



C4

Command & Control Communications Cyber/Computers

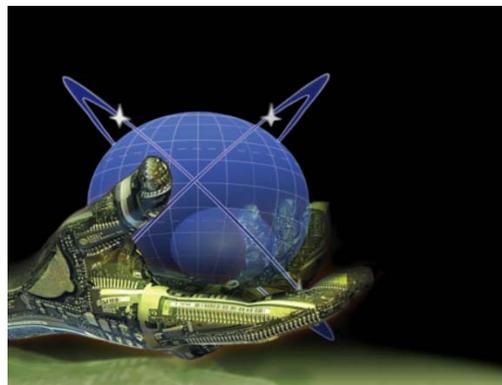
Integrity ★ Service ★ Excellence



C4



- **Mission: To lead the discovery, development, and integration of affordable warfighting C4 technologies for our air, space, and cyberspace force**
- **Vision: To defend America by unleashing the power of innovative C4 science and technology to anticipate, find, fix, track, target, engage, and assess anything, anytime, anywhere.**

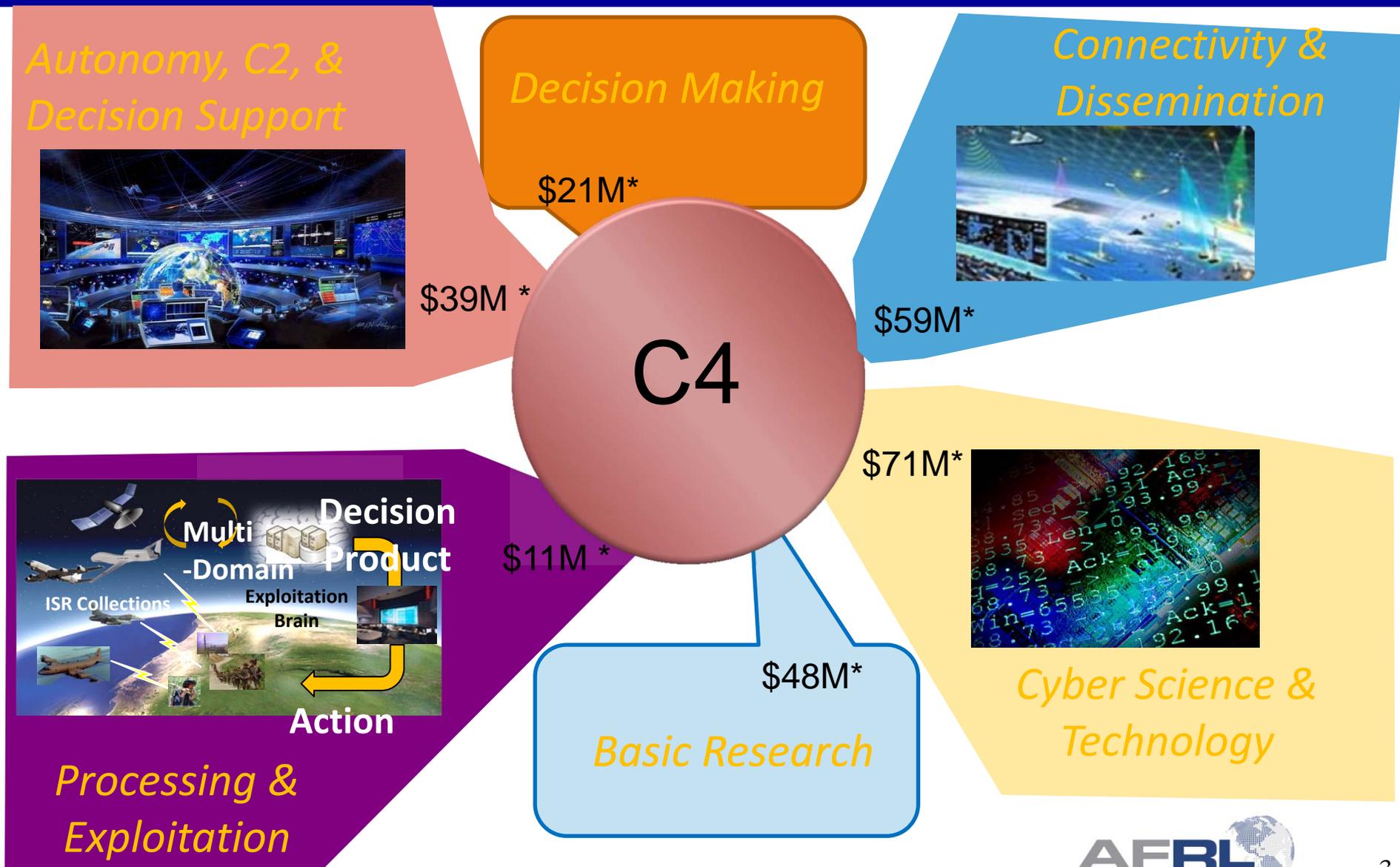




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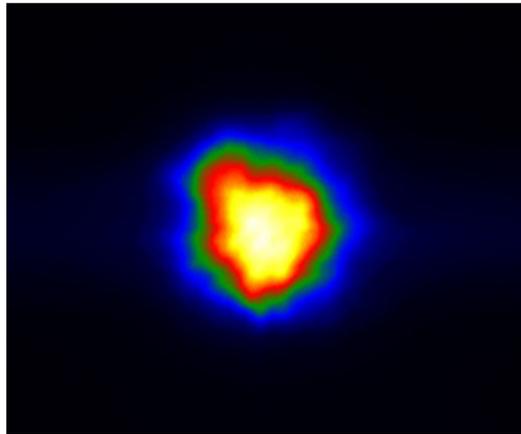
Core Technical Competencies (CTCs)





C4

Basic Research (\$48M)



Dr. Alex Kuzmich at Georgia Tech researching entangled quantum memories for use in securing long distance transmission of secure information and quantum computing.

Motivation

- To understand fundamental approaches to secure information exchange over all communication
- To advance the system and network performance prediction, design, and analysis
- To advance information operations and security; and advancement of human-machine systems
- To develop methods for enhanced network-centric mission effectiveness

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: To further science that underlies fundamental new secure-by-design architectures of communications and decision-making platforms.

Objective: To enable reliable and secure exchange of information and predictable operation of networks and systems.

Technical Approach/Ideas

- Basic research to establish a new, highly secure foundation for the information technology infrastructure
- Increase research effort on identifying attacks against information systems
- Protecting information systems from attack, assuring the confidentiality of critical information
- Develop techniques for inherently hardened software
- Develop the understanding and tools to build inherently secure software
- To ensure the security of the vast amounts of information flowing through relevant networks and information spaces





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Autonomy, C2 and Decision Support CTC (\$39M)



Motivation

- Increase speed of C2 in high tempo conflict
- Manage complexity, without additional manpower
- Assure the mission in denied and contested environments
- Anticipate future threats and opportunities
- Mitigate uncertainty

Mission/Vision Statement

