Human Systems Community of Interest Government Panel

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1

Human Systems Community of Interest Active Membership

STEERING GROUP

Dr. John Tangney (Navy)
Dr. Bindu Nair (OSD)
Mr. John Lockett (Acting) (Army)
Dr. Kevin Geiss (AF)
Dr. Michelle Sams (Army)
Mr. Doug Tamilio (Army)
Dr. Patrick Mason (Navy)
Ms. Lisa Sanders (SOCOM)

WORKING GROUP

Dr. Todd Nelson (AF)
Dr. Marty Bink (Army)
Dr. Paul Chatelier (Navy)
CAPT Sidney Fooshee
Ms. Karen Gregorczyk (Army)

Dr. Kelvin Oie (Army)
LCDR Pete Walker (Navy)
Ms. Cheryl Stewardson (Army)
Ms. Josephine Wojciechowski (Army)
Dr. Ben Petro (OSD)

SUB-AREAS

Personalized Assessment, Education, and Training	Protection, Sustainment, and Warfighter Performance	Systems Interfaces and Cognitive Processes	SICP (cont'd)
Dr. Glenn Gunzelmann (AF)	**Dr. Mike LaFiandra (Army)**	**Dr. Todd Nelson (AF)**	Dr. Liz Bowman (Army)
Mr. Rodney Long (Army)	Dr. John Ramsay (Army)	Dr. Susan Hill (Army)	Dr. David Scribner (Army)
Dr. Kendy Vierling (USMC)	**Dr. Peter Squire (Navy)**	Dr. Micah Clark (Navy)	Dr. Rebecca Goolsby (Navy)
Dr. Ray Perez (Navy)	Ms. Stephanie Miller (AF)	Dr. Mark Derriso (AF)	Mr. Eric Hansen (AF)
CAPT Sidney Fooshee (OSD)	Dr. Lloyd Tripp (AF)	Dr. Erica Johnson (AF)	Dr. Edward Palazzolo (Army)
Dr. Sae Schatz (ADL)	Dr. John Schlager (AF)	Dr. Caroline Mahoney (Army)	Dr. Lisa Troyer (Army)
Dr. Marty Bink (Army)	Ms. Roxanne Constable (AF)	Dr. Jennifer Serres (AF)	Dr. Laurie Fenstermacher (AF)
	Dr. Karl Van Orden (Navy)	Mr. Ed Davis	Dr. Adam Russell (DARPA)
		Dr. Tom McKenna	

Human Systems Community of Interest Vision and Goals

Vision:

Develop and deliver new human-centered technologies to quantify mission effectiveness and to select, train, design, protect, and operate for measurably improved mission effectiveness.

Goals – to enhance mission effectiveness

- **Integrated simulations for mission training and experimentation**
- **Human-machine designs for mission effectiveness**
- **Assessment of (candidate) operator effectiveness**
- **Operating through battlespace stresses**
- **Mastering the PMESII* battle space**

*Political, Military, Economic, Social, Infrastructure, & Information

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3

State of Technology: Focus Areas*

* Note: Slide as example only

Personalized Assessment, Education, and Training

Right Person, Right Job, Right Skills

- First Principles for Training Design
- Personnel Selection and Assignment

Protection, Sustainment, and Warfighter Performance

Ensuring Warfighter Safety and Survivability

- Understanding and Quantifying the Effects of Critical Stressors
- Critical Stressor Mitigation Strategies

System Interfaces and Cognitive Processes

Effective, Natural Human-Machine Teaming

- Human-Machine Teaming
- Intelligent, Adaptive Aiding
- Human Information Interpretation & Influence

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4

Operational Concept
Mission Effectiveness Quantification

Capability: Integrated, persistent Live-Virtual-Constructive (LVC) training environments incorporating adaptive training methods to accelerate Service, Joint, and Coalition Readiness
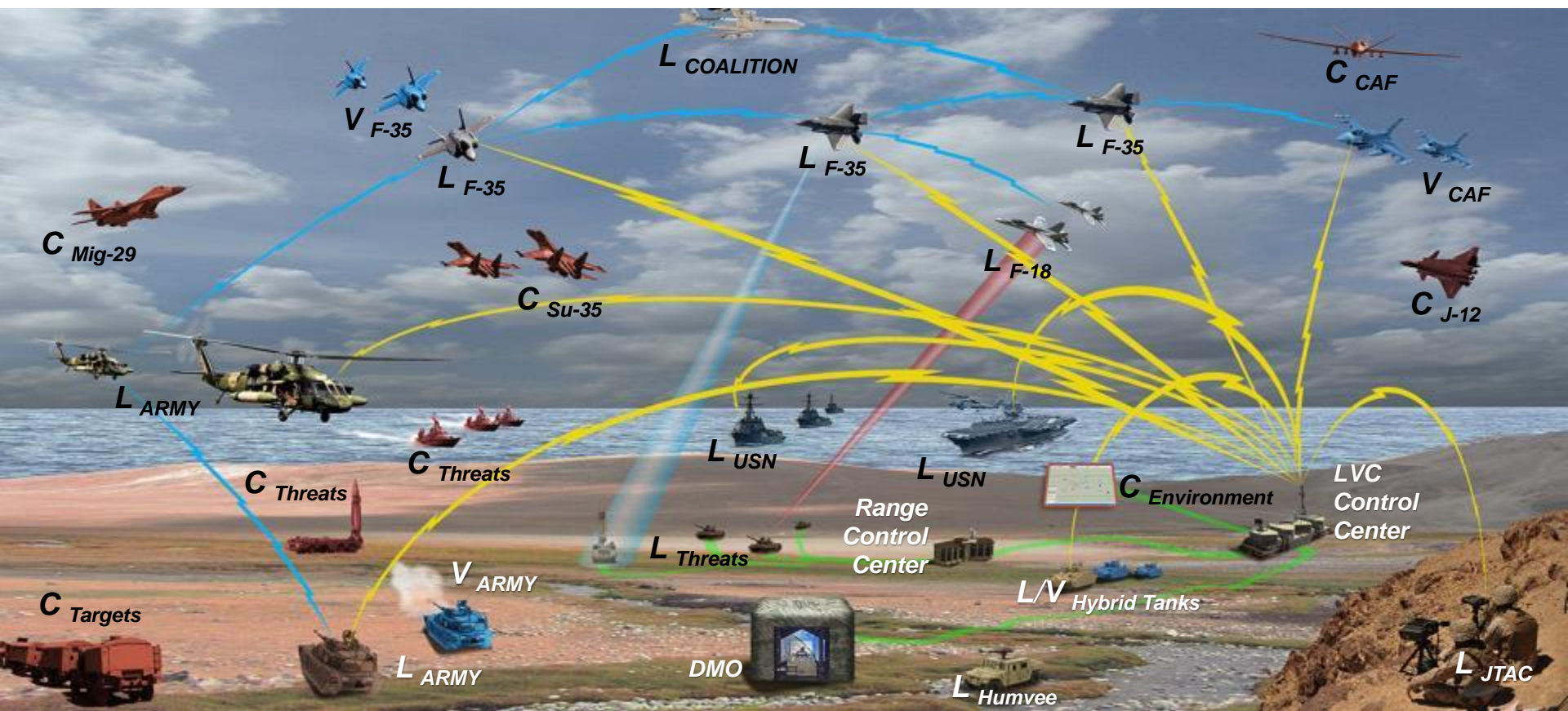
Affordable Mission Realism – Integrated Forces – Quantified Effectiveness

