Weapons TFA

Integrity ★ Service ★ Excellence

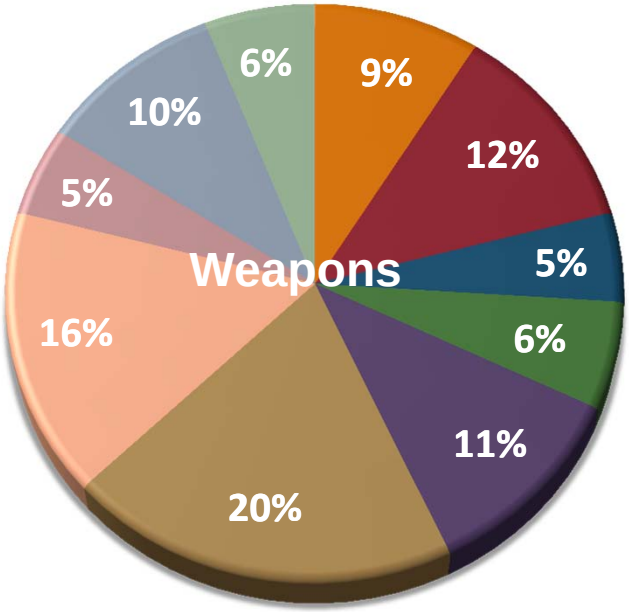
Vision Statement

Fully *integrated weapons S&T portfolio* that exploits both the unique and complementary capabilities of *Kinetic and Directed Energy* systems in meeting the *needs of the US Air Force and the Joint Warfighter*

Tech Focus Area Core Technical Competencies (CTCs) ($310M FY14 TOA)

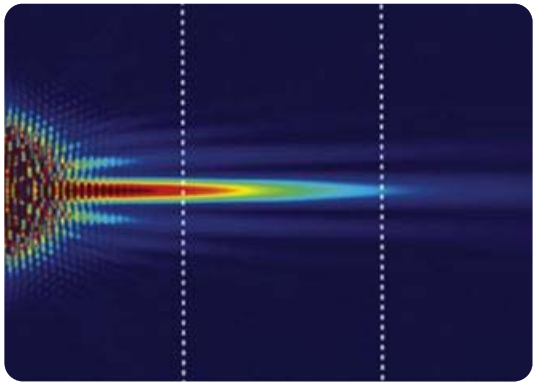
- Bio-Effects
- Basic Research
- Fuzing
- Ordnance Sciences
- Laser Systems

15% of FY14 TOA allocation



- Air Vehicles/High Speed Systems
- Guidance
- High-Powered Electro-Magnetics
- Munitions Systems Effects Sciences
- Functional/ Structural Materials

Weapons
Basic Research (FY 14 $3.1M)



Federico Capasso at Harvard University demonstrated a new type of light beam that propagates without spreading outwards which will improve photonic devices.

Mission/Vision Statement

Mission: We discover, shape, and champion basic science that profoundly impacts the future Air Force.

Vision: The U.S. Air Force dominates air, space, and cyber through revolutionary basic research.

Goals/Objectives

Goals: Revolutionary advances in nonequilibrium chemistry, nanotechnology, high power laser research as well as novel propulsion, production, storage, and utilization of energy.

Objectives: To develop novel energetic materials by integrating core disciplines of combustion, plasma dynamics, chemistry, hybrid simulation, structures and materials.

Motivation

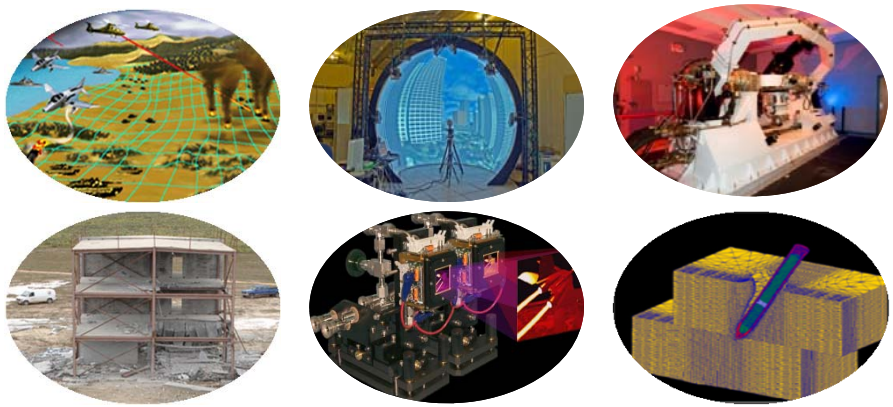
- Develop power systems that involve materials at high energy density as well as plasma effects on combustion and control surfaces
- Discovery of novel, thermally robust materials and new techniques for characterizing, predicting and controlling thermal phenomena
- New theoretical and experimental approaches to advance macro and micro energetic systems

