THE AIR FORCE RESEARCH LABORATORY

LEAD | DISCOVER | DEVELOP | DELIVER

AF S&T Challenges for Responsive Space

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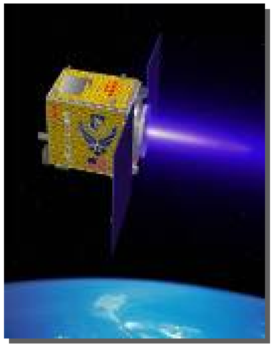
Overview

- AFRL Focused Long Term Challenges (FLTCs)
- Responsive spacecraft
- Responsive lift
- Responsive range
- Opportunities for industry collaboration

AF Technology Vision

CORONA Top, Jul 05

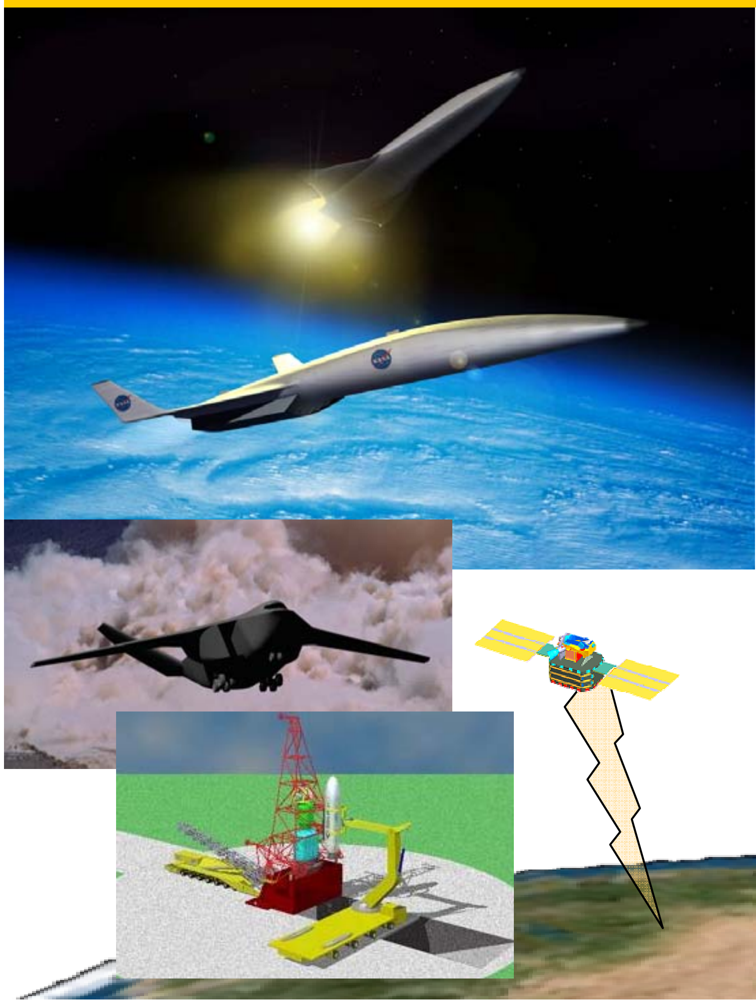
Anticipate, Find, Fix, Track, Target, Engage, Assess – Anything, Anytime, Anywhere



Energized By Focused Long Term Challenge (FLTC) Plans

FLTC #7

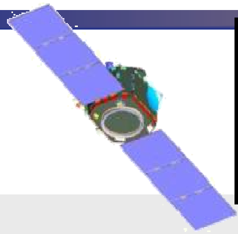
Timely Deployment of Flexible Ground & Space Capabilities for the AOR Commander



- 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

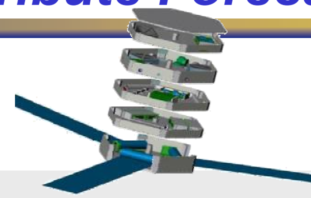



Rapidly Developed Tactical Satellites
- Modular s/c Bus
- Agile Orbit Transfer

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



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

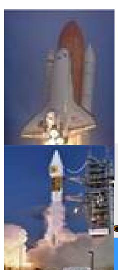
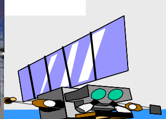
Rapid S/C Checkout & Autonomous Ops
- Autonomous Mission Management