Human-Machine Teaming Collaboration; Combat Teaming

Human Systems COI S&T Focus Areas that Address Human-Machine Teaming

1. **Learning Machines**

   - Computational Models of Human Cognitive, Psychomotor, and Perceptual Capabilities

2. **Human-Machine Collaboration**

   - Intuitive, Multi-sensory, Adaptive Interfaces
   - Natural Language Interfaces

3. **Assisted Human Operations**

   - Intelligent, Adaptive Aiding

4. **Human-Machine Combat Teaming**

   - Trust Calibration and Transparency of System Autonomy
   - Metrics of Mission Effectiveness at Individual and Unit Level

5. **Autonomous Weapons**

   - Systems that can take action, when needed
   - Architectures for Autonomous Agents and Synthetic Teammates

… and Experiments Using Realistic Mission Scenarios

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6

Service Demand Signals

Personalized Assessment, Education and Training

- ❖ Personalized, integrated assessments and training to improve performance, accelerate proficiency and increase affordability
- ❖ Enhanced warfighter performance through scenario based training & automated performance based readiness assessments
- ❖ Maintain air superiority over complex, evolving threats using adaptive training

Protection, Sustainment and Warfighter Performance

- ❖ Greater force protection to ensure survivability across all operations and environments
- ❖ Maintain health & injury recovery; reduce noise induced hearing loss
- ❖ Agile Combat Support through countering aerospace physiology and toxicology threats, reducing cognitive workload

System Interfaces and Cognitive Processing

- ❖ Achieve operational maneuverability through soldier-system integration
- ❖ Design systems to enable effective human machine interaction, including robotics & autonomous systems
- ❖ Enhanced interaction & trust w/ autonomous systems; increased SA for operators; reduced analyst workload
- ❖ Provide situational awareness; timely mission command and tactical intelligence human-agent teaming

- ❖ *Army Enduring Challenges*
- ❖ *Navy Vision/Objectives*
- ❖ *AF Core Mission/Challenges*

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7

COI-to-COI Collaborations

- **ASBREM**
  - Human Performance Optimization Committee
  - Joint Biomedical Modeling and Simulation Initiative
  - Walter Reed Army Institute of Research (WRAIR) evaluating TAPAS as a contributor toward predictors of mental health & medical attrition

- **ASBREM, Sensors, CWMD**
  - Wearable Physiological Monitors

- **Autonomy**
  - Roadmap development: Human-Machine Teaming shared area
  - V&V Licensing Study
  - Executing Joint-Service Autonomy Research Pilot Initiatives

- **Cyber**
  - Cyber Selection and Training
  - Cyber Situational Awareness

- **CWMD**
  - Dark web concerns, social network analysis, and counter-terrorism research

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8

COI Activity 2017

Major Accomplishments

- IMPACT DoD Virtual Lab allowed one operator controls 12 vehicles – force multiplier, lauded by OSD as Autonomy Re-search Pilot Initiative (ARPI) poster child
- Advanced technologies for Battlefield Airman (BATMAN) resulted in 30 tech transitions to Special Tactics operators in advanced audio/visual communications and lightweight equipment, mission rehearsal, and multi-patient monitoring. Transitioning Battlefield Airmen Trauma Distributed Observation Kit capability to Army and joint medical community.
- Augmented Immersive Team Training (AITT) provided a unique JTAC training capability for Joint Staff exercises. Scheduled to transition to multiple Marine Corps programs.
- Multiple Live Virtual Constructive (LVC) product transitions; Deployable LVC baseline, Learning Management SOA Advanced Technology Demonstration completed
- Generalized Intelligent Framework for Training transitioned to 900 users in 53 countries
- DoD Wearables Technology Workshop Feb 2017

Engagements with organizations, individuals, entities outside DoD

- 2017 NDIA HS Conference well attended
- 2017 IR&D event 20-23 June , 3rd Biennial (27 Companies participated)
- HS COI sub area meetings at I/ITSEC
- Digital and Social Media Assessment course at National Defense University with NATO attendees
- Ongoing Metrics White paper discussions Between PAET & Industry
- 2017 All Hands COI meeting, NASA, DOE, DHS presented
- Aerospace Medical Association Annual Meeting April 2017

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9

Impact of Human Systems Community of Interest

Doctrine — Organization — Training — Materiel — Leadership — Personnel — Facilities

