Solutions to Current Challenges: FY07-FY09

Major General Ted Bowlds

4 April 2007

AFRL
THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER

AFRL Vision

Air Force S&T Vision

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

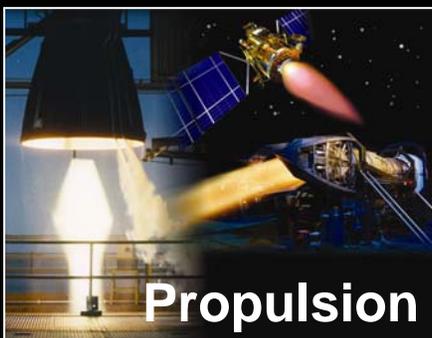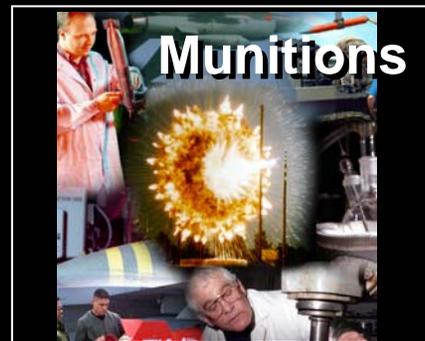## AFMC Vision

**War-winning Capabilities…
On Time, On Cost**

AFRL Vision

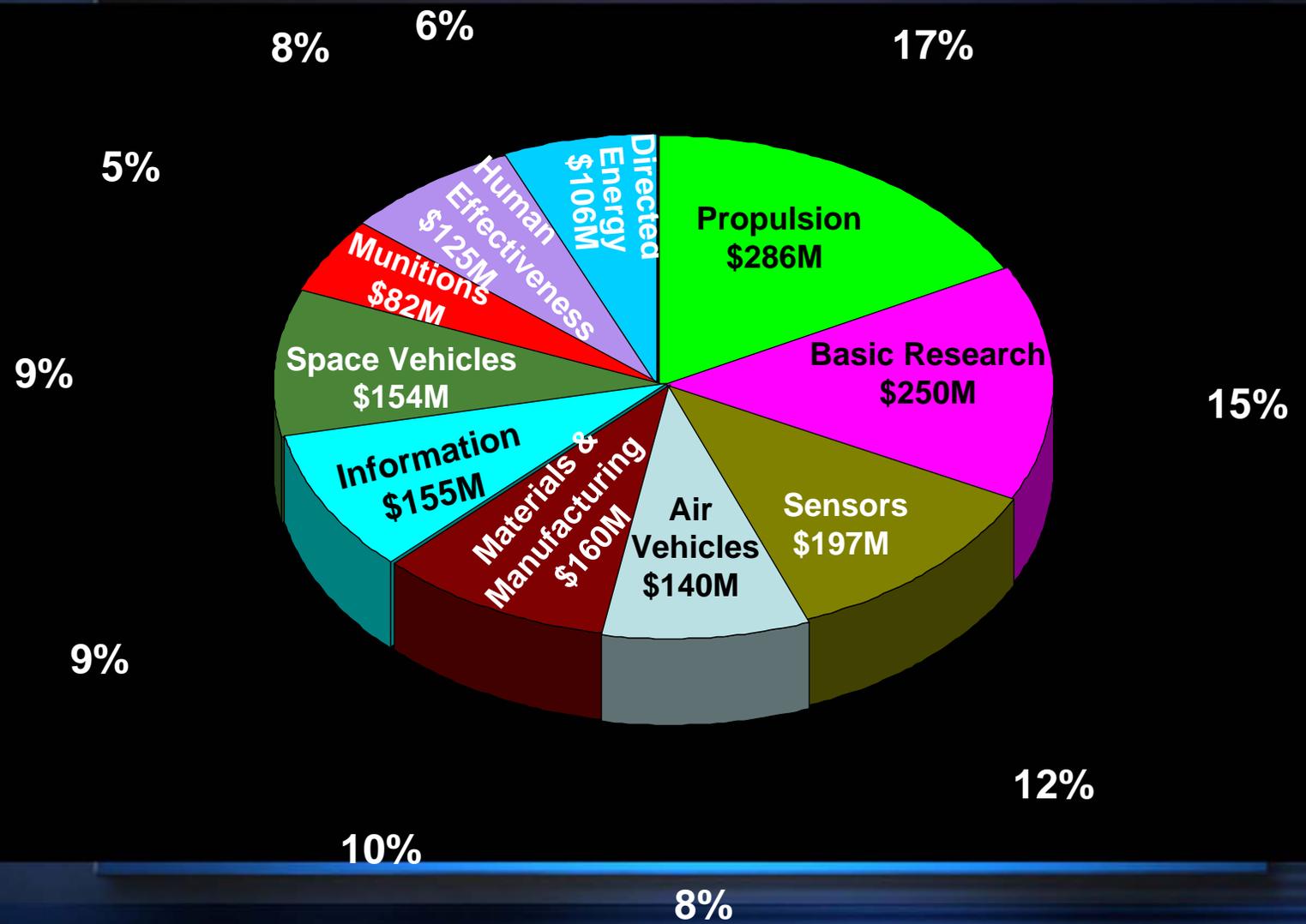**We defend America by unleashing the power of innovative science and technology**

Core Work Areas

Space Vehicles

Directed Energy

AFOSR

Materials

Human Effectiveness

Munitions

Sensors

Air Vehicles

Propulsion
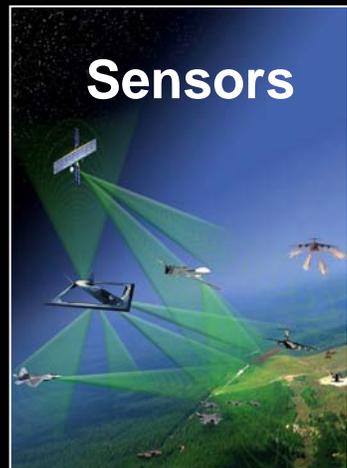
Information

AF Budget Investment By Tech Area

8%   6%   17%

5%

9%

9%

15%

12%

10%

8%

Directed Energy $106M

Human Effectiveness $125M

Munitions $82M

Space Vehicles $154M

Information $155M

Materials & Manufacturing $160M

Air Vehicles $140M

Sensors $197M

Basic Research $250M

Propulsion $286M

FY07 Presidential Budget
Values May Not Add Due to Rounding

AIR   SPACE   CYBERSPACE

AFRL Customers

AF Senior Leadership

• Top-level guidance and strategy

Program Managers (Capability Developers)

•Anticipate, Find, Fix, Track, Target, Engage,

Warfighter

• Core S&T connected to operational needs

• Solve capability gaps and shape future concepts

• AFRL pushes to show operators what's possible

AFRL's Core Processes Aligned with Customer Needs

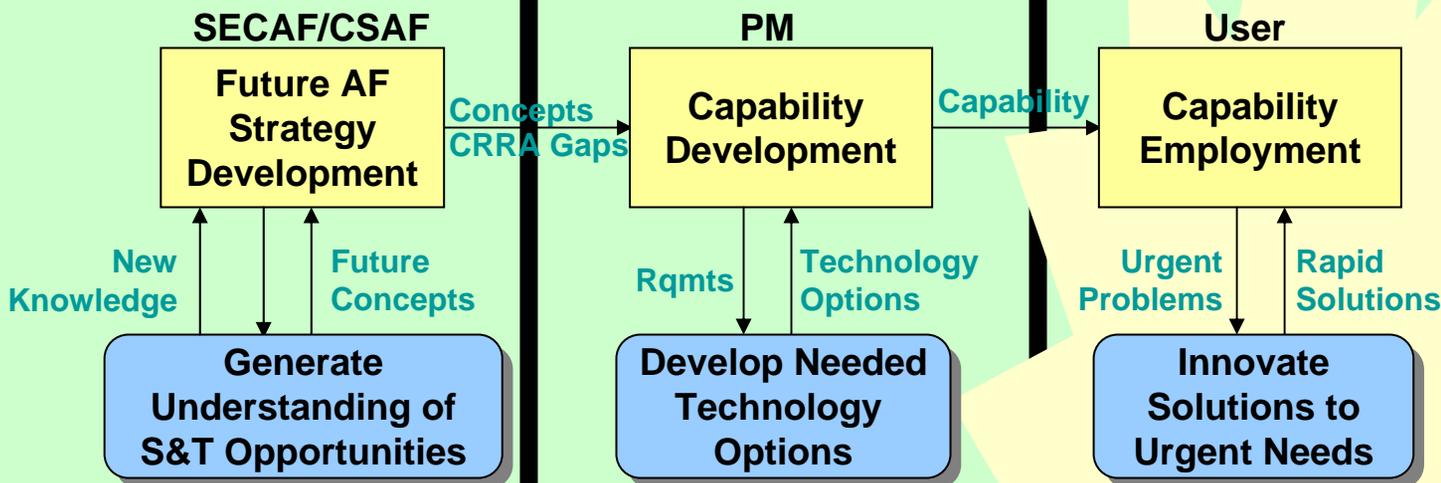| Needs	Future Transformational Warfighting Systems	Timely Technology Insertion into Systems	Problem Solving and Adaptation of Systems

