AF S&T Challenges for Responsive Space

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Overview

• AFRL Focused Long Term Challenges (FLTCs)
• Responsive spacecraft
• Responsive lift
• Responsive range
• Opportunities for industry collaboration
AF Technology Vision

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Anticipate, Find, Fix, Track, Target, Engage, Assess – Anything, Anytime, Anywhere

Energized By Focused Long Term Challenge (FLTC) Plans
Timely Deployment of Flexible Ground & Space Capabilities for the AOR Commander

• Rapidly Constitute Multi-Mission, Affordable Tactical Satellites
• Rapidly Deploy Multi-Mission, Affordable Space Payloads
• Generate On-Demand, Reusable Affordable Space Access
• Rapidly Checkout Spacecraft
• Globally Project Ground Forces Anywhere in Any Weather
• Globally Move, Manage and Process Information in Real Time
FLTC 7—On-Demand Theatre Force Projection, Anywhere
Attribute Forecast

Rapidly Developed Tactical Satellites
- Modular s/c Bus
- Agile Orbit Transfer
Rapidly Developed Payloads
- Plug-n-Play Payloads
- Reconfigurable Components
Hybrid Responsive Space Access
- Rapid Turn 48 Hrs
- 3x Lower Ops Cost
- Vehicle Reliability .995
Rapid S/C Checkout & Autonomous Ops
- Autonomous Mission Operations

Near Term (thru 13)
Rapidly Developed Tactical Satellites
- Enhanced Capability Microsats
- Rapid SC/LV Mate & Transport
- Collaborative Microsatellite Clusters
Rapidly Developed Payloads
- Reconfigurable Monolithic Sensor/Processor Subsystems
Fully Reusable Responsive Space Access
- Rapid Turn 24Hrs
- 10X Lower Ops Cost
- Vehicle Reliability .999
Rapid S/C Checkout & Autonomous Ops
- Autonomous Mission Management

Mid Term (14-18)
Rapidly Developed Tactical Satellites
- Flexible Printed Satellites
- Nanosatellites
Rapidly Developed Payloads
- “Morphable” RF & EO Sensor Systems
- Monolithic EO Sensor (Sensor, Laser Cooler, Readout, Processor, & Protection on a Chip)
Fully Reusable Responsive Space Access
- Rapid Turn 4hr
- 100X Lower Ops Cost
- Vehicle Reliability .9998
Rapid S/C Checkout & Autonomous Ops
- Anticipatory Mission Planning/Ops
- Automated On-Orbit Servicing

Far Term (19-25)
Baseline – long lead-time microsatellites, non-responsive launch
Multi-Mission, Low-Cost, Rapidly Developed Tactical Satellites

Far-Term Vision
- Rapid integration of new payloads & technologies using PnP architecture
- < $30M total mission cost
- < 12 month acquisition cycle
- Direct theater downlink and tasking
- Call up to operation < 6 days

Technology Challenges
- Responsive avionics & software
  - Getting fast software faster
- Responsive/modular spacecraft bus
  - Driving responsiveness down the modular hierarchy
- Extreme miniaturization
  - Driving mass fraction of S/c bus down & performance up
- Reconfigurable communication
- Satellite system design & test tools

Mid-Term Demonstration (2013)
- Assemble TacSat bus and integrate with payload within one week
  - Structure
  - Power system
  - Propulsion
  - Avionics
  - Software

In Inventory…..Produced in Quantity……Employable in Hours
Multi-Mission, Low-Cost, Rapidly Developed Payloads

Far-Term Vision

- The “real deal” PnP
- Ability to assemble payload within a day
- Eliminate custom interfaces, wiring harnesses, etc

Technology Challenges

- Large, high-performance, light-weight RF apertures
- High-performance, light-weight mirrors and telescopes
- Advanced EO front-ends
- Advanced RF front-ends
- Miniature, high-performance signal/fusion processor
- Reconfigurable sensors/electronics

Mid-Term Demonstration (2013)

- Integrate TacSat payload within one week
  - Apertures
  - Front-end
  - Control and Processing
  - Bus Interface
Rapid S/C Checkout and Autonomous Operations

Far-Term Vision

• Autonomous on-board mission manager
  – Intelligent sensor control
  – Fault detection, isolation and resolution
  – Task decomposition and management
• Lights out ground operations
• Opportunistic real-time sensor control
  – Optimize data collection and downlink
• Collaborative decision making across multiple satellite bodies

Mid-Term Demonstration (2012)

• On-orbit processing of sensor data
  – 80% percent of ISR data processed
• Autonomous re-tasking of satellite based on processed sensor data
• On-board cross-cueing between sensors
  – At least two sensors working cooperatively
• Autonomous TacSat two ship performing complex mission

Technology Challenges

• On-orbit checkout
  – Development of algorithms to support complex missions/vehicles
• On-board planning and reconfiguration
• Autonomous mission managers
• Inter-satellite/object collaboration
• On-orbit robotic refueling, reconfiguring, and repair

Near immediate availability following autonomous checkout

On-orbit planner

Target Location, etc.
Generate On-Demand, Reusable Affordable Space Access

Far-Term Vision

- Horizontal takeoff/landing fully reusable vehicle
  - Turbine Based Combined Cycle (TBCC) 1st stage
  - Rocket Based Combined Cycle (RBCC) 2nd stage
- Up to 40K lbs to LEO
- Rapid turn, 4 hrs or less
- 100X lower ops cost
- Vehicle reliability 0.9998
- All weather availability
- 1000 sortie airframe

Technology Challenges

- Reusable, long-life, operable propulsion, airframe, thermal protection systems (TPS) and seals repairable in hours with 100s mission life
- Low cost, reliable expendable upper stage
- Autonomous and adaptive GN&C for take-off, ops & landings
- 48 hour call-up mission planning
- Highly reliable Integrated System Health Monitoring for in-flight trajectory modification

Mid-Term Demonstration

- ARES hybrid launch vehicle (2017)
  - reusable 1st stage vertical takeoff
  - 10K lbs to LEO
- Reusable 2nd Stage (2025)
  - RBCC
  - 40% P/l increase
- Reusable horizontal takeoff 1st stage (2025)
  - TBCC
  - Flexible basing 10K lbs to LEO
Responsive Range

Technology Challenges

• Robust, low-cost flight termination system
  – Autonomous flight safety systems
  – Space-based communications
  – GPS/INS to eliminate need for ground-based tracking assets
  – Eliminate components that need to be recertified and tested on a regular basis

• Rapid trajectory analysis
  – Optimizing trajectories in real time
  – Rapid calculation of range safety corridors

• Unmanned surveillance tools for continuous observation of launch area

• Autonomous Flight Safety System
  – Rule-based logic to emulate human-in-the-loop flight safety decision processes
  – Flight qualification and range safety certification

• Transportable/deployable range assets
  – Integrating assets with existing ranges
  – Maintaining assets in a state of readiness to support responsive missions
Opportunities for Industry

- **Broad Agency Announcement**
  [http://vsearch2.fbo.gov/servlet/SearchServlet](http://vsearch2.fbo.gov/servlet/SearchServlet)

- **Small Business Innovative Research**
  [http://www.sbirsttrrmall.com/Portal.aspx](http://www.sbirsttrrmall.com/Portal.aspx)

- **Cooperative Research and Development Agreements**
  [http://www.vs.afrl.af.mil/TechOutreach/TT/CRADA.aspx](http://www.vs.afrl.af.mil/TechOutreach/TT/CRADA.aspx)

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