D O T M L P F

Selection, Protection

Decision Making

Human-Machine Teaming

Adaptive Training

Mission

Effectiveness

$450M COI Budget Has Broad Impact in Several DOTMLPF Areas
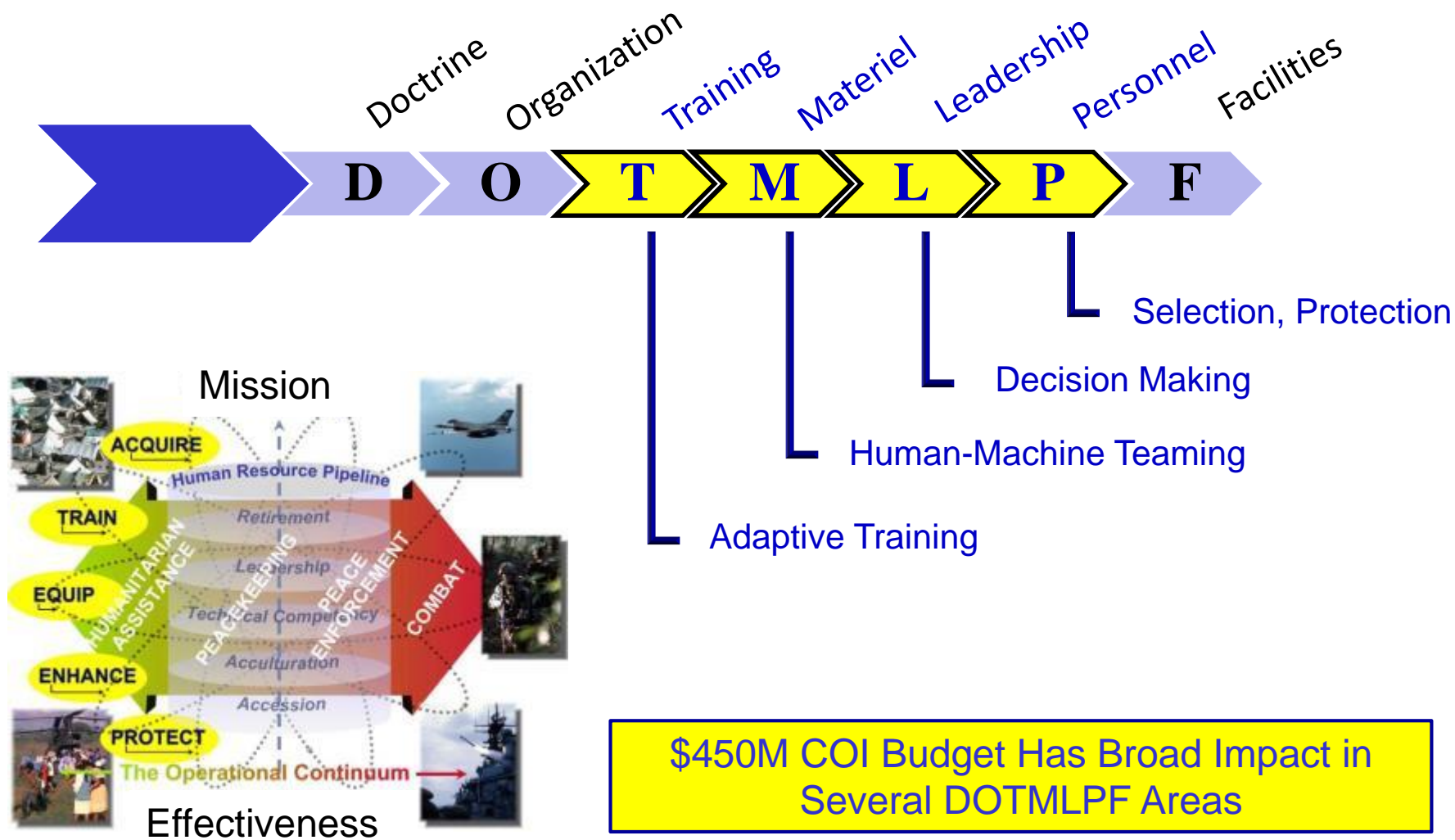
SUB-AREA S&T THRUSTS

Personalized Assessment, Education, and Training

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12

PAET Scope
Personalized Assessment, Education & Training (PAE&T)

Research and development in personnel assessment will produce integrated measures and adaptive testing for more precise assessment of individual potential, yielding improved personnel selection and assignment. Meanwhile, work in education and training will produce competency-based systems grounded in quantitative metrics to enable personalized, proficiency-based training to accelerate acquisition and enhance operational performance. The end result is more capable warfighters with decreased training costs.

Thrust Area 1:

Training, Education, and Personnel Development

S&T Focus Areas on Roadmap:

- Realistic, secure, and adaptive LVC environments

- Persistent **and** personalized readiness assessment and tracking

- Multi-Level modeling for readiness management

- Computational cognitive science research to support model and agent development for training and operational support

Thrust Area 2:

Personnel Selection and Assignment

S&T Focus Areas on Roadmap:

- Predictors: Expand/refine non-cognitive measures (e.g., Tailored Adaptive Personality Assessment System)

- Outcomes: Expand/refine behavior and performance data

- Models: Expand/refine predictive analytic model for integrated cognitive plus non-cognitive measures to predict attrition, performance, and behaviors

VISION

A readiness ecosystem that ensures the right person has the knowledge, skills, and experiences needed to be mission ready for a dynamic and uncertain 21st century operating environment