SECAF/CSAF

Future AF Strategy Development

→ Concepts CRRA Gaps →

PM

Capability Development

→ Capability →

User

Capability Employment

New Knowledge — Future Concepts

Rqmts — Technology Options

Urgent Problems — Rapid Solutions

Generate Understanding of S&T Opportunities

Develop Needed Technology Options

Innovate Solutions to Urgent Needs

Values	Invention Vision / Communication Technical Depth	System Engineering Due diligence Delivery on time	Innovation Rapid response Trans-disciplinary

Core Process 1   Core Process 2   Core Process 3

FY07 $ in FY07 PB
By Area

$27M-Recent support*
($5.5M is CP3)

CP1-
Knowledge
$1434M

CP2-
Products
$194M

Focused Long
Term Challenges

Space
$500M

Air
$761M

Cyber
$400M

TOTAL: $1.655 Billion
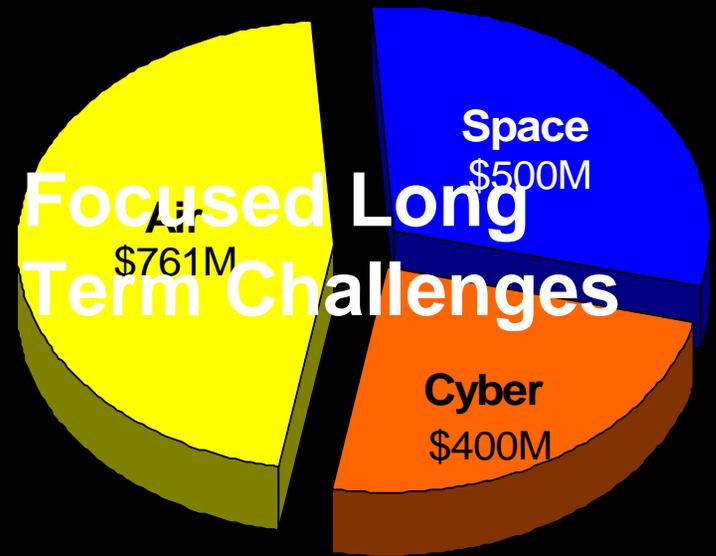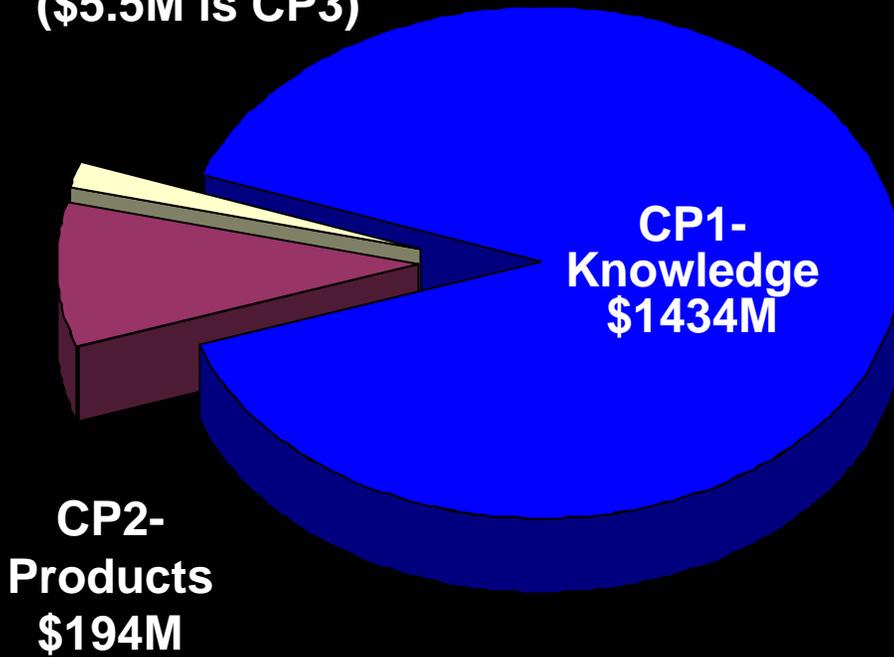
AIR   SPACE   CYBERSPACE

* Delivered to supporting current on-going combat operations

USAF S&T Vision:

Focused Long Term Challenges (FLTC's)
• Defined by AF Corporate Structure
• Approved by Fmr. AF SecDef

Problem Statements
• Address each FLTC
• Defined by HQ USAF

Programs (5-50) to
address each problem
Each FLTC & problem statements

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

AF²T²EA⁴

- FLTC #1
- FLTC #2
- FLTC #3
- FLTC #4
- FLTC #5
- FLTC #6
- FLTC #7
- FLTC #8

- Problem #1
- Problem #2
- Problem #3
- Problem #4

- Program
- Program
- Program

Many AFRL programs tied directly to the user's problems

FLTCs – Examined

Problem Statement #1

Anticipate...

Unprecedented Surveillance...

Dominate...

Persistent...

Problem...

FLTC #1
FLTC #2
FLTC #3
FLTC #4
FLTC #8

2.1 Enable High Performance Networks for Assured C2 and Sensing

Command, Control & Intelligence (C2I)

2.2 Deliver On-demand Fused Multi-Source ISR for Total Battlespace Awareness

Difficult Surface Target Engagement/Defeat

2.3 Assure Closed-Loop C2, ISR, Sensing and Processing (anticipatory)

Responsive Precision Engagement

Attribute   Evolution

2.4 Generate Wide-Area, Global Access...

- X Resolution
- Find Y size space objects
- Z Bandwidth

- X+ Resolution
- Find Y- size space objects
- Z+ Bandwidth

- X++ Resolution
- Find Y-- size space objects
- Z++ Bandwidth

Near   Mid   Far

FLTCs – Examined

Unprecedented Proactive Intelligence, Surveillance, and Reconnaissance (ISR)

Problem Statement #2

2.2 Deliver On-demand Fused Multi-Source ISR for Total Battlespace Awareness

Mid-Term Attribute 2.2.1

Survivable, High-altitude, Long Endurance, Multi-INT Sensing for Battlespace Awareness

Product 2.2.1.1 — **Improved Light Aircraft Structures (VA)**

Product 2.2.1.2 — **Structurally Integrated Aircraft Antennas (VA)**

Internally Funded Program

Partially or Un-Funded Program

Jointly Funded Program

Externally Funded Program

TRL MRL

TRL MRL

TRL MRL

TRL MRL

TRL Technology Readiness Level

MRL Manufacture Readiness Level

Socialization Process to Date

- 20 Jun 06   ACC/A8 and ACC Staff
- 21 Jun 06   AFSPC/A3 and AFSPC Staff
- 26 Jun 06   AFSOC/A8/A5 and AFSOC Staff
- 27 Jun 06   AFFTC Staff
- 28 Jun 06   AETC/A5/A8 and AETC Staff
- 14 Jul 06   SMC/CC
- 20 Jul 06   AFC2ISRC/A8 and AFC2ISRC Staff
- 25 Jul 06   ESC
- 28 Jul 06   AMC/A5 and AMC Staff
- 3 Aug 06   DTRA
- 7 Aug 06   Air Staff – A3, A8, AQR
- 30 Aug 06   NSSO S&T IPT
- 30 Agu 06   Air War College
- 31 Aug 06   AFSPC/CC
- 1 Sep 06   AF SAB
- 5 Sep 06   PACOM
- 7 Sep 06   ONR
- 11 Sep 06   N-81 Study Team
- 21 Sep 06   AFSPC

Socialization Process to Date

- ➤ **25 Sep 06**   **NAVAIR Process Council**
- ➤ **28 Sep 06**   **AFSOC**
- ➤ **5 Oct 06**   **Dir NASA Dryden**
- ➤ **5 Oct 06**   **AFRL-AFIT Summit**
- ➤ **6 Oct 06**   **AFSPC/CV Brief**
- ➤ **19 Oct 06**   **DTRA**
- ➤ **14 Nov 06**   **USSOCOM**
- ➤ **30 Nov 06**   **ACC/AFC2ISRC**
- ➤ **8 Dec 06**   **NASA HQs**
- ➤ **19 Dec 06**   **ASC/XR**
- ➤ **3 Jan 07**   **SAF/AQ**
- ➤ **3 Jan 07**   **DDR&E**
- ➤ **9 – 11 Jan 07**   **Deep Dive Workshop #1 – DC**
- ➤ **17 Jan 07**   **Cyber Command**
- ➤ **31 Jan 07**   **Dr Erbsloe, AMC/ST**
- ➤ **5 Feb 07**   **ASC Aeronautical Enterprise IPT**
- ➤ **7 – 8 Mar 07**   **Oak Ridge National Lab**
- ➤ **8 Mar 07**   **Idaho National Lab**
- ➤ **14 Mar 07**   **NGA**