Technical Approach/Ideas

Fundamental science to support AF needs in multiple applications:

- Investigate new technology such as thermopower wave, that convert chemical energy to fuel cells
- Explore layered metallic systems for optimal synergy between magnetic, structural & superconductors
- Develop the mechanistic understanding of catalytic processes to activate small, gaseous inorganic molecules
- Developed new materials using carbon nanotubes and composites to create systems such as morphing
- Create new optical cavities to generate powerful laser beams

Weapons TFA
Munition System Effects Sciences CTC
(FY14 $15.5M)



Mission/Vision Statement

- **Mission** - Provide the knowledge and M&S capabilities to support the design, test, assessment, and transition of advanced munition system and subsystem technologies
- **Vision** – Be the preeminent munition launch-to-lethality assessment group reducing the time, cost, and risk associated with development and transition of munition components and concepts

Goals/Objectives

- Advanced physical modeling, higher fidelity, and faster running
- More accurate physical modeling of advanced technology and environments
- M&S tools and analyses

Motivation

- Launch to lethality simulation capability including physics based, 6-DOF, mission, scene generation, and HWIL
- Accurate analysis limited by numerous tech challenges outlined in detailed CTC research plan
- Reduced risk in development

Technical Approach/Ideas

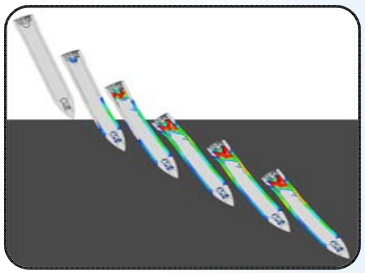
What are key technical ideas

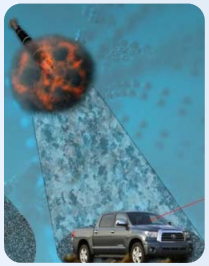
- Mesoscale, molecular, and atomistic scale computational mechanics for lethality and survivability
- EO/IR/RF/Ladar scene projectors – high temp IR, wide FOV, IR LED, multi-spectral/hyper spectral projectors
- KE/DE integrated effects tools for analyses/ weaponeering
- Synthetic scene generation tools – FPGA and massively parallel GPU's, distributed, hyper spectral
- 6-DOF, mission, and campaign level simulations for performance analysis and concept development

Weapons TFA
MSES CTC

Near-Term 2013-2015

Weapon/Target Interaction

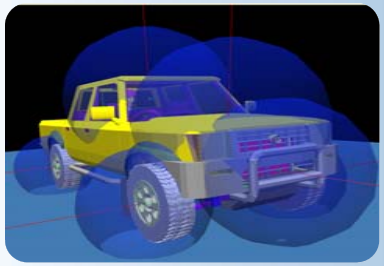




- Precision small weapon blast
- Combined blast+fragment loading
- Multi-phase blast effects models
- Functional defeat
- Validation of structural response
- Propagation through failed openings

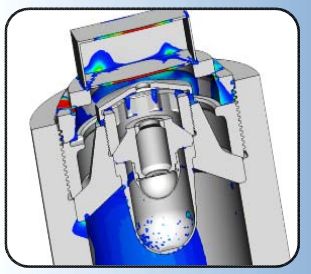
Mid-Term 2016-2020

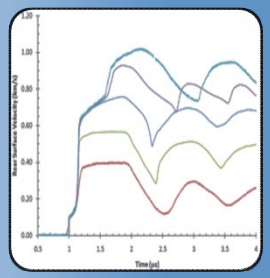
Coupled, Validated M&S Tools



- Coupling molecular mechanics models into hydrocodes
- Testing and model development of functional defeat methodologies
- Modeling synergistic effects
  - KE / DE
  - Blast/frag
- Collective Defeat

Far-Term 2021-2025





- High resolution physics models into fast running lethality codes
- Complete warhead system simulation at quantum physics level

Higher Lethality Warheads, Energy Coupling and Robust M&S

Weapons TFA
Fuze Technology CTC (FY 14 $15.5M)

Mission/Vision Statement

- **Mission**: discover, develop, integrate, and transition fuze technology that maximizes weapon lethality, survivability, and safety for air-delivered munitions
- **Vision:** To work the technologies today that provide the safest, most reliable, and most lethal fuzing systems of tomorrow's air-delivered weapons.