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14
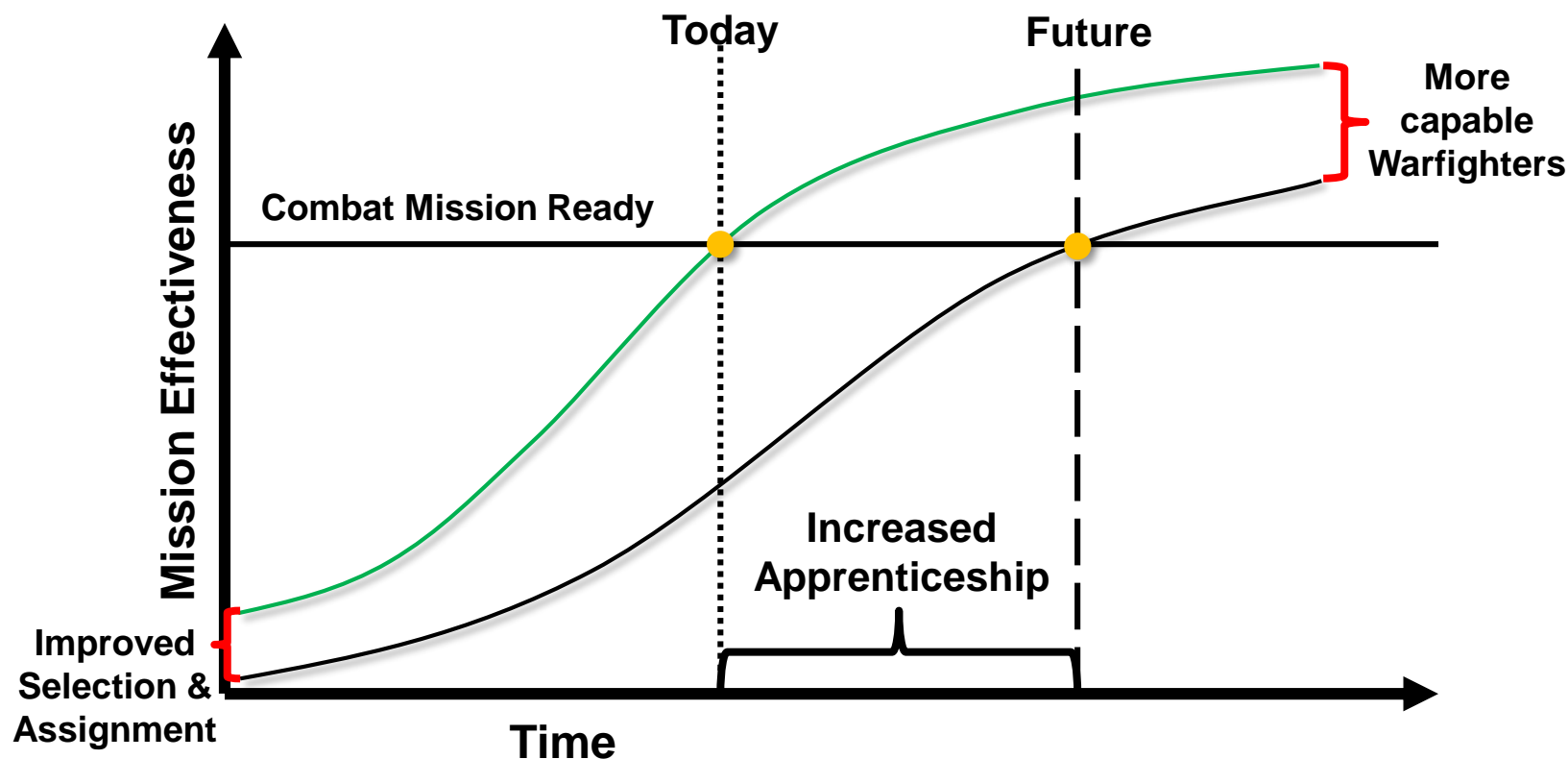
Our Story

• Challenges

- **More unpredictable and asymmetric adversaries**
- **Dynamically evolving operational environments**
- **One solution does not meet all**
- **Reduced manning**
- **Diverse personnel pool**
- **Budget & manpower constraints**
- **Better training at point of need**

• S&T Solutions

- **Adaptive LVC environments that keep pace with operations**
- **Human Science models for assessment and training**
- **Performance measurement and assessment to tailor training**
- **Cognitively-based instruction, agents and training schedules**
- **Science of Learning**

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15
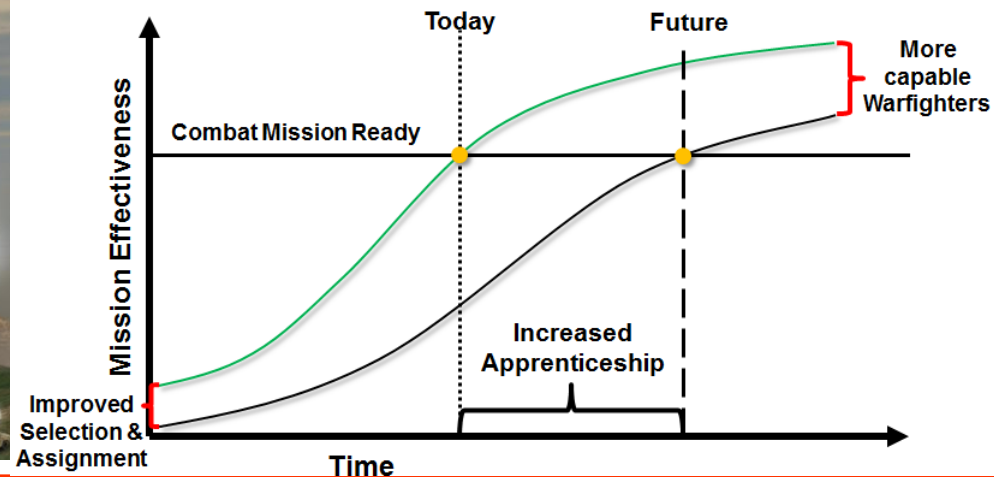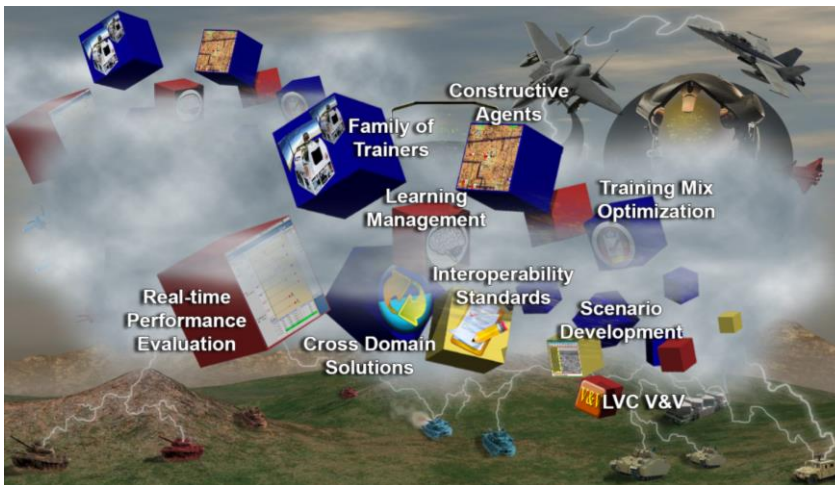
Thrust 1: Training, Education, and Personnel Development

Delivering the Mission

Education & Training Practices and Technologies that Support Efficient and Effective Development of Mission Readiness and Cognitive Agility

- Leverage learning sciences and technology to reduce resource costs (cost, manpower, time)

- Tailor training to individuals to enhance warfighter capabilities and agility

- Measure, track, & warehouse quantitative, proficiency-based performance measures