Technology Insertion Day/Night EO/IR Tracker CM

➤ **Locates and defeats / denies use of passive infrared fire control systems and active laser trackers on man-portable and mobile SAM systems**

  – **Compatible with AFSOC/SOCOM platforms using DIRCM IR CM systems**

➤ **Detects threat IR sensors before weapon launch**

➤ **Provides threat location and possible threat classification**

➤ **Provides option to avoid, deny or counter the threat beyond missile launch range**

➤ **Denies enemy the ability to operate passively (forces RF use) and increases survivability**

➤ **Negates AAA and laser beam rider tracking**

COUNTERMEASURE

NWIR & LWIR Lasers

Azimuth Platter

Polygon Mirror

LWIR & NWIR Receivers

Receiver Electronics

Fine Steering Mirror
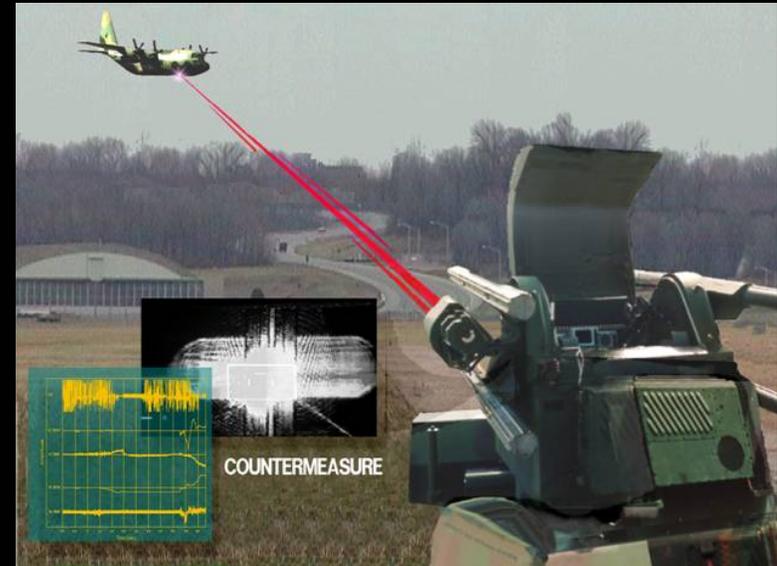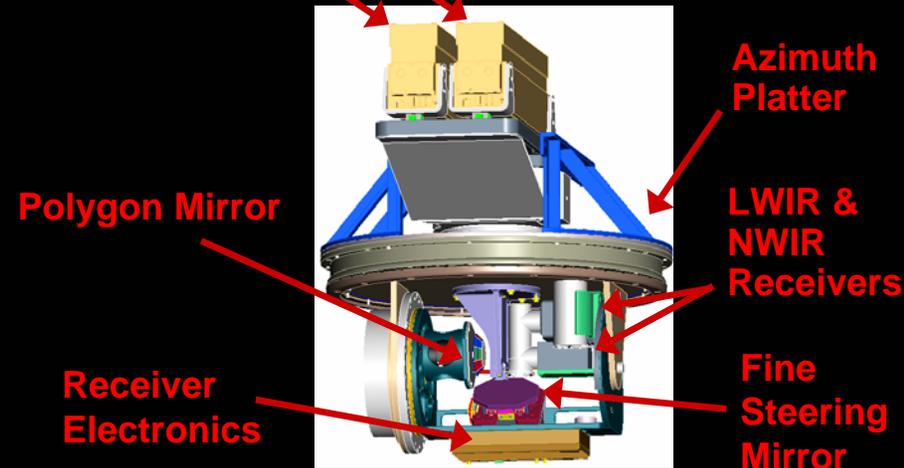
Technology Insertion
TacSat-3 Real Time Downlink & C2

TacSat-3 will explore multiple tasking and data dissemination methods; focused on delivering tactical effects

SIPRNET

VMOC (KAFB & TGS)

Payload DC (HAFB)

Mission Planning (KAFB)
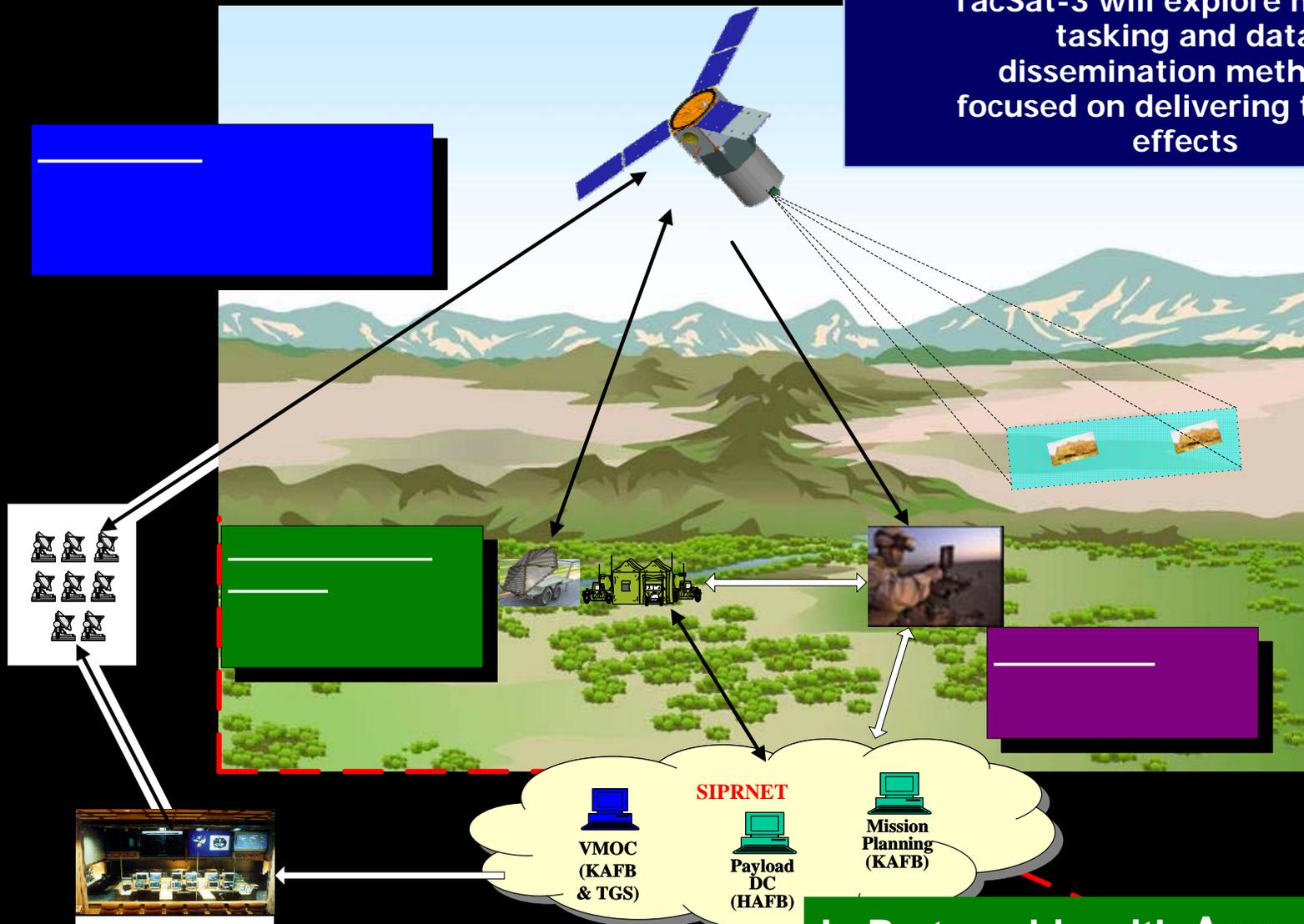
In Partnership with Army SMDC

BAO BRITES ATD SPIRAL 2

(PM – Lt. Josh Johnson, AFRL/PR)

Methanol Fuel Cells
~500 W·hr/kg

Solid Oxide Fuel Cell
~600 W·hr/kg
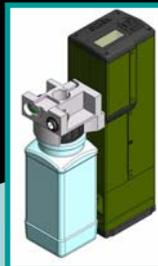
Zinc Air
~350 W·hr/kg

Rechargeable
Li Metal
~300 W·hr/kg

High Energy

Optimized Li Ion
~200 W·hr/kg

High Power

Lithium Ion
~200 W·hr/kg

**Power
Management**

Spiral 3
50%

Spiral 2
33% Wgt Savings

Spiral 1
25%

Technology Insertion
Trusted Tactical Weaponeering for Cyberspace
(PM – Rick Metzger, AFRL/IF)