Rapidly Developed Tactical Satellites
- Flexible Printed Satellites
- Nanosatellites

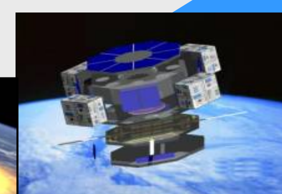
Rapidly Developed Payloads
- "Morphable" RF & EO Sensor Systems
- Monolithic EO Sensor (Sensor, Laser Cooler, Readout, Processor, & Protection on a Chip)

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





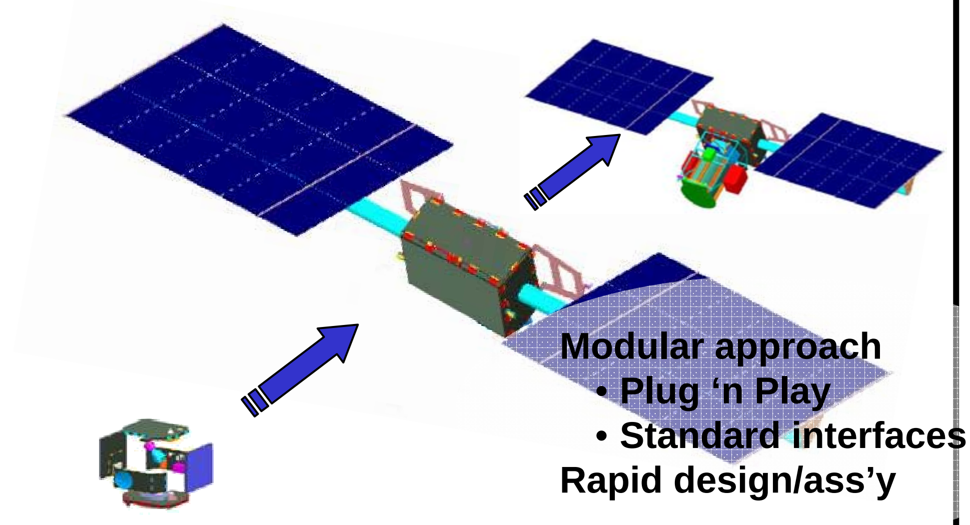

Baseline – long lead-time microsatellites, non-responsive launch

Near Term (thru 13)

Mid Term (14-18)

Far Term (19-25)

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

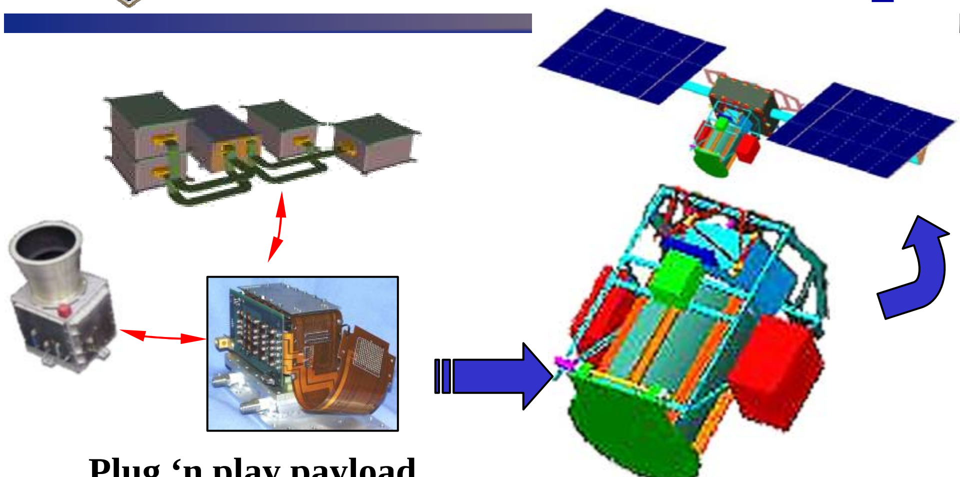
- Responsive avionics & software
  - Getting fast software faster
- Responsive/modular spacecraft bus
  - Driving responsiveness down the modular hierarchy
- Extreme miniaturization
  - Driving mass fraction of S/c bus down & performance up
- Reconfigurable communication
- Satellite system design & test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