Delivering Capability (i.e., End States)

- Persistent, interoperable learning "ecosystem" …with personalized measurement; readiness tracking

- Secure LVC joint/coalition training environments …with realistic constructive teammates / adversaries

- Consistently high-quality training and education, tailored to individuals and available when needed

- Increased insight into personnel (data) informs individual learning decisions and mission planning

Key Technical Challenges

- Developing, deploying, and using proficiency-based performance measures / analyses

- Warehousing & using (big) learning data to inform life-long learning and operational decisions

- Securely integrating LVC environments

- Develop adaptive and valid cognitive agents

- Adapting learning sciences to military contexts and foster the right culture for their use

Example Program Successes

EXPERIENCE API

PPO
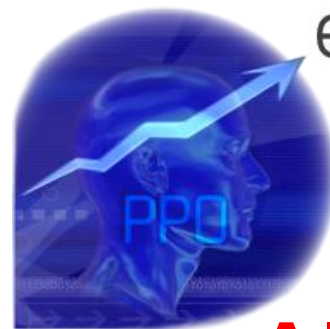
TXA AITT

Training, Education, and Personnel Development
Roadmap

Mission Need	Education & Training Practices and Technologies that Support Efficient and Effective Development of Mission Readiness and Cognitive Agility

Military Capabilities

- Secure LVC joint/coalition training environments
- Individually tailored training and education
- Persistent, interoperable learning "ecosystem"

Technical Goals

- Secure, integrated LVC environments
- Secure, scalable, on-demand joint and coalition LVC events
- Adaptive and valid cognitive agents
- Pedagogical models
- Adapting learning sciences to military contexts
- Integrated Infrastructure for Human-Machine Team Training
- Proficiency-based performance measures/analyses
- Warehousing & using (big) learning data

S&T Focus

- Secure Environments for LVC Training
- Infrastructure for Performance Measurement, Tracking, and Personalized Training
- Learning Sciences for Military Training
- Adaptive, Multi-level Constructive Models
- Agent-based Instructional Systems
- Large Scale Computation for Human-Machine Training & Assessment

Participation Legend:
- 🟢 Army
- 🟡 Navy
- 🔵 Air Force
- 🔴 Marines
- 🟣 OSD/Joint

Shading Legend
- Dark: Funded
- Light: Not/partially funded
- 6.3
- 6.2
- 6.1

Timeline: 2016 — 2018 — 2020 — 2022 — 2024 — 2026

S&T Focus Areas	Near-term					Mid/ Far-term	Operational Opportunities
	FY 16	FY 17	FY 18	FY 19	FY 20		
Secure Environments for LVC Training *Develop, validate, and demonstrate seamlessly integrated Live, Virtual, and Constructive (LVC) components into persistent, secure, and manageable training and operations environments across the Range Of Military Operations (ROMO)*	Adaptive LVC Training for Enhanced Warfighter Readiness — Adaptive Training for C4ISR — Secure LVC Advance Training Environment. — EDUCAT2E (see notes) — Live Virtual Constructive Simulation & Training — Live, Virtual, Constructive Training Fidelity — Future Integrated Training Environment						Seamless integration of live, virtual, & constructive training environments; personalized training grounded in operationally relevant proficiency assessments; Range infrastructure to support LVC integration for 4th/5th gen aircraft; air-ground simulation integration, scalable, adaptive constructive agents that think and act like people to support training & ops
Infrastructure for Performance Measurement, Tracking, and Personalized Training *Quantitative, embedded performance measures in training and operational systems, combined with warehousing capabilities and metrics to assess mission readiness and effectiveness over a career*	Autonomous Models and Agents for Training & Operations — Learning Continuum and Performance Aid — Adaptive LVC Training for Enhanced Warfighter Readiness — Adaptive Training Research — Total Learning Architecture — Complex Cognitive Skills						Formal, quantitative measures of proficiency; Embedded performance measures in training environments and operational systems; Integrated and persistent warehousing, diagnosis, and assessment of readiness to drive personalized training requirements and career-long readiness management

Training, Education, and Personnel Development
Program Detail (2)

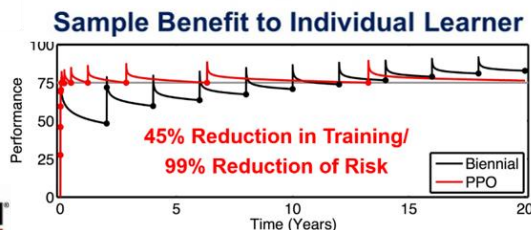| S&T Focus Areas	Near-term					Mid/ Far-term	Operational Opportunities
	FY 16	FY 17	FY 18	FY 19	FY 20		
Adaptive, Multi-level Constructive Models *More robust, valid, & Integrated mechanisms that enable constructive agents that truly think and act like people for training and operational applications; Incorporate robust capabilities for situation representation and language processing to support human-machine teaming.*	Adaptive LVC Training for Enhanced Warfighter Readiness ✈ Autonomous Models and Agents for Training & Operations ✈ Computational/Cognitive Models for ITS ⚓ Live, Virtual, Constructive Training Fidelity ⚓						Realize the full potential of LVC to provide personalized, anytime, anywhere training. Reduce manpower costs for training with increased adaptivity in constructive forces. Enhanced validity; increased cognitive & behavioral fidelity; agents that are language enabled & situationally aware; consideration of cognitive moderators; emphasis on complex & uncertain operational contexts; also facilitates human-machine teaming
Human-Machine Training & Assessment *We must prepare for the need to train autonomous systems for the same operational realities as humans, including training with human teammates; requires bridging among machine learning, large scale computing, and LVC.*	Autonomous Models and Agents for Training & Operations ✈ Adaptive LVC Training for Enhanced Warfighter Readiness ✈						Training to tailor baseline autonomous systems for specific capabilities, environments, and operations. Integration of large-scale computing resources with machine learning capabilities in LVC training environments will be a game changer in human-machine teaming by providing the opportunity for humans and machines to train separately and together in the same environments to prepare for the uncertainty of real operations.

