- Operations Center
NIWC

Space Test Program
ULA Atlas 5

CubeSat Based Cognitive RF

N/A

Cognitive Radio Functionality
- 1 CubeSat (12U)/3 Ground Nodes
- Dynamic, multi-band routing based on mission needs
- Partnership with AFRL

Operations Center
AFRL

Space Test Program
Virgin Orbit

MDA Space Test Program
Virgin Orbit

NTI Architectures enable Advanced, Risk Reduction Technology Demonstrations

4 Launches in 2021 encompassing 7 Space Vehicles
DoD Space Test Program (STP) and Space Experiment Review Board (SERB)

- **DoD Space Test Program (STP)** established in 1965 by the Director of Defense Research and Engineering (DDR&E)
  - Provides flight opportunities for DoD research and development activities in an efficient, cost-effective manner

- **DoD Space Experiments Review Board (SERB)**
  - Provides program oversight and guidance to the STP Program Office through the review and prioritization of candidate experiments for space flight manifest

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**MDA SERB**
- Informs **DoD SERB**

**DoD SERB**
- **Membership**
  - Air Force
  - USSTRATCOM
  - Army
  - DARPA
  - Navy
  - USD (AT&L)

- **SAF/AQS**
  - Approves DoD SERB
  - Approval Authority for >$10M missions
  - AF Funding via Corporate Process
  - Executive Agent for DoD

- **SMC/ADS STP**
  - Executes mission
  - Approval Authority for <$10M missions
  - Satellite bus development
  - Launch Operations (1yr)
  - ISS ops
  - Does NOT fund experiments

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20 Years of Education
What is UNP?

- Air Force Research Laboratory (AFRL) STEM Program
- Established in 1999
- Centered on U.S University development and education in Small Satellites
- MDA is now a participant in UNP!

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Primary Objective: Education
- Systems engineering training
- Workforce development
- Foundation for all UNP decisions

Secondary Objective: Technology
- Innovative, low-cost technology development
- Motivation for government and industry sponsors
- DoD relevant

Tertiary Objective: University Development
- Develop space hardware laboratories
- Support university research and professors
UNP Program Structure

Design
Integration and Testing
Environmental Testing
Operations

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• Funding
• Comprehensive User’s Guide
• Dedicated Engineers
• Design and Fabrication Courses
• Formal design reviews and feedback
• Environmental testing facilities
UNP Impacts to the University

• Premier educational opportunity
  • Non-traditional exposure to hands-on engineering and research projects
  • Gateway to internships and full-time employment
• University Small Satellite Lab Development
  • Financial resources
  • Flight Opportunities

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UNP Impacts to the Community

- High caliber graduates ready to enter the workforce with fundamental skills
- Potential collaborations within industry for technology development
- Think tank for transferable technology and early development
Summary

• Technology Maturation is conducting a series of CubeSat demonstrations to reduce risk for future kill vehicles, DoD communications needs, Hypersonic Defense, and sensors

• Current experiments
  — Funded through Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Rapid Innovation Funds (RIF), Agency Funds
  — Multiple DoD mission partners
  — Leverages pre-existing DoD infrastructure
  — 4 launches in 2021

• Planning for additional technology demonstrations

• MDA in now an active participant in UNP!