Goals/Objectives

- **Goal:** maximize weapon lethality, survivability, and safety for air-delivered munitions through revolutionary advances in high shock physics of materials, energetic material initiation sciences, terminal target detection and initiation control
- **Objectives:** Reliable fuzing in hypervelocity penetrators, lethal coupling of electrical/mechanical/chemical energy, Adaptive active imaging, novel power generation technique

Motivation

- Current fuzing technology evolution of WWII concepts
- Limits flexibility in weapon design and forces complexity with reduced reliability
- Research in revolutionary fuzing architectures, techniques, materials, and components allows for systematic approach to novel weapon design resulting in reduced size, decreased costs, and increased performance

Technical Approach/Ideas

- Distributed Embedded Fuze System - DEFS
  - Simplifies Ordnance design
  - Increases reliability
  - Decreases cost of acquisition and logistics
- Miniaturized Sub-millimeter wave proximity fuzing
  - Form factor compatible with both full-size and miniature munitions
  - Advanced Algorithms for sub-meter accuracy
- Sub-nanosecond interferometer initiation growth diagnostics

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Weapons TFA
Fuze Technology CTC

Near-Term 2013-2015

Mid-Term 2016-2020

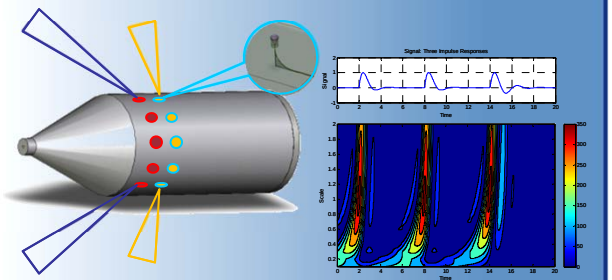
Far-Term 2021-2025

Fuzing

Brilliant Fuzing

- Survivability protocol for legacy fuzing applications
- Hardened post-impact fuze module
- Precision Height of Burst (HOB)

- Validation (test, M&S) of fuze environment
- Distributed fuzing



- Non-inertial target detection
- Tactical imaging for mass-focused directional ordnance

Enhanced Survivable Fuzes

Weapons TFA
Ordnance Sciences CTC (FY 14 $49.7M)

Mission/Vision Statement

- **Mission:** Discover, develop, integrate and transition leading-edge science and technology in ordnance systems for ensured effects required by the AF mission.
- **Vision:** US air power supremacy through ordnance systems having precision outcome; every time and at every application.

Goals/Objectives

- **Goal:** Provide the optimal response of conventional weapons through core competencies in ordnance materials, understanding energy effects and coupling to the target, and leading new energetic formulations for tomorrow's warfighter requirements.
- **Objectives:** Selectable and tailored response of the weapon-target engagement, safe but robust lethality for explosive ordnance, highly survivable in the extreme environments of impact and weapon carriage.

Motivation

- Today's weapon system must be highly flexible across a wide-range of applications.
- Targets of tomorrow are harder, deeper and more greatly protected against strike effects.
- Autonomous weapons evolving today require selectable and responsive kill mechanisms
- Integrated weapon effects for non-linear increases in complex and functional kill are now realizable
- Space & volume constraints require multi-functional materials with structure and energy release

Technical Approach/Ideas

- Reactive Material Structures
  - Strength and density of steel with 4X energy of explosive/steel penetrating systems
- Survivable explosives for tomorrow's $5^{th}/6^{th}$ Gen
  - High thermal and vibration of explosives in hypersonic platforms
  - Shock survivable in high speed penetrators
- Multi-phase blast and optimal target coupling
- Sound, international lead in specific Ordnance Sciences tech base and Discovery for tomorrow's capabilities

AFRL

Weapons TFA
Ordnance Sciences CTC

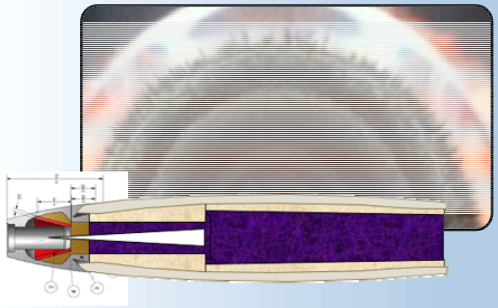
Near-Term 2013-2015

HDBT Defeat & Small Wpns

- Survivable warhead design with novel nose and tail fuzewells
- Low collateral damage and miniature warheads
- Material properties under extreme loading conditions
- Eglin Steel - ES-1V