S&T Focus Areas	Near-term					Mid/ Far-term	Operational Opportunities
	FY 16	FY 17	FY 18	FY 19	FY 20		
Learning Sciences for Military Training *Adapt research on learning and training to the unique requirements of the military environment*	Adaptive LVC Training for Enhanced Warfighter Readiness Adaptive Training Research Total Learning Architecture Personal Assistant for Learning Accelerating the Development of Small Unit Decision-Makers						A significant scientific base exists in the learning sciences, but most of it has been developed in non-military contexts. Adapting and extending existing research for the unique requirements of military training will improve its efficiency and effectiveness

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20

Technology Highlight: Predictive Performance Optimization (PPO)

Sample Benefit to Individual Learner

45% Reduction in Training/
99% Reduction of Risk

Program

- Use quantitative models of human learning and forgetting to optimize and personalize training schedules

Status & Impact

- Improves training efficiency
  - Shifts from calendar-based training to cognitively principled personalization schedules
  - Minimizes training costs/time while maximizing performance effectiveness
- More effective acquisition of training objectives & more sustained proficiency
- Demonstrated to maximize performance effectiveness while simultaneously reducing time/costs in training

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21

What? Developed by the Advanced Distributed Learning (ADL) Initiative, **Experience API (xAPI)** is a technical specification that facilitates the standardized documentation and interoperable communication of learning experiences (i.e., data) among disparate software systems. Essentially, it helps breakdown data stovepipes between education and training technologies.

Why? xAPI helps fuel learning analytics, not just within a single training system or course, but potentially across someone's entire lifelong learning set of experiences. Today, xAPI has been integrated into numerous COTS systems and demonstrated in various DoD/Federal settings. Even TechCrunch recently published an article about how xAPI-based data will soon replace the standard resume!

Who Cares? Using xAPI will allow multiple, disparate learning devices (e.g., e-learning, mobile learning, simulations, physical sensors) to be used longitudinally as a cohesive system. It enables broad human performance data management and interoperable exchange. Ultimately, this will enable much improved analysis of learning/performance, better informing lifelong instructional adaptation and planning, as well as talent management activities.

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22
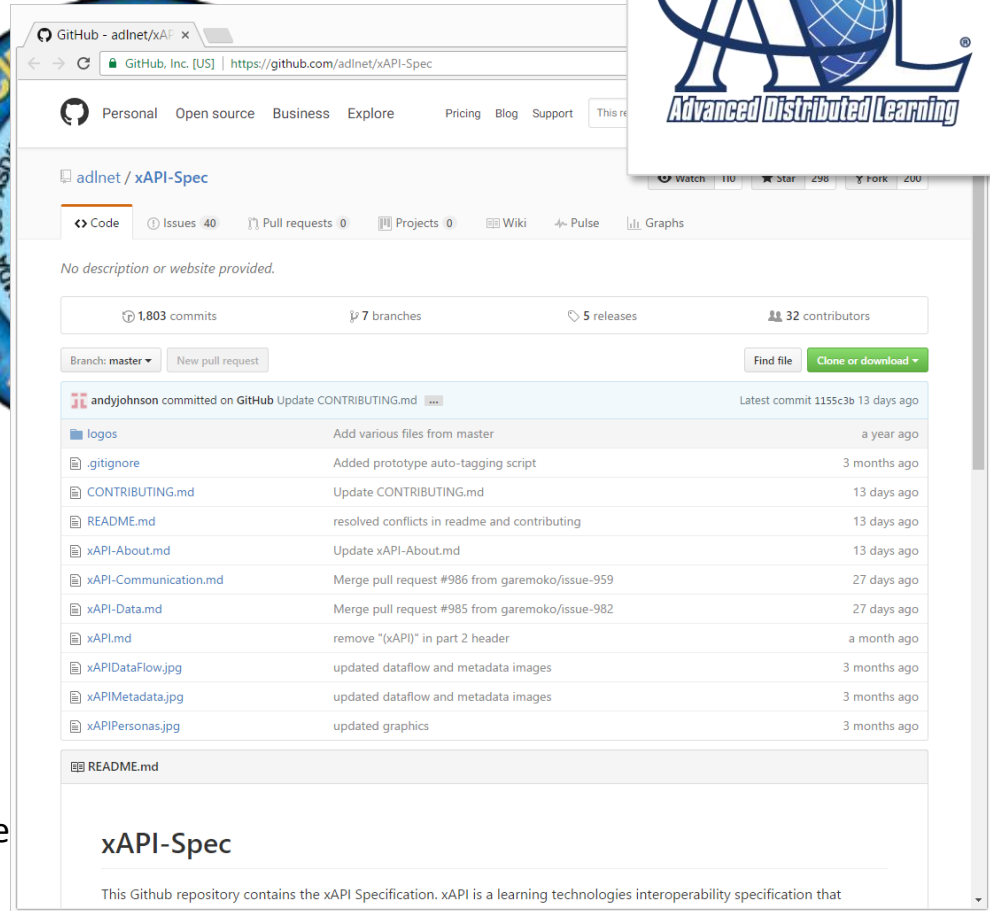
Technology Highlight: Secure LVC Advanced Training Environment (SLATE)

Live, Virtual, Constructive Operational Training Advanced Technology Demonstration Funded

- $47M demonstration of 4th and 5th generation LVC training
  - Aircraft software modifications
  - Waveform, Radio
  - Model and data processor
  - Multiple Independent Levels Encryption (MILS)
  - P5 Pod and F35 LRU form factor
  - Enhanced range infrastructure
  - Standards, data specifications, interface control docs
- Mission impact and effectiveness use cases

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23

Success Story: Computer Generated Forces
Training Executive Agent (TXA)

Operational Challenge

"An integrated LVC training environment with today's battle complexity is essential to improving proficiency across all current and future mission sets." (Naval Aviation Vision 2016-2025)

Problem: High manpower to run complex virtual training

Objective: Make Computer Generated Forces (CGF) more intelligent and adaptive to training objectives

Outcome: Transitioned the Training Executive Agent (TXA) into the Navy's Next Generation Threat System

S&T Accomplishments

- TXA monitors a training exercise and issues "directives" to other CGFs to modify behaviors according to a higher level scenario director (training objectives)