Plug 'n play payload components and subassemblies → Rapidly assembled spacecraft payload

Far-Term Vision

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

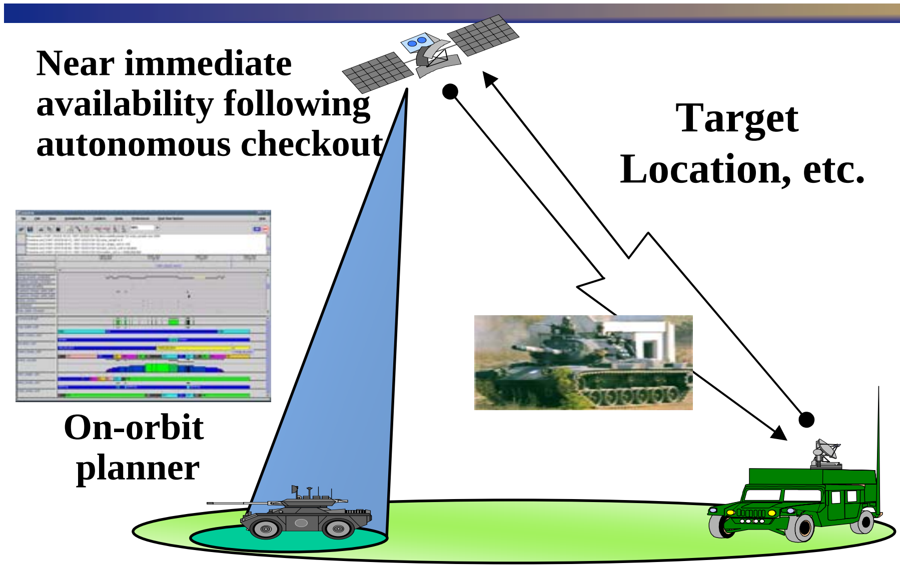
Technology Challenges

- 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

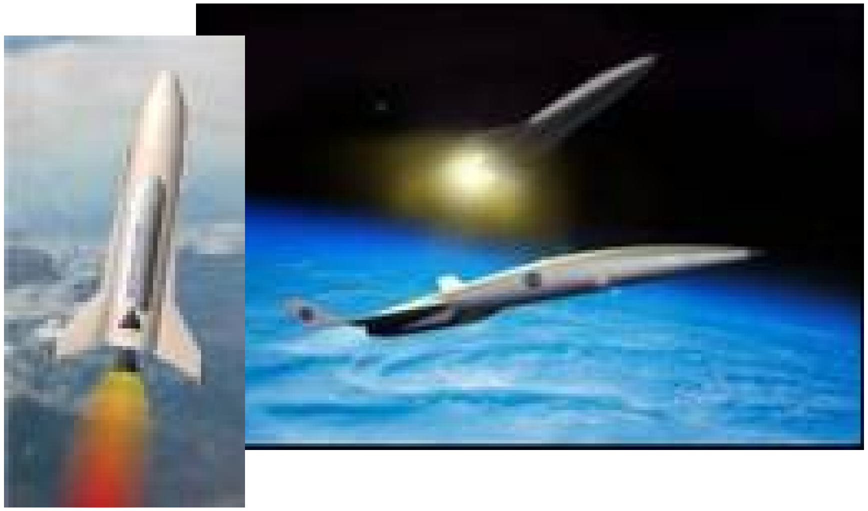
Technology Challenges

- 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

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

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

- **Small Business Innovative Research**

http://www.sbirsttrmall.com/Portal.aspx

- **Cooperative Research and Development Agreements**

http://www.vs.afrl.af.mil/TechOutreach/TT/CRADA.aspx

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