➤ **Program objectives**
- Combines disparate cyber programs throughout the AF and Intelligence community
- Enhance C2 with remote cyberspace attack capabilities
  - Third leg of "C2 Triad"

➤ **Benefits to the Warfighter**
- Enables warfighter to dominate the cyberspace: strike anytime, anywhere
- Global reach: unprecedented access beyond physical and geo-political boundaries.
- Gathers intelligence for IPB
- Acts as non-traditional ISR asset: supports BDA

➤ **Schedule**
- Contract (Jan 06)
- Demo (Sep 09)
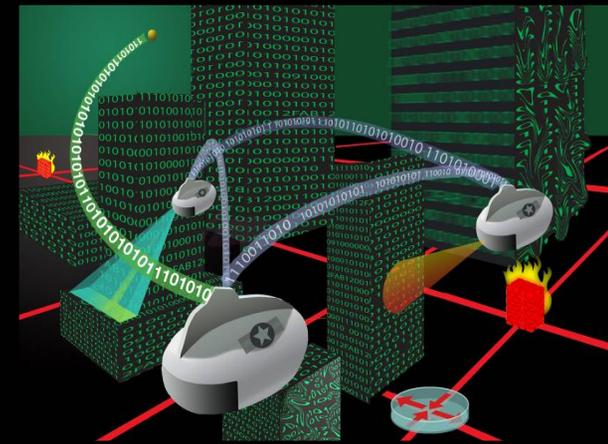
➤ **Commander Joint Space Operations Urgent Need**

  – **Rapid ability to assess space situation using existing information**

➤ **70% Quick-to-Field Solution Identified**

  – **Data fusion and intuitive display of telemetry, ephemeris, and space weather data**

  – **Plan to validate in Joint Space Operations Center (JSpOC)**

➤ **Coordinating plan with broader community (AFSPC, SMC, etc)**

Proposed

Q3 06	Q4 06	Q1 07	Q2 07	Q3 07	Q4 07

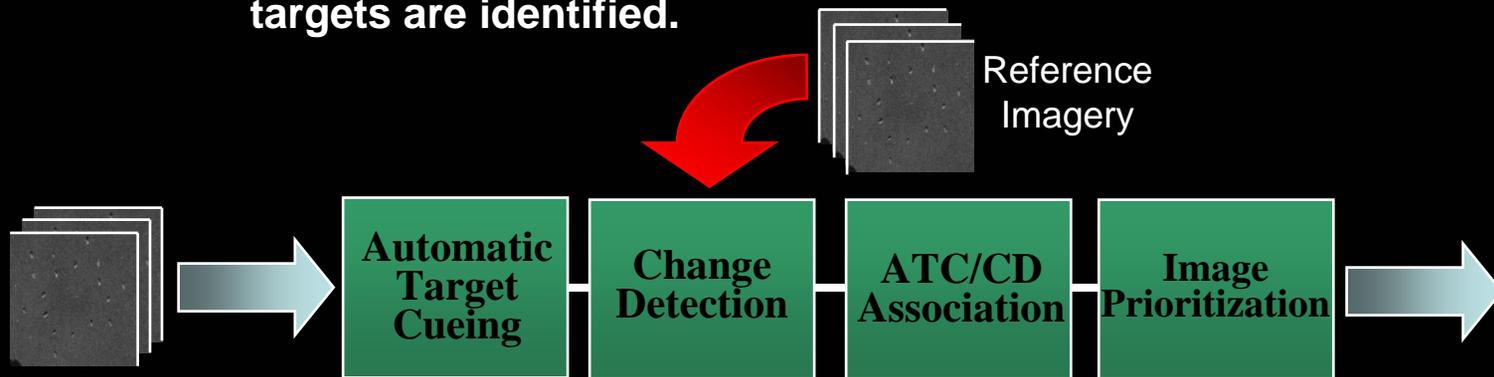**Need**   **Start**   **Demos**   **JSpOC TEST**
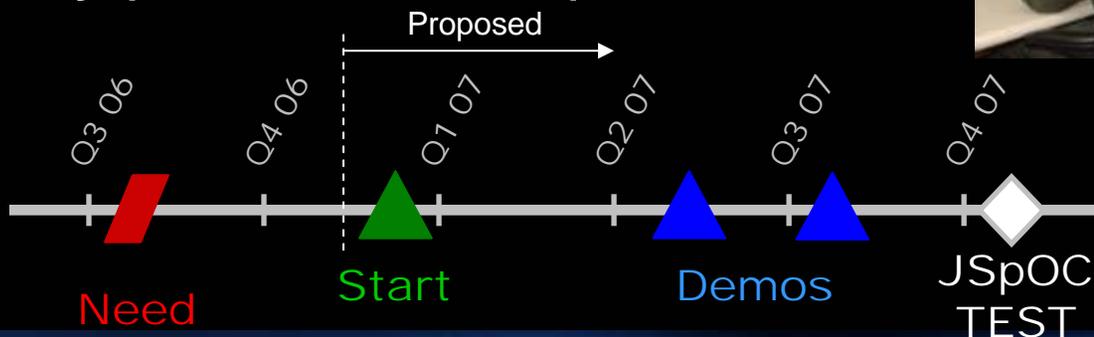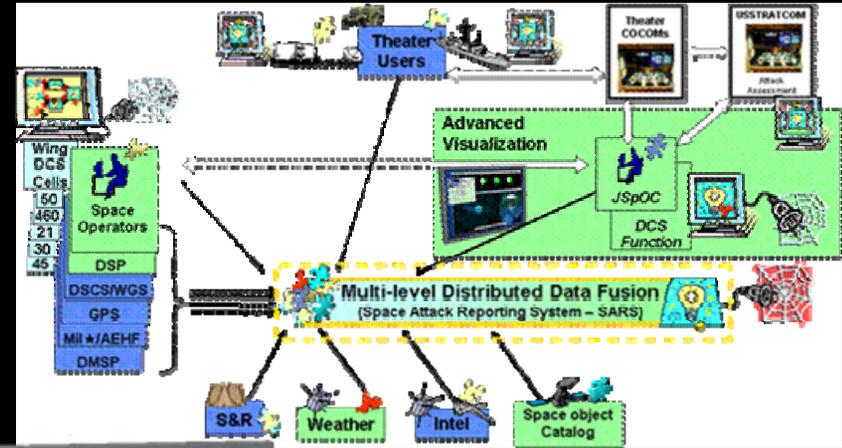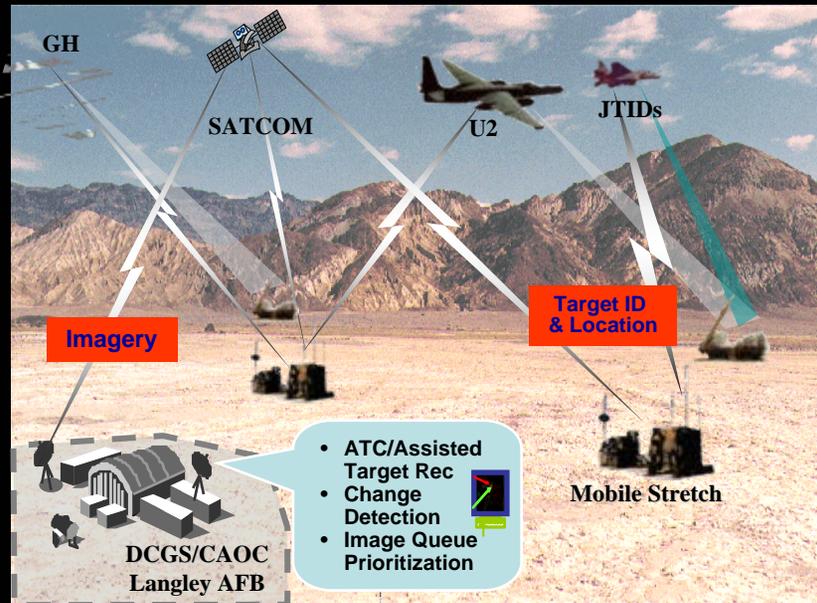
Rapid Response

Assisted Target Recognition for Time Critical Targeting

(PM – Lt. Amanda Martin, AFRL/SN)

➤ **Dynamic high value targets are only vulnerable for short periods of time**

➤ **Image Analysts are responsible for ever increasing, large volumes of data**

➤ **Solution**
 – **Automatic Target Cueing (ATC)**
  • **Automatic Target Detection**
  • **Assisted Target Recognition**
 – **Change Detection (CD)**
  • **Compares images collected at different times to identify change.**
 – **Image Prioritization.**
  • **Sources of information are correlated and images are most likely to contain targets are identified.**

GH
SATCOM
U2
JTIDs
Imagery
Target ID & Location

• ATC/Assisted Target Rec
• Change Detection
• Image Queue Prioritization

Mobile Stretch

DCGS/CAOC Langley AFB

Reference Imagery

Automatic Target Cueing → **Change Detection** → **ATC/CD Association** → **Image Prioritization**