- TXA used in NIFC-CA training scenarios

- Exploring TXA usage on aviation pods, thus providing unique flexible embedded training capabilities
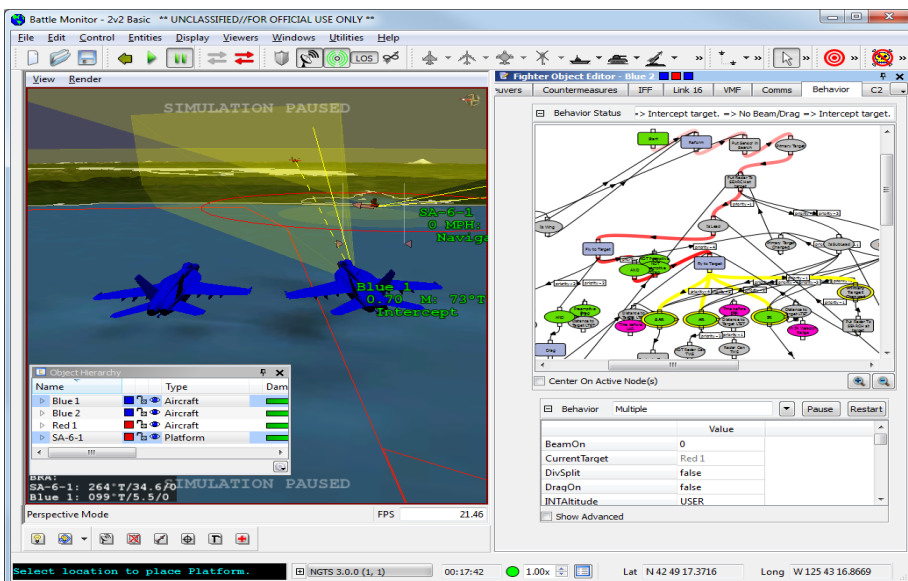
Return on Investment

Affordability

- Aid instructors and "pucksteers" who dynamically controls CGF during execution of a training scenario.

- Reduce number of required "pucksteers", reduce overall training costs

Readiness

- Provide trainees with tactically realistic entities, in realistic complex battle scenarios

- Allow instructors to focus on trainee, not on playing roll in scenario

Thrust 2: Personnel Selection and Assignment

Delivering the Mission

- Initial Military Training attrition is ~10% ($1.7B cost/yr)

- IMT attrition could be reduced to ~ 8% (saving ~.34B/yr) if current S&T product (TAPAS) was implemented to assess personality. IMT attrition could be reduced to 6% (saving $.68B/yr) with FY22 S&T products.

- Reduce negative behaviors for enlisted by ~5%.

- Increase satisfaction, performance, and retention in critical specialties by ~15%.

Delivering Capability

Maintain our competitive edge in Human Capital (Force of Future).

- Reduce attrition and negative behaviors with more precise assessments of candidates for initial entry & job assignment.

- Improve performance and retention with an emphasis on critical specialties (e.g., cyber) through advancements in talent assessment.

Key Technical Challenges

- <u>Predictor measures</u>: Existing measures lack individualized precision and are not integrated.

- <u>Outcome measures</u>: Performance and behaviors are difficult to measure and systematically obtain over a career.

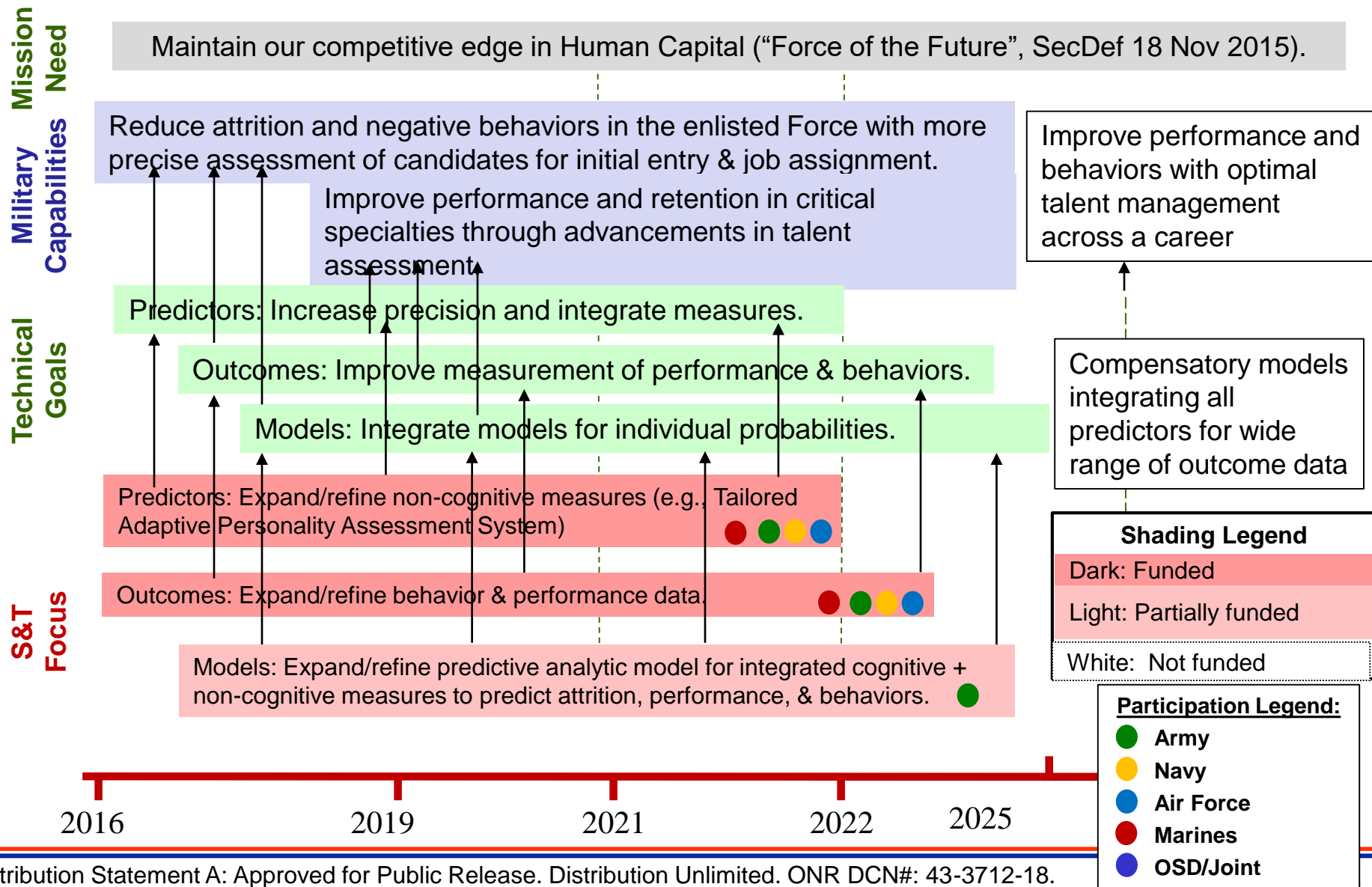- <u>Predictive models</u>: Existing models are stove-piped and based on group probabilities.