Vision: Enable comprehensive understanding and agile Integrated C2 on a global scale

Mission: Deliver affordable solutions for distributed, resilient, timely, IC2 decision making technologies for the monitor, assess, plan and execute processes associated with Air Force command, control and intelligence operations

Goals/Objectives

- Plan, integrate, synchronize and optimize global and theater air, cyber, and space assets to achieve maximal effects in dynamic, contested environments
- Timely and continuous situation understanding of the battle space: Knowledge of Us, Knowledge of Them
- Develop technology to enable robust, resilient, adaptive autonomous C2I systems

Technical Approach/Ideas

- Synchronized operations across/within air, space, and cyberspace based on understanding of interdependencies and relationships
- Anticipatory planning to “out turn” adversary’s OODA loops
- Resilient C2 systems to assure the mission
- Automated indications and warning to discover intent, identify threats, and aide decision making
- Continuous assessment to ensure we’re doing the right things and doing them right
- Machine intelligence to provide mission autonomy





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Autonomy, C2 Planning, and Decision

Near-Term (FY13-15)



- Automated Indications & Warning capabilities to help discover emerging threats early with minimal false alarm rates
- Optimized planning of air, space and cyber assets for effect for limited scale and complexity event
- Assess effects of executing operations - operational to tactical with 90% accuracy, correlating observables to planned effects
- Quickly identify C2 enterprise anomalies and notify stakeholders to develop mitigation plans
- R&D on Machine Learning Techniques
 - State based abstraction – reduce analysis time
 - Feature selection – analyze most relevant data

Mid-Term (FY16-20)



- Anticipate adversary intentions via automated decision aiding and data gathering and analysis
- Planning and synchronization: Increased scale – common plan understanding across all domains
- Assess effects of full-spectrum force options at all levels (Strategy – Task): Improved accuracy and coverage
- Proactive resilient services able to forecast instabilities accurately and correctly identifying potential causes
- Demonstrate self-organization among >100 information gatherers
- Demonstrate autonomous teaming for understanding new data and tasks