New Imagery

AFT

Prioritization

Priority	Image Filename
92	FtChaffee
77	CompareNew
70	Reactor
26	NewZealand
16	GermanPhoto

ATR - Assisted Target Recognition

Confidence	ATR	ATR & DICE
☑ High	■	■
☐ Medium	▲	▲
☐ Low	●	●

Potential ATR Uses – Shorten Timelines

Current Process

Scene 31
Scene 30
Scene 29
Scene 28
Scene 27
Scene 26
Scene 25
Scene 24
Scene 23
Scene 22
Scene 21
Scene 20
Scene 19
Scene 18
Scene 17
Scene 16
Scene 15
Scene 14
Scene 13
Scene 12
Scene 11
Scene 10
Scene 9
Scene 8
Scene 7
Scene 6
Scene 5
Scene 4
Scene 3
Scene 2
Scene 1

Scene 31 → Report 31

Report 15
Report 14
Report 13
Report 12
Report 11
Report 10
Report 9
Report 8
Report 7
Report 6
Report 5
Report 4
Report 3
Report 2
Report 1

ATR

Exploitation Queue Prioritization

Scene 30
Scene 29
Scene 28
Scene 27
Scene 26
Scene 25
Scene 24
Scene 23
Scene 22
Scene 21
Scene 20
Scene 19
Scene 18

Scene 31 → Report 16
Scene 17 → Report 15
Scene 16 → Report 14
Scene 15 → Report 13
Scene 14 → Report 12
Scene 13 → Report 11
Scene 11 → Report 10
Scene 10 → Report 9
Scene 9 → Report 8
Scene 8 → Report 7
Scene 7 → Report 6
Scene 6 → Report 5
Scene 5 → Report 4
Scene 4 → Report 3
Scene 3 → Report 2
Scene 2 → Report 1
Scene 1

Key Observations

- Collaboration a must

- Direct warfighter-scientist interaction essential

- Put high risk efforts in lab, not in programs

AFRL

LEAD | DISCOVER | DEVELOP | DELIVER

AFRL Rapid Reaction Project Cyberspace

- ➤ **Addressing urgent needs for MAJCOMs (PACOM) and soon to be:**
  - Cyber Command
  - ISR Command
- ➤ **Understanding the urgency for rapid action within the cyber arena**
  - Access, stealth and persistence
  - Cyber tracking technology
  - BDA/IPB
  - PSYOPS
  - Cybercraft
  - Anticipatory modeling of human behavior
- ➤ **Identified CP3 projects**
  - Information Support Server Environment Guard
  - Web Enabled Timeline Analysis
  - DODIIS Trusted Workstation
  - Joint Targeting Toolkit

ANDREW M. COLARIK
CYBER TERRORISM
Political and Economic Implications
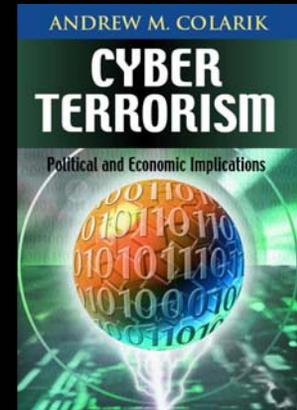
Core Process Alignment with Customer Timelines and Needs

SECAF, Chief – long view, strategic planning

PM, Industry/Product Center – next generation, acquisition timelines

Warfighter – day-to-day, employing capabilities

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023

rapidly deliver technical innovation, driven by warfighter emergencies –*reshape today's battles*

Core Process 3 — **CP3**

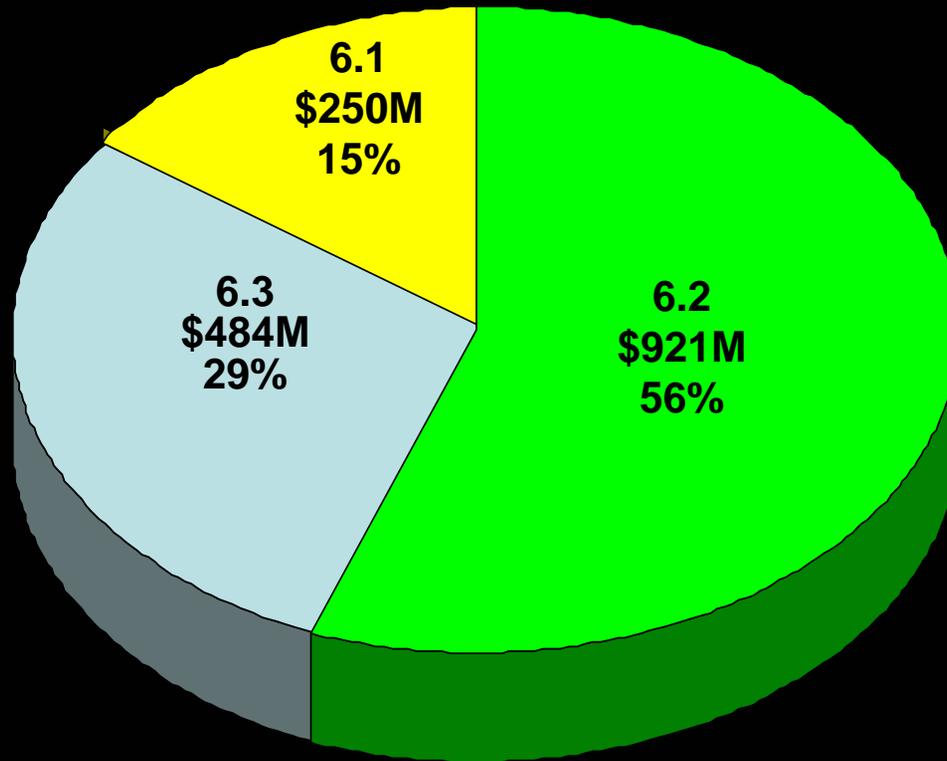**develop technology options that meet the needs of capability developers – *shape today's Air Force***

Core Process 2 — **CP2**

conduct long-term research, driven by a bold technology goal – *shape the future Air Force*

Core Process 1 — **CP1**

AF Budget Investment
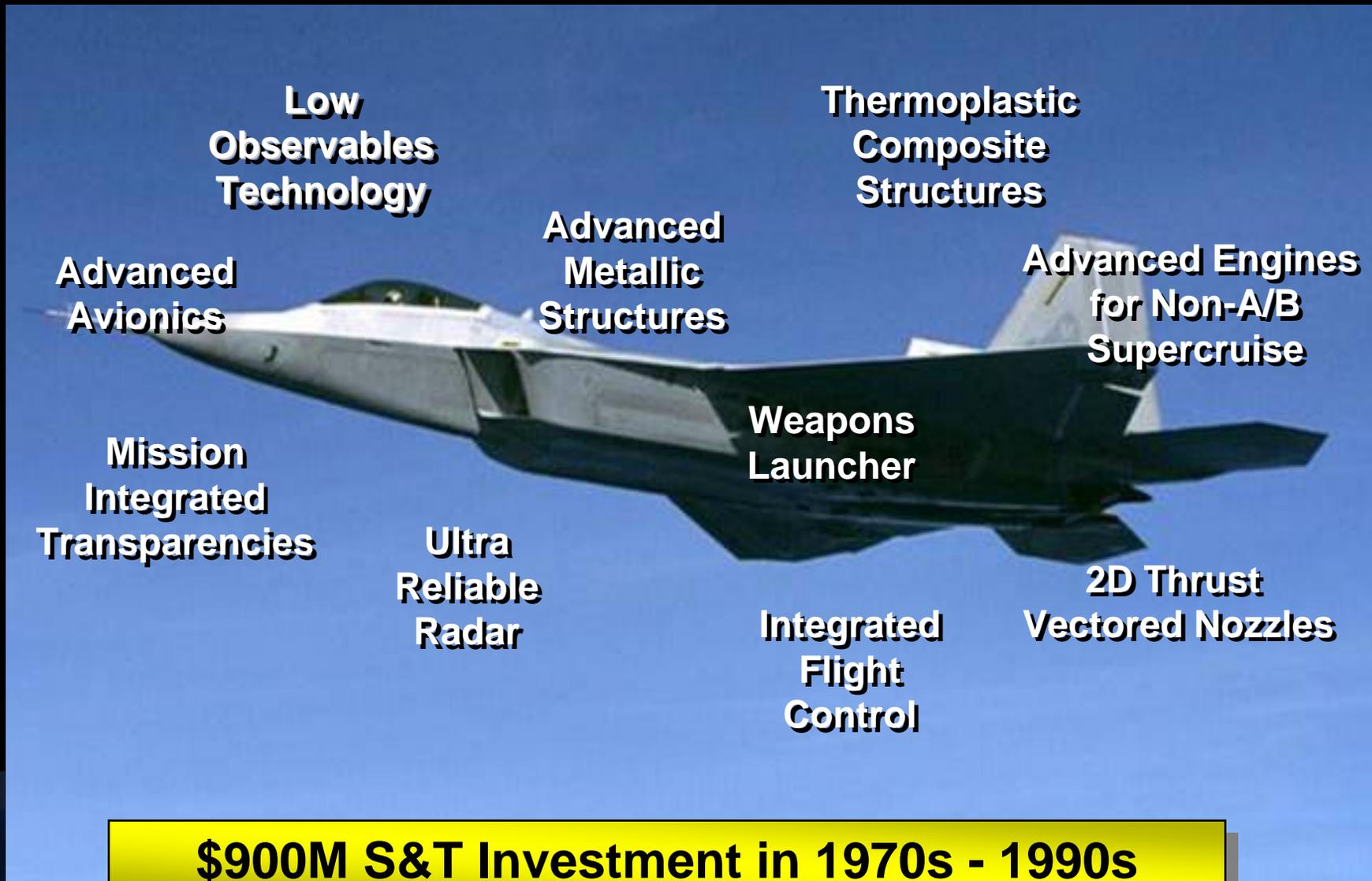# By Budget Activity