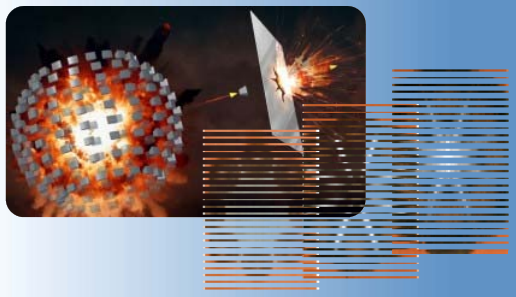
Mid-Term 2016-2020

Enhanced Lethality – Increased Loadout



- Materials and structures for extreme environment survivability
- Adaptive response for increased lethality and low collateral damage
- Optimized multifunctional warhead technologies, e.g., reactive structures

Far-Term 2021-2025



- Non-kinetic energy solutions for target defeat
- Directional, multimode, tailorable output warheads
- Joint/multi-service integrations

HPEM CTC
(FY 14 $15.5M)

Mission/Vision Statement

- Research & Develop Non-Kinetic Technologies to enable electronic attack
- Develop technologies for HPEM weapons across the full span of legacy, new, and future air platforms

Goals/Objectives

- Develop HPEM sources and components that provide significant size reductions with enhanced power/energy
- Seeking knowledge in HPEM sources, materials and components
- Deliver laboratory breadboard systems and employment concepts for transition to the warfighter

Motivation

- CHAMP JCTD demonstrated the operational utility of HPM weapons
  - Engage multiple targets with no collateral damage
- Legacy, new, and future air platforms require further size reductions with increased effectiveness ranges
- Enable HPEM weapons for both rapid acquisition and for future air platforms

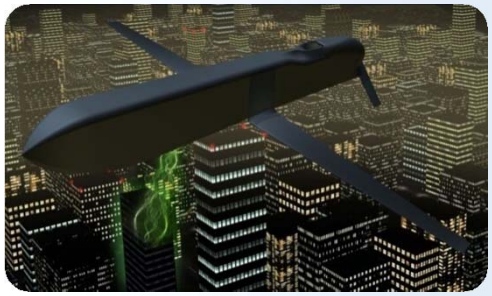
Technical Approach/Ideas

- Exploit nanomaterials and metamaterials for high power microwave sources and systems
- Exploit advances in energy storage and power generation to build compact HPM/DE power systems
- Advance computational capabilities to address multi-scale simulation requirements for HPEM system design
- Develop predictive effects models to simulate HPM effects across multiple systems

HPEM S&T Strategy
Capabilities / Deliverables (FY14 $40M)

Near-Term FY13-18

Next Gen Airborne Counter Electronics Demo with operationally relevant ranges



- Compact flexible HPM sources and pulsed power
- Characterize complex effects, model effectiveness
- Design, develop, test and assess a multi-shot and multi-target HPM cruise missile
- Agile waveform sources, compact pulsed power
- Transition to acquisition

Mid-Term FY19-24

Deliver enhanced Counter Electronic Effects from operational platform

- Transition technology & knowledge to acquisition, industry & warfighter
- Optimize waveforms for enhanced effectiveness
- Improve source efficiency
- Reduce system size / weight
- Develop BDA technologies

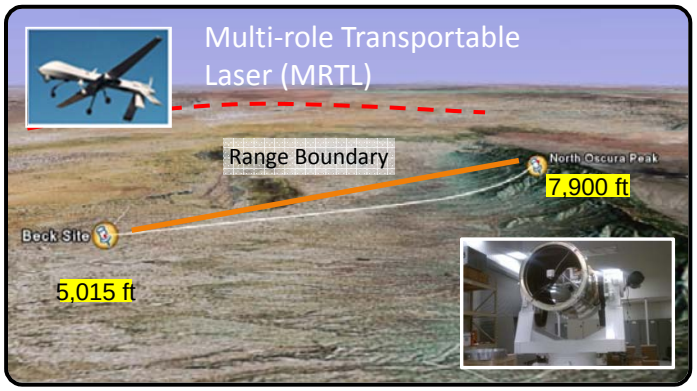
Far-Term FY25-30

Deliver Adaptive, Long-Range Counter Electronic Effects, Smart Waveform Cyber/EW Attack