Far-Term (FY21-25)



- Accurately predict adversary range of potential options with high degree of confidence
- Agile Operations - Able to recognize, seize and assess opportunities quickly within & across air, space, cyber domains (“living plan”)
- Comprehensive in-depth understanding of causal relationships - Linked effects, actions, and desired end-states
- Self-adaptive C2 systems. Resilient C2 Mission Functions
- Demonstrate a robust, unified autonomy capability for complexity: 1000’s of adaptive collaborating autonomous agents



C4

Decision Making CTC (\$21M)



Decision Making



Motivation

- Need to reduce personnel costs at same time mission demands increase putting stress on system operators
- New operating regimes resulting in unexpected human performance issues
- Need to meld humans and the ever-increasing automation that supports them into high performance teams

Mission/Vision Statement

We discover and transition innovative human-machine interface solutions to ensure effective warfighter decisions in Air Force operations.

Goals/Objectives

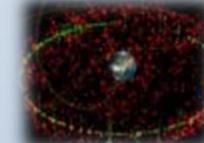
- Optimize linkages between man and automation
- Optimize human cognitive performance
- Take advantage of all modes of human communication to optimize information transfer based on situation

Technical Approach/Ideas



Battlespace Acoustics :

Battlefield Airmen ATD Transferred 13 Technologies
Sonic Counter-Detection – Strong ATD Candidate



Battlespace Visualization :

Space Situation Awareness (SSA)



Human Role in Semi-Autonomous Systems :

Multi-Role Control Station



Applied Neuroscience :

Cyber Operator Augmentation



C4

Decision Making CTC



Near-Term (FY14-16)	Mid-Term (FY17-19)	Far-Term (FY20 ->)
Wearable Interfaces to support Decision Making	Reconfigurable, Interoperable, Control Stations to Minimize Crew Size	Mission-Selectable, Fully-Integrated Wearable Technology
Multi-Modal Interfaces	Cognitive Performance Optimization Toolkit	Peer-to-Peer Human-Automation Collaboration
Multi-Service Tactical Comm	Flexible, Adjustable Human-Automation Interaction	Adaptive Warfighter Performance Optimization
Metrics/Biomarkers for Predicting Cognitive State	Advanced Interfaces for Urban Navigation	Real-Time Performance Assessment Technologies
Cyber Operator Augmentation	Symbiotic Sensing for Enhanced Decision Making	Multi-sensor Fusion Visualizations
C4 Acoustic Displays	Authority Sharing- Human or Intelligent Associate	Brain-actuated Supervisory Control
Interfaces for Distributed Teams	Adjustable Cyber Information Visualizations	Adaptive Mission Assurance Tools



C4

Connectivity & Dissemination CTC (\$59M)



Mission/Vision Statement

Vision: Seamless networked communications fabric across the C2ISR enterprise – Assuring delivery of timely, reliable, and actionable information to warfighters and systems.

Mission: To conceive, develop and demonstrate innovative and affordable technologies that provide agile and secure information transmission, network and dissemination capabilities that enable the sharing of quality information within resource and policy constraints

Goals/Objectives

- Mission-derived network resource allocation
- Secure Multi-Domain Network Services
- Reliable Wideband LOS/BLOS Links
- Tactical ↔ Enterprise Information Services
- Secure Tactical Intranet (Airborne bridge)
- Link Survivability in denied & contested RF environs

Motivation

- Secure communications in Contested/Denied environments
- Aging satellites
- Nuclear modernization
- Shrinking DoD spectrum
- Emerging EW threats

Technical Approach/Ideas

- Robust, high capacity RF communications
- Data flows as information objects and manage network resources for on-demand network agility and resilience
- Secure cross-domain interoperability and information sharing across coalition, joint, and AF enterprise systems
- High-capacity beyond-line-of-sight (BLOS) communications
- Distributed, autonomous systems; flexible, open standards; and pod-based



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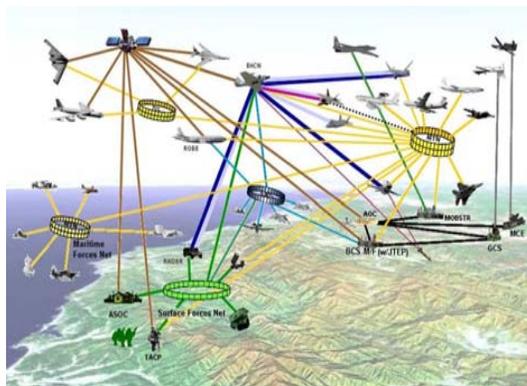
Connectivity and Dissemination CTC