TOTAL: $1.655 Billion

AFRL Technology Transitions to F/A-22

Low Observables Technology

Thermoplastic Composite Structures

Advanced Avionics

Advanced Metallic Structures

Advanced Engines for Non-A/B Supercruise

Weapons Launcher

Mission Integrated Transparencies

Ultra Reliable Radar

Integrated Flight Control

2D Thrust Vectored Nozzles

$900M S&T Investment in 1970s - 1990s

CE

Pneumatic Ejection

Affordable, Unitized Composites

Flight Control Development

Multi-Function Integrated RF System

Diverterless Supersonic Inlet

JSF Integrated Subsystems Technology & More Electric

IHPTET & Materials for F135 & F136

Engineering & Campaign Simulations

AFRL Technology Transitions to UAVs

Electric Actuators

Automatic Collision Avoidance

Operator-Vehicle Interface

Multifunctional Structures

Low Cost Structures

Reliable Autonomous Control

Revolutionary Manufacturing Processes

Antenna Integration Testing

Unusual Configuration Aerodynamics

Continuous Moldline Technology

Command, Control, & Communications

Aerial Refueling/Rearming

Advanced Propulsion Integration

Miniaturized Munitions

Advanced Targeting

Small/Micro UAV Development

AIR   SPACE   CYBERSPACE

AFRL Technology Transitions to Space

Propulsion/Propellants

Synthetic Aperture Radar

Electric Power - Solar, Chemical & Mechanical

Electro-Optic Sensors

Communications

Signal Processors

Radiation Hardening

Satellites

Microelectromechanical Systems

Antennas

Structures & Materials

Ground Processing
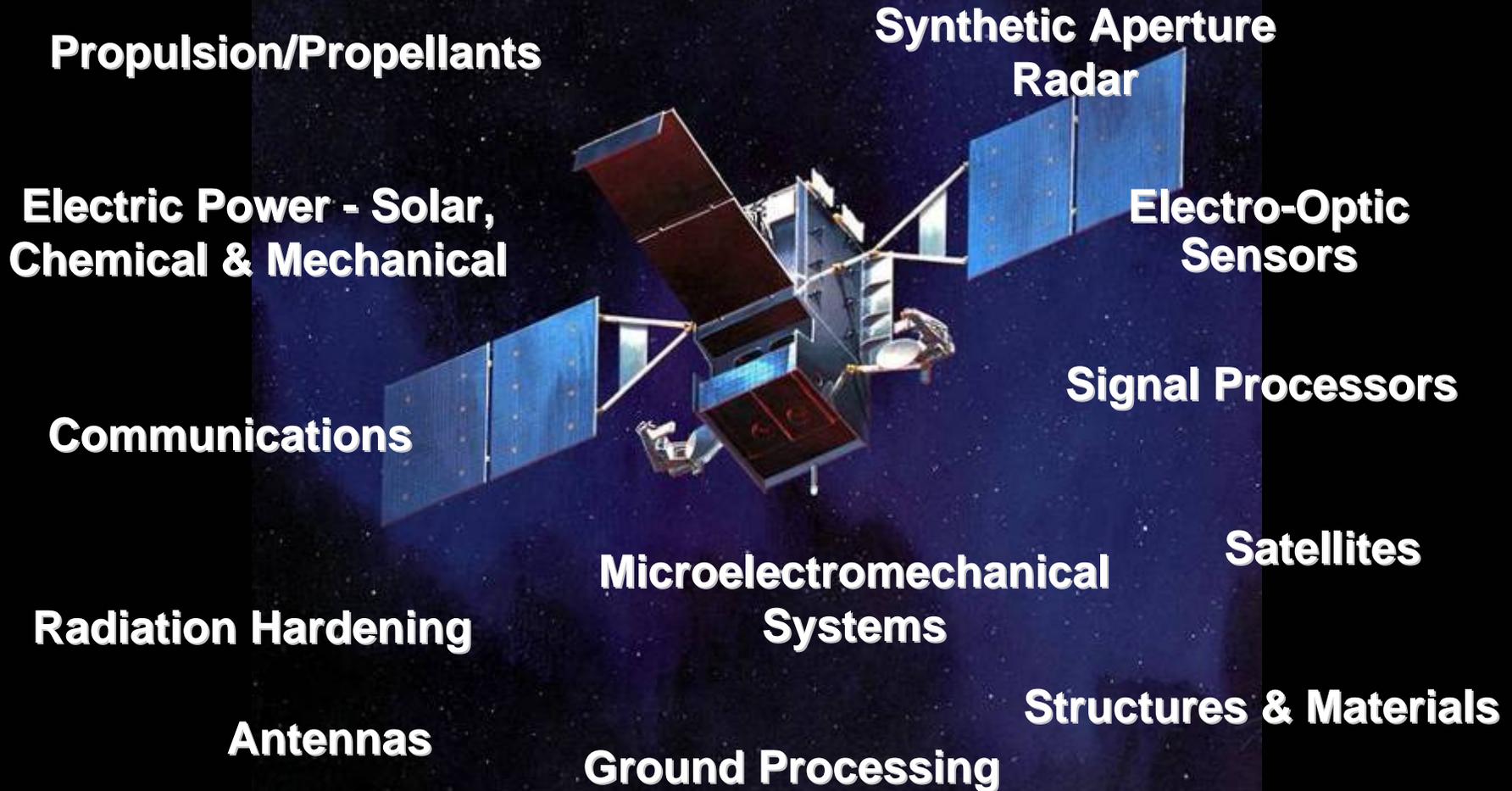
AIR *SPACE* *CYBERSPACE*

AFRL Information Technology Transitions

Work-Centered Technology

Dynamic Planning and Execution

Sensor Data Information Fusion

Cyber-Cognitive Processors

Intelligent Agents

Fuselets Technology

Decision Support Technologies

High Bandwidth Data Transmission

Cryptological Technologies

Information Assurance Technologies

Intelligent Databases

Network Languages
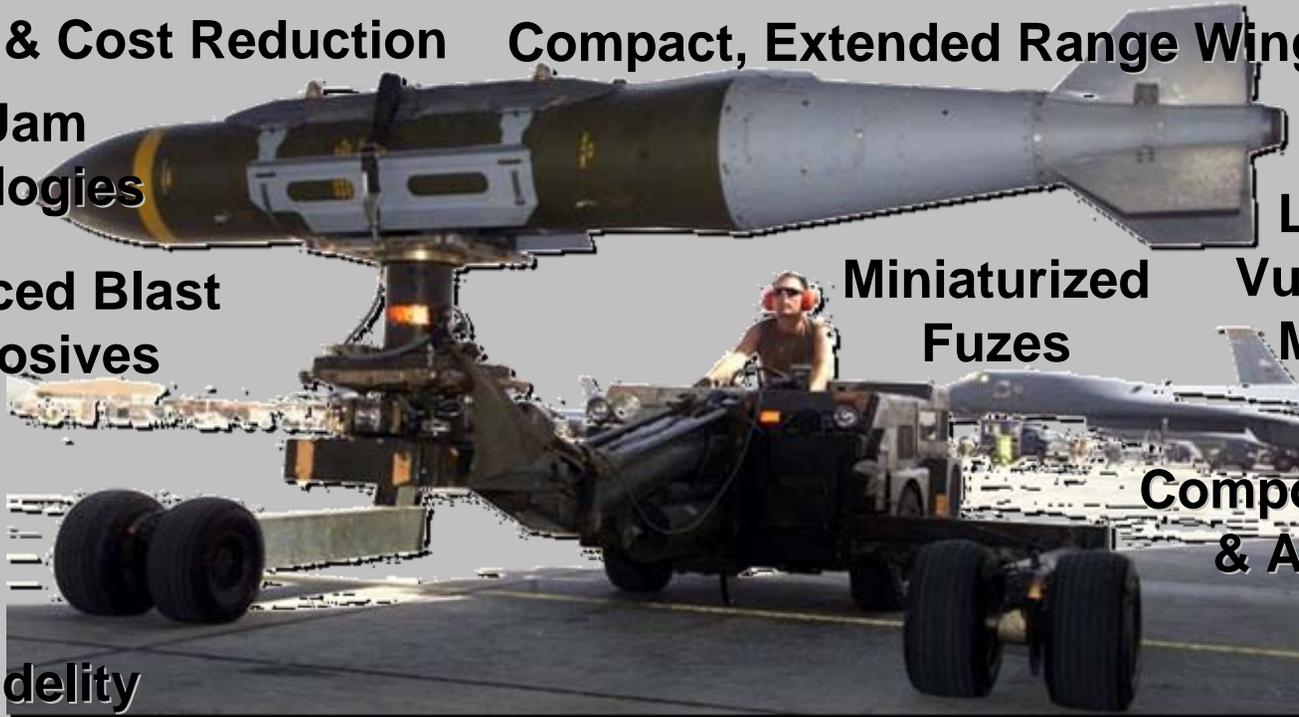
AIR   SPACE   CYBERSPACE