- Smart waveform HPM subsystems to greatly reduce weight / volume on small re-useable platforms
  - Decreased SWAP HPM sources
  - Cooperative target engagement real time BDA
  - Waveform control for optimized effects; validation of target vulnerability assessments

Transition Increasingly Capable, Game-Changing CE Weapon Technologies

Weapons
Laser CTC (FY 14 $62M)



Mission/Vision Statement

- Develop and Integrate Laser Systems to meet the MAJCOM gaps and S&T needs
  - Emphasize solutions for an A2/AD environment

Goals/Objectives

- Demonstrator Laser Weapon Systems
  - Objective: Integrate first-gen electric laser (HELLADS)/beam control and demonstrate lethality
- Ground-based Self-defense (Multi-Role Transportable Laser)/ Retire S&T by Integrating a fiber laser system into a platform

Motivation

- Develop solutions to address the A2/Ad environment
- Improve SA and CID, and Defeat air and ground targets
- Develop a ground based defensive capability for area/unit defense

Technical Approach/Ideas

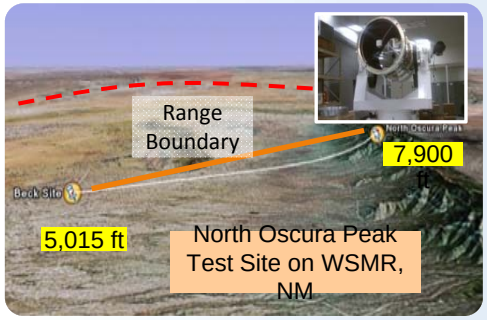
- Integrate/demonstrate planning capability concept to retire fiber laser integration risks with specific emphasis on future airborne systems.
  - End-to-end modeling
  - Lethality demonstration
- Integrate/demonstrate Pod mounted planning capability concept to increase the TRL level of an airborne countermeasure system
  - Perform ground demonstration tests
  - Perform airborne demonstration tests

AFRL

Laser Systems Strategy
Capabilities / Deliverables (FY14 $55M)

Near-Term FY13-17

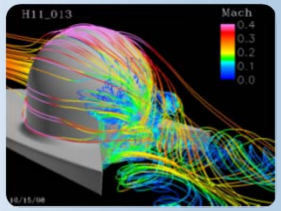
- Demo lethal effects with integrated
  1st gen HELLADS/LS technology



- Multi-Role Transportable Laser (MRTL)

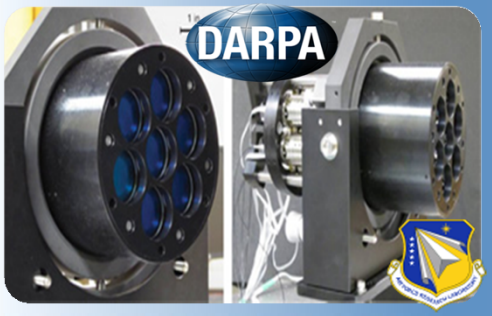
Mid-Term FY18-22

- Airborne POD mounted flight test on Legacy Aircraft



- Proactive Self-Defense with NIR and MWIR laser capability
- Fully-predictive Laser System models, validated by integrated flight tests

Far-Term FY23-28

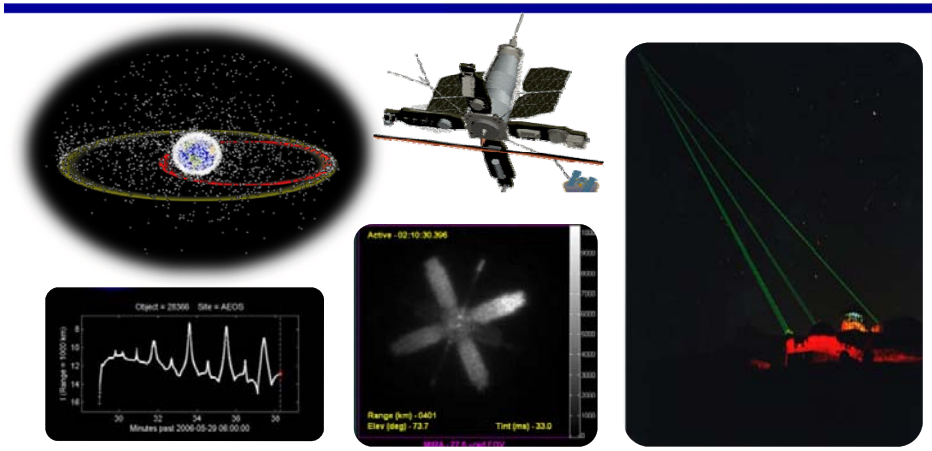


- Efficient, light-weight HEL with conformal aperture beam delivery for Future Air Dominance A/C