Near-Term (FY13-15)

Mid-Term (FY16-20)

Far-Term (FY21-25)



- Cross-domain enablement of real-time collaboration (secure VTC, VoIP)
- Joint network situation awareness and integrated NetOps (JCTD)
- Info mgmt embedded within sensors
- Metadata auto-tagging & manage of unstructured and semi-structured data and relationships
- Secure information gateways between tactical and enterprise environments
- Secure and fault tolerant SOA cloud services for assured mission operations in federated environs

- High speed airborne hybrid (RF-optical) links
- Spectrum mutability for airborne links in contested environments
- MLS mobile devices
- Secure reconfigurable protocols for self-healing airborne routing
- Cross-layer mission-responsive traffic shaping
- Secure, dynamic ad hoc airborne mesh networking
- Federated discovery/control of tactical info sensors & assets
- Cloud scale, mission info services responsive to contested environs

- Autonomous link connectivity for contested environments with robust, on-demand AJ
- "OpenFlow-like" admission control to optimize throughput of tactical networks
- Resilient directional networking & robust interoperability for contested aerial environments
- Dynamic proactive adaptation of enterprise resources in response to fluctuating systems, network and mission performance

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Cyber Science and Technology CTC (\$71M)



Mission/Vision Statement

Vision: Create the future assured operating environments that provide for Mission aware and Resilient full spectrum capabilities.

Mission: Design, Develop and Transition Innovative cyber capabilities to the AF and Joint communities

Goals/Objectives

- Embedded Systems for Cyber Defense
- Transform the AFNET into a proactive, dynamic, survivable environment based on Mission Assurance
- Develop a common operating platform for AF operational cyber missions – an enterprise-level resilient operational framework for dynamic defense and full spectrum cyber operations

Motivation

- Mission Aware Applications and Infrastructure
- Root of Trust within Embedded systems
- Cyber ISR
- Integrated offensive operations
- Resilient, agile Cyber Systems
- Assured Cloud computing

Technical Approach/Ideas

- Formal Verification Methods
- Security for cloud computing
- Decomposition and Trustworthiness modeling
- Secure systems foundations
- Mathematically proven mission assurance techniques



C4

Cyber Science and Technology CTC



Near-Term (FY13-15)

Mid-Term (FY16-20)

Far-Term (FY21-25)



- Mission Mathematical representations
- Trustworthiness metrics
- Mathematical transformations making critical apps threat incompatible
- Mission Aware Routing (10 Gbit)
- Dynamic Mission Mapping
- Anticipatory Planning
- Instruction set morphing
- Resilient hypervisors
- Mission enabled cloud computing
- Develop Mission essential competencies
- Objective measures of human trust

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- Tools for automated mission mapping and vulnerability identification
- automated supply chain inspection
- Mission Aware routing & protocols
- Real time C2 for the AFNet
- Mission assured operations in a cloud environment
- Polymorphic enclaves
- Automated protection process
- Competency based Training
- Cognitive Control for increased Situational Awareness

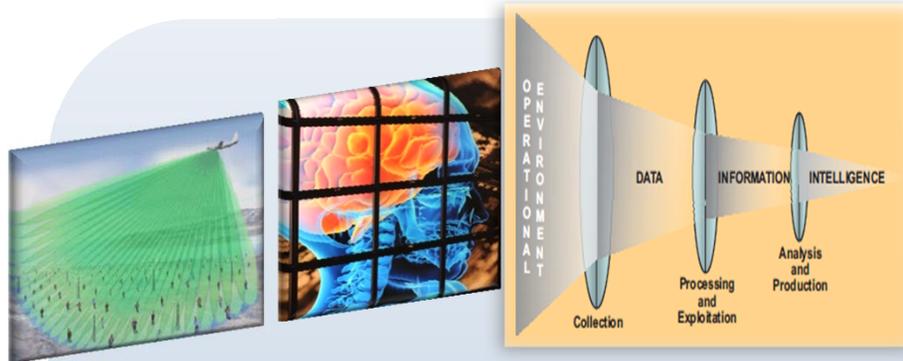


- Quantitative risk modeling
- Mathematically provable mission assurance
- Predictive threat models
- Self-Protecting Information
- Integrated planning for Air, Space and Cyber
- Self regenerative code
- Composable Security Architectures
- Autonomic anti-tamper
- Predictive Assessments
- Human machine Performance Optimization
- Full SA for full spectrum responses
- Noninvasive brain stimulation





C4 Processing & Exploitation CTC (\$11M)



Mission/Vision Statement

Vision: Massive cognitive analytics for ISR

Mission: Lead the discovery, development, and transition of all-source processing and exploitation innovations for the AF and Joint communities.