AFRL Technologies Support Operation Iraqi Freedom

- **Battlefield Air Operations Kit**
- **Anti-Jam GPS**
- **Massive Ordnance Air Burst**
- **Panoramic Night Vision Goggles**
- **CRASH Prompt Agent Defeat**
- **Surface Target Ordnance Package**
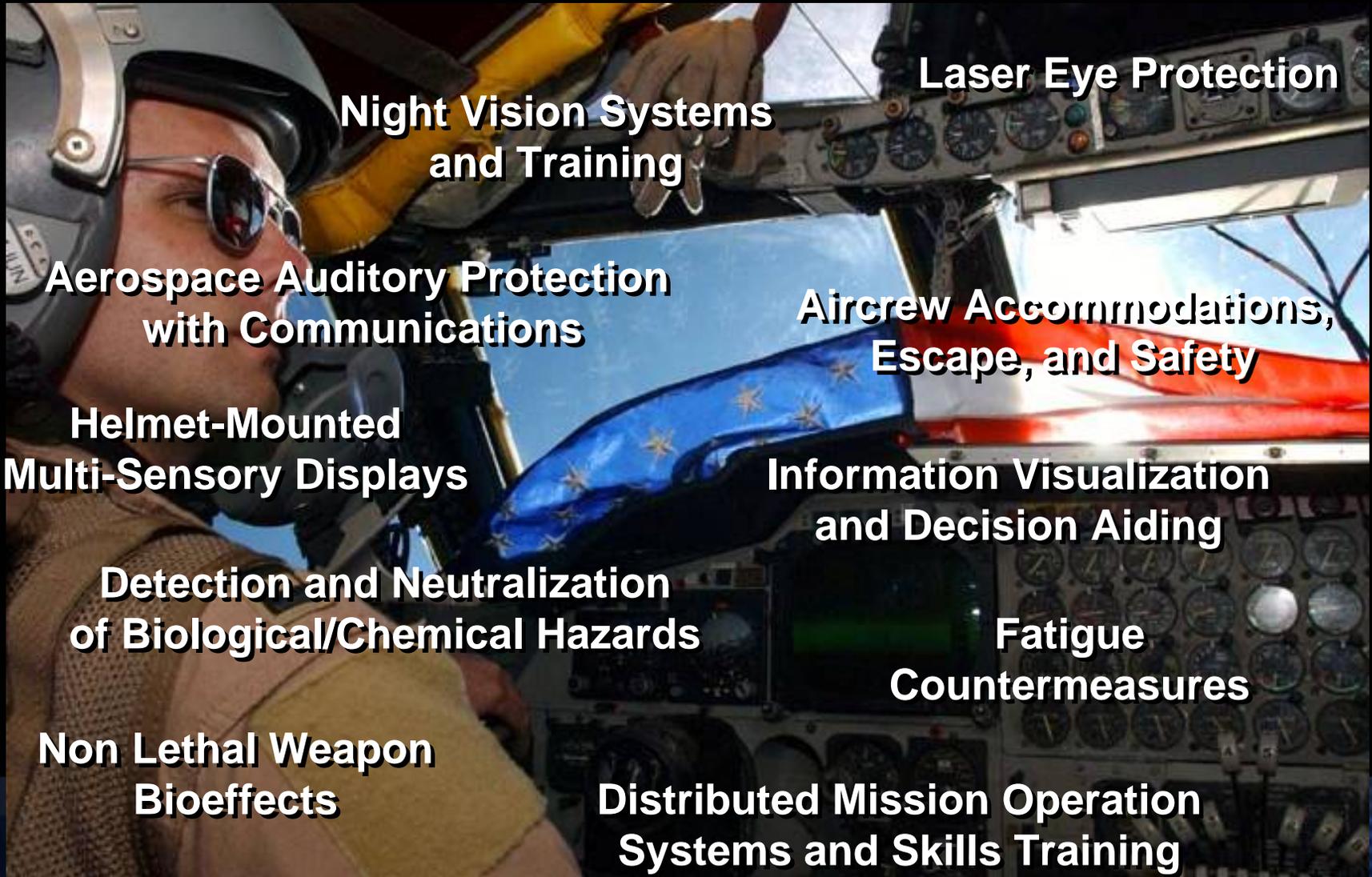- **Laser Eye Protection**