- Flight qualified turret

Move Toward the Full Range of Tactical Platforms

SPACE
Directed Energy & Electro Optics for Space Superiority (DEEOSS) CTC



Mission/Vision Statement

- Develop directed energy and electro-optical technologies to improve the nation's space superiority capability

Goals/Objectives

- Optimize the performance of the baselined operational SSA architecture
- Cost-effectively augment the architecture
- Create affordable trade-space for eventual expansion of the architecture

Motivation

- Space domain has become significantly more congested, contested, and competitive
- Space is an integral part of the fabric of our nation's infrastructure supporting both peacetime and wartime capabilities
- Directed energy and electro-optical technologies offer unique ability to find, fix, track, and characterize space objects anytime, anywhere

Technical Approach/Ideas

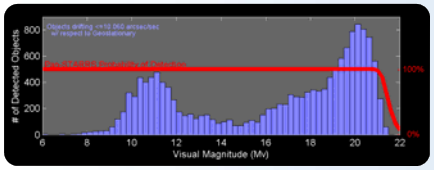
- Detect, track, and ID small, dim objects in GEO and GEO-transfer orbits
- Timely characterization techniques to identify adversary threats and capabilities
- Threat warning and assessment concepts to enable attribution and allow for response time
- New data integration and exploitation capability for the JSpOC Mission System POR
- Dynamic and automated sensor tasking to optimally tip/cue SSA assets
- Evaluate space system resiliency and protection options to include operational & material solutions

DEEOSS S&T Strategy
Capabilities / Deliverables

Near-Term

Forensic

- **Space Catalog development**
  - Deliver new tools to JSPOC Operators
  - Processing for 150K+ Object Catalog
  - Rapid UCT (uncorrelated track) resolution

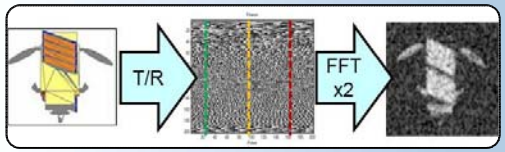


- **Use of EO imagery & signatures to understand satellite characteristics**
  - Extend high-resolution imaging of LEO objects to daylight & full-dark for improved timeliness
  - Link unresolved EO signature data to EEIs through physical/functional models
- **Sodium Laser Guidestar**
  - Image dim objects and satellites in full-dark
  - Detect small, dim objects next to larger objects at GEO

Mid-Term

Predictive

- **Tactical Persistent Monitoring**
  - Provide GEO Threat awareness using ground-based optical telescopes
  - Dynamically task sensors to provide persistent surveillance and maintain custody from launch through insertion
- **Demonstrate High-Res GEO imaging**
  - ISAL – Inverse Synthetic Aperture LIDAR

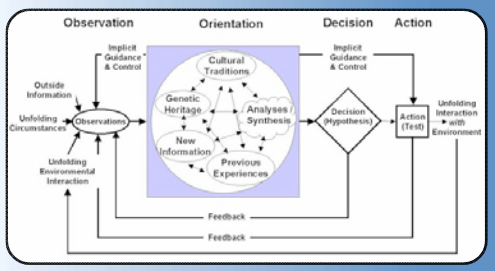


- **Apply predictive signature modeling to enable threat Indications and Warnings (I&W) for SSA**
  - Deliver JSpOC applications to integrate EO signatures with non- EO data sources
  - Improve characterization and timely change detection of threat objects
- **Protection and Resiliency**
  - Threat modeling and options for Comm & Navigation in the A2/AD environment

Far-Term

Operationally Responsive

- **Exquisite characterization and modeling to enable predictive awareness and threat mitigation**
  - Support DCS operations through Intel Prep of the Battlefield (IPB) for Space
- **Integrated and timely knowledge**
  - Allow implementation of Courses of Action (COAs) in response to space events, threats, and opportunities
  - Ability for our space warfighter to operate inside adversaries' OODA Loop – Operational Responsiveness



- **<u>Bottom Line</u> - Situational Dominance for Space Control Operations**

Techniques & Tools to Increase Speed & Fidelity of Knowledge for SSA

Summary

- **AFRL is poised to provide technologies for future weapon systems**
- **AFRL relies heavily on collaboration with industry, academia and other national laps**

- **For more information contact:**

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