Goals/Objectives

- Agile Exploitation & Multi-Source Fusion
- Massive Analytics for Activity Based Intelligence
- Cognitive Computing enabled Exploitation, Analysis, and Collection Optimization

Motivation

- Transforming big data across air/space/cyber domains into information into knowledge into actionable intel
- Current capabilities lack analytic breadth, depth, speed and agility – and need to better support shift to denied/contested/non-permissive environments
- High demand for analytic leap-ahead in AOC ISR/D, DCGS, NASIC, and Big Safari

Technical Approach/Ideas

- Distributed exploitation and novel use of machine learning for rapid pattern discovery
- Recursive analytics optimizing massive reach of aggregate air/space/cyber domains
- Rapid employment and aggressive advancement of advanced computing (exascale, neuromorphic, quantum) as foundation for near real-time and low C-SWAP (cost-space, weight, and power) processing, exploitation, and analysis architectures



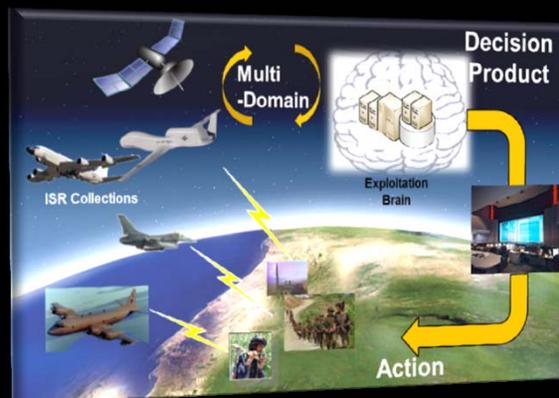


C4 Processing & Exploitation CTC



Near-Term (FY13-15)

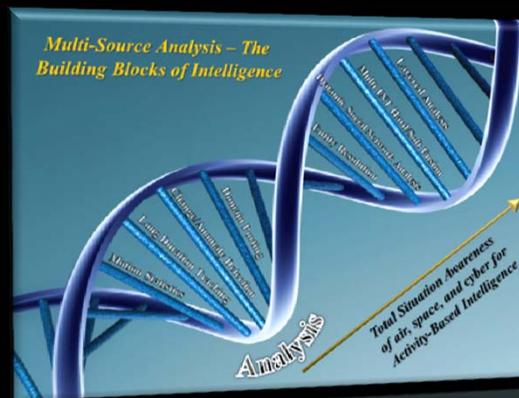
Agile Exploitation & Multi-Source Fusion



- Agile detection and geo-location for software-defined emitters
- Cross-document entity co-referencing and Text-Video-MTI fusion tools
- Embedded high performance computing for sensor processing

Mid-Term (FY16-20)

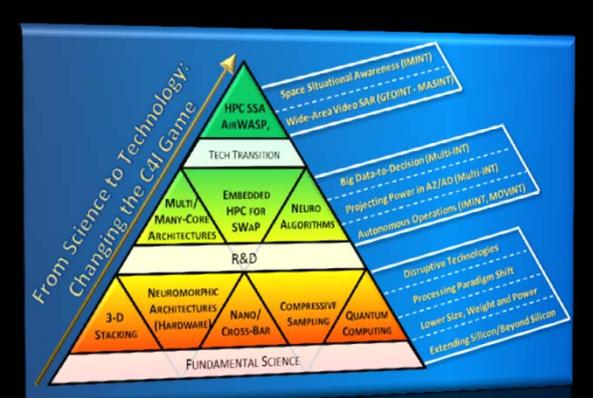
Massive Analytics for Activity Based Intelligence (A2/AD & Permissive)



- Raw sensor data fusion for low emitter SNR & high emitter agility
- Cooperative machine learning & statistical analytics for air/space/cyber ABI
- Extreme low power autonomous pattern recognition

Far-Term (FY21-25)

Cognitive Computing enabled Exploitation, Analysis, and Collection Optimization



- Cognitive (vs parametric) threat emitter classification
- Autonomous multi-INT hard/soft fusion at massive scales
- Quantum Co-processor for massive data searches



Summary / Contact Information



- **Team with us to create affordable warfighting C4 technologies for our air, space, and cyberspace force!**
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