AIR　　　　　*SPACE*　　　　　*CYBERSPACE*

AFRL Human Effectiveness Technology Transitions

Night Vision Systems and Training

Laser Eye Protection

Aerospace Auditory Protection with Communications

Aircrew Accommodations, Escape, and Safety

Helmet-Mounted Multi-Sensory Displays

Information Visualization and Decision Aiding

Detection and Neutralization of Biological/Chemical Hazards

Fatigue Countermeasures

Non Lethal Weapon Bioeffects

Distributed Mission Operation Systems and Skills Training

AIR   SPACE   CYBERSPACE

AF Office of Scientific Research

- **Physics & Electronics**

- **Mathematics & Space Sciences**

- **Aerospace & Materials Sciences**

- **Chemistry & Life Sciences**

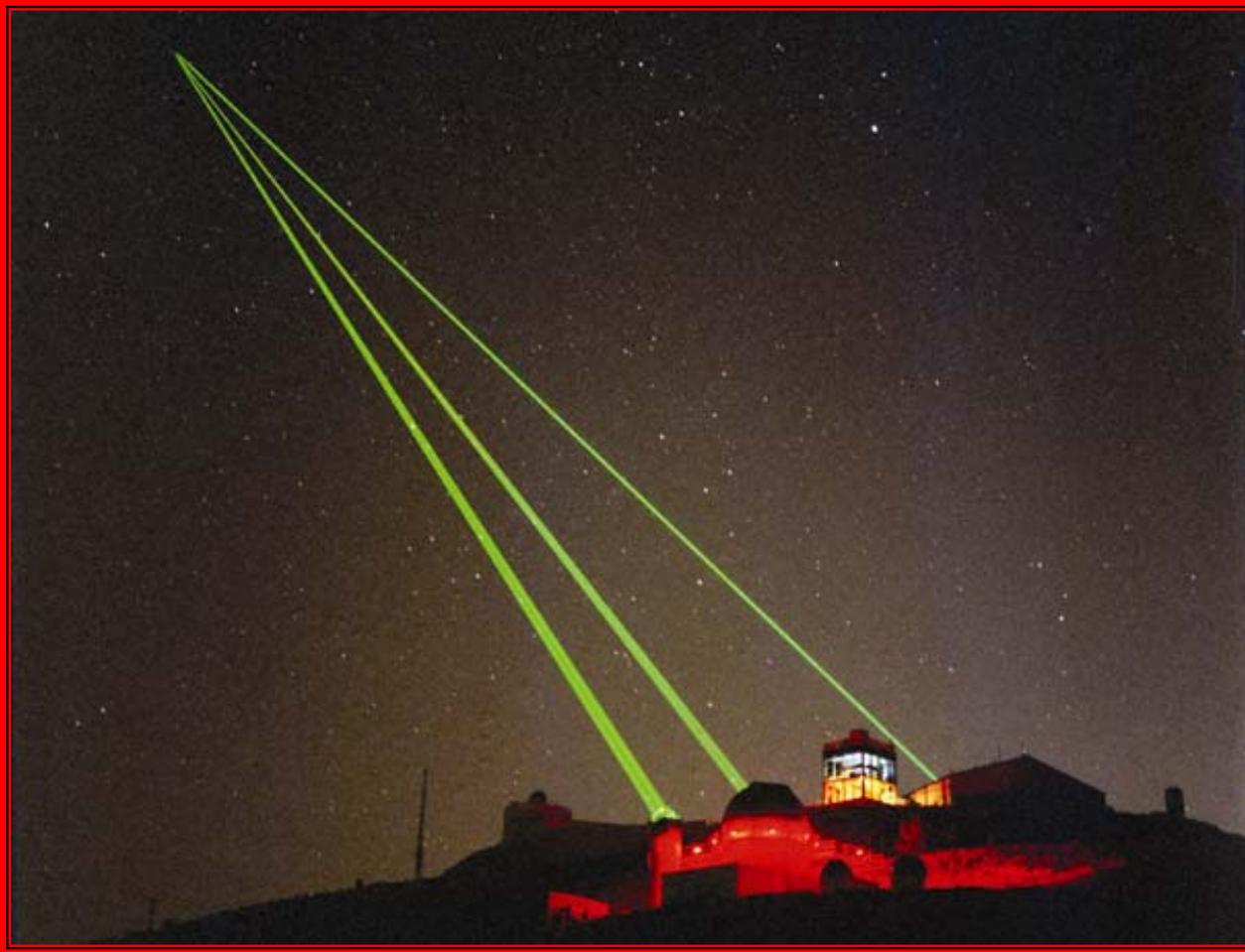# Air Vehicles Directorate

- **Sustaining Today's Fleet**

- **Unmanned Air Vehicles**

- **Space Access & Future Strike Technologies**

Directed Energy Directorate

- Lasers
- High Power Microwaves
- Advanced Optics & Imaging

Human Effectiveness Directorate

- **Warfighter Training**

- **Crew System Interface**

- **Bioeffects & Protection**

- **Deployment & Sustainment**

Information Directorate

- ➤ **Dynamic Planning & Execution**
- ➤ **Global Awareness**
- **Global Information Enterprise**

Materials & Manufacturing Directorate

- Metals, Ceramics
- Polymers, Composites, & Coatings
- Laser-Hardened & Sensor Materials
- Manufacturing Technology
- Non-Destructive Evaluation
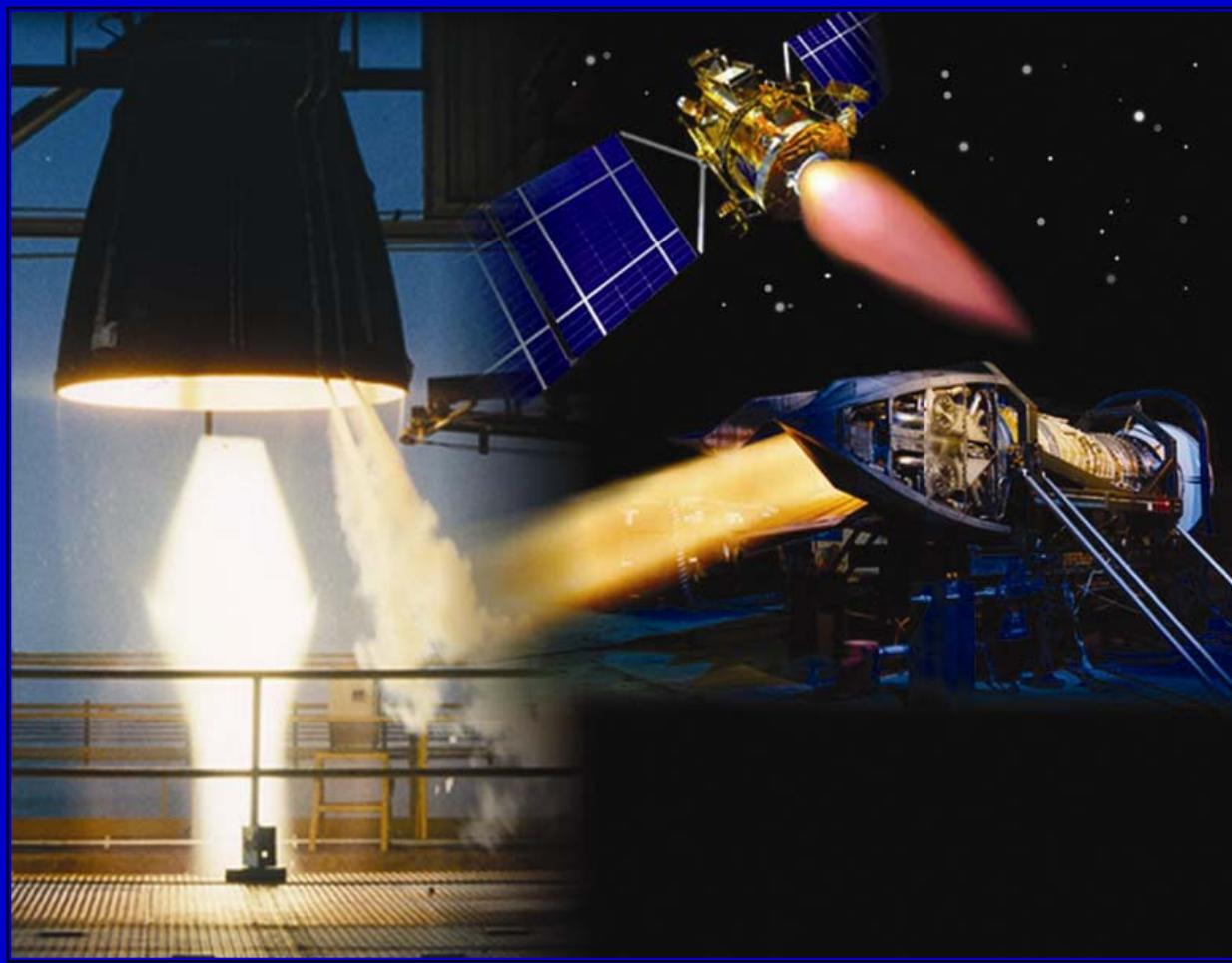- System Support

Munitions Directorate (MN)

- **Precision Munitions**

- **Counterproliferation**

- **Alternative Effects Weaponry**

Propulsion Directorate (PR)

- **Turbine Engines**

- **Fuels & Lubricants**
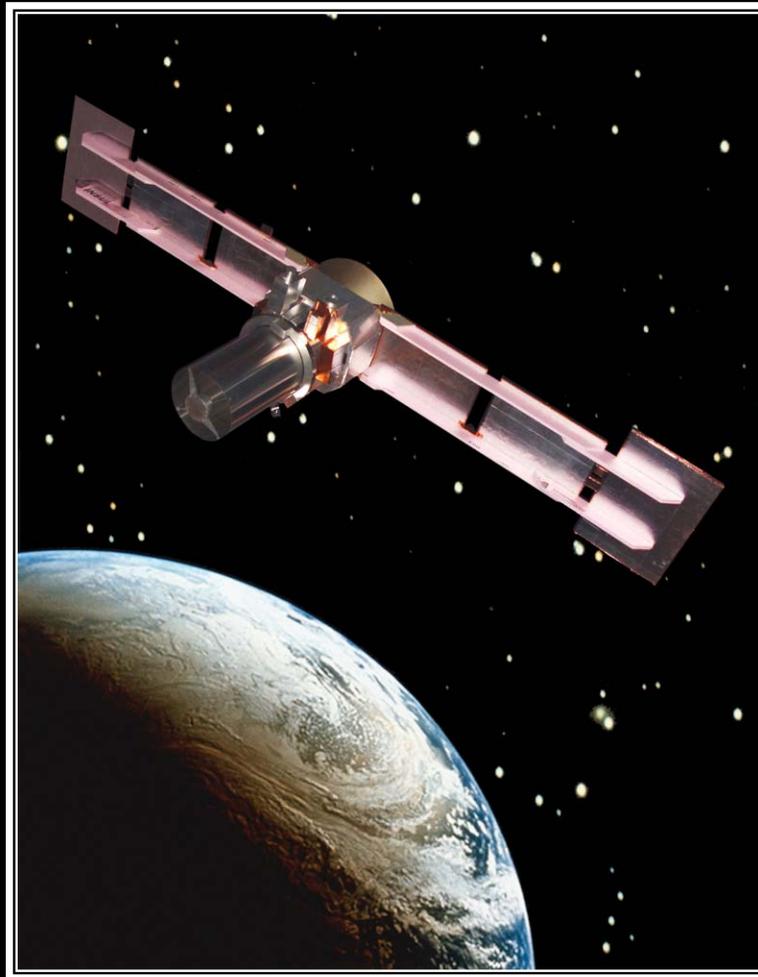
- **Liquid & Solid Rocket Power**

Sensors Directorate (SN)

- **Radio Frequency Sensors & Countermeasures**
- **Electro-Optical Sensors & Countermeasures**
- **Automatic Target Recognition & Sensor Fusion**

Space Vehicles Directorate

- Space-Based Surveillance
- Space Capability Protection
- Counterspace
- Space Access