Space Technologies for Air Force Capabilities

Space Weather
Specifying, Forecasting & Mitigating Space Environment Hazards to DoD Systems

Space Communications
Broadband Comm Support for High Data Rate Users

Space Power
VS-Heritage Solar Cells
Aboard 95% of DoD Operational Satellites

Space Electronics
VS-Heritage Electronics are Aboard All DoD Operational Satellites

Space Structures
VS Structures Technology on EELV & Minotaur Launch Vehicles
Space Weather Impacts to DoD Systems

**Direct Solar Hazards**
- Radio, optical and X-ray interference
- Solar energetic particle dose degradation and detector clutter
- Radiation dose to humans at high altitudes

**Space Particle Hazards**
- Radiation degradation and electronics upsets
- Surface and internal charging / discharging
- Thin film and coating degradation

**Ionosphere/Neutral Hazards**
- Communication/Navigation link degradation and outage
- Surveillance clutter
- Tracking & geolocation error
- Satellite Drag
Environment

- DoD space systems operate in a harsh radiation environment
- We develop cost-effective solutions to military-unique requirements

Commercial electronics won’t work!

Infrastructure

- Manufacturing cost grows exponentially
  -- New fabs cost $3B+
- Takes 30 yrs to amortize one dedicated rad hard manufacturing plant

Dedicated fabs not sustainable
Space Power

Power is a limiting factor for nearly every space application

Current Power Ceiling 
~19 kW – Array Mass & Volume Limitations

Space-Based Radar & Communications Drive Power Requirements
Space Structures

Aperture Size

Example: Effect on SBR performance

- Resolution: $\propto \left(\frac{1}{L}\right)$
- Minimum Detectable Velocity: $\propto \left(\frac{1}{L}\right)$
- Area Search Rate: $\propto L^2$
- Independent Tracks: $\propto L^3$

System Weight

Parasitic Mass/Payload Mass Fraction

Lightweight, High Packaging Efficiency Structures

Critical to Communications and Remote Sensing!
Space Communications

**Circa 2000**
- Circuit switched
- Unconnected, separate services
- Limited support for small terminals
- Low protected capacity

**Circa 2005**
- Mix of packet and circuit switched capacity
- Adaptive links for channel conditions – built-in protection
- High bandwidth trunks/circuits
- Support for small user terminals
- Integrated EHF, SHF, Ka band services

**Circa 2015**
- Internet-like transport with interconnectivity and cross-banding
- Support for small, mobile terminals
- High protected capacity

**Strategic EHF Comms**
- Milstar
- AEHF

**Wideband SHF Protected Comms**
- DSCS
- WGS

**Wideband L, C, Ku, Ka-band Comms**
- Commercial

**Satellites**
- WGS
- Commercial
- AEHF
- TSAT
Summary

• AFRL leads the way in space technology
  — New affordable means for reusable access
  — Smaller, cheaper, more capable payloads
• Partnership counts!
  — Collaboration with NASA is strong and growing
• Need attention to assure tomorrow’s talent pool