Example Program Success

- Enlisted Personnel Selection – TAPAS

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25

Personnel Selection and Assignment

Mission Need

Maintain our competitive edge in Human Capital ("Force of the Future", SecDef 18 Nov 2015).

Military Capabilities

Reduce attrition and negative behaviors in the enlisted Force with more precise assessment of candidates for initial entry & job assignment.

Improve performance and retention in critical specialties through advancements in talent assessment.

Improve performance and behaviors with optimal talent management across a career

Technical Goals

Predictors: Increase precision and integrate measures.

Outcomes: Improve measurement of performance & behaviors.

Models: Integrate models for individual probabilities.

Compensatory models integrating all predictors for wide range of outcome data

S&T Focus

Predictors: Expand/refine non-cognitive measures (e.g., Tailored Adaptive Personality Assessment System)

Outcomes: Expand/refine behavior & performance data.

Models: Expand/refine predictive analytic model for integrated cognitive + non-cognitive measures to predict attrition, performance, & behaviors.

Shading Legend

Dark: Funded	
Light: Partially funded	
White: Not funded	

Participation Legend:

- 🟢 **Army**
- 🟡 **Navy**
- 🔵 **Air Force**
- 🔴 **Marines**
- 🟣 **OSD/Joint**

2016   2019   2021   2022   2025

Personnel Selection and Assignment
Program Detail

S&T Focus Areas	Near-term					Mid/ Far-term	Operational Opportunities
	FY 15	FY 16	FY 17	FY 18	FY 19		
Predictors *Expand and refine non-cognitive measures (temperament, interests) and specialized cognitive assessments.*	Expand and increase precision of Tailored Adaptive Personality Assessment Develop, refine, and validate Vocational Interest Inventories Develop and refine specialized selection tests (e.g., Cyber, UAS) Personnel Measures Research Selection for UAS Personnel (SUPer)						More precisely and fully assess individual potential and risk.
Outcomes *Integrate the behavioral and competency data that define criterion job performance.*	*Leverage Training S&T competency assessments in realistic mission scenarios.* *Develop, refine, and validate behavioral outcome measures* *Readiness and Resilience*						More accurately assess performance and behaviors.
Models *Expand and refine predictive analytic models for integrated personnel measures to predict attrition, performance, & behaviors.*	Predictive analytical models based on predictors and longitudinal outcomes. Human Science Models						With enhanced Talent Management, improve performance, reduce attrition and negative behaviors.

Success Story: Enlisted Personnel Selection
Tailored Adaptive Personality Assessment System

Operational Challenge

Increase precision of assessing individual potential, risk, and fit to a military career.

- 26 personality dimensions such as optimism, excitement seeking, and non-delinquency
- Applicant chooses from statement pairs generated on-the-fly based on responses

S&T Accomplishments

- State of the art personality assessment
- Developed in partnership with industry
- 2009: Limited operational screening (Army)
- 2010-2011: Administered to recruits (Navy)
- 2014: Began selection for 5 specialties (AF)
- 2015: Administered to recruits (Marines)

TAPAS

Which of these statements is most like you?

- I am not one to volunteer to be group leader, but would serve if asked.
- My life has had about an equal share of ups and downs.

(example statement pair)

Return on Investment*

Readiness

- Reduces attrition by 5%
- Reduces Initial Military Training re-starts by 3%
- Reduces conduct incidents by 5%

Affordability

(attrition cost – recruiting, training)
- Current implementation saves ~ $30M/year
- Expanded use can save ~ $50M/year

* Based on Army data for limited operational screening.

System Interfaces and Cognitive Processes

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29

HUMAN SYSTEMS COI SUB-AREA:
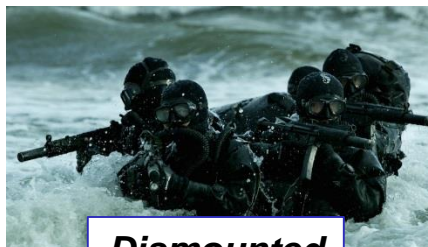## System Interfaces & Cognitive Processes

VISION
Warfighters teamed with machines through intuitive, personalized interfaces that enhance warfighters' mission effectiveness.

Information Systems Operators

Dismounted Operators

Air Systems Operators

Medical Support Operators

Thrust 1: Human-Machine Teaming

Delivering the Mission
- Increased capability with smaller force structure across air, land, sea, space, and cyber
  - 1 MQ-9 Operator controlling 7 simulated MQ-9s
  - Reduced ISR PED Cell Operators from 5 to 3
  - Closed Loop Medical Technology Research
- USTRANSCOM Global Mission Scheduling System
  - Reduced logistics and personnel footprint ; reduced planned flying hours >2% saving $37M/yr
- Trusted synthetic teammates that provide recommendations for battlespace operations
  - Reduced manpower and training requirements
- Ability to operate safely in highly contested environments
  - Reduced exposure to personnel

Delivering Capability

Seamless human-machine interfaces enabling optimized weapon system and warfighter performance in all contested domains and mission environments:

- Demonstrate highly effective, agile human-machine teaming

- Create actively coordinated teams of multiple machines

- Ensure safe and effective systems in uncertain and dynamic environments

Key Technical Challenges
- Immature intuitive, multisensory, adaptive interfaces
- Lack of robust and reliable natural language interfaces
- Absence of effective gesture control interfaces
- Fragile cognitive models and architectures for autonomous agents and synthetic teammates
- Insufficient degree of trust calibration and transparency of system autonomy
- Immature decision support tools

Program Overview

- Human-Robot Interaction
- Multisensory Perception and Data Presentation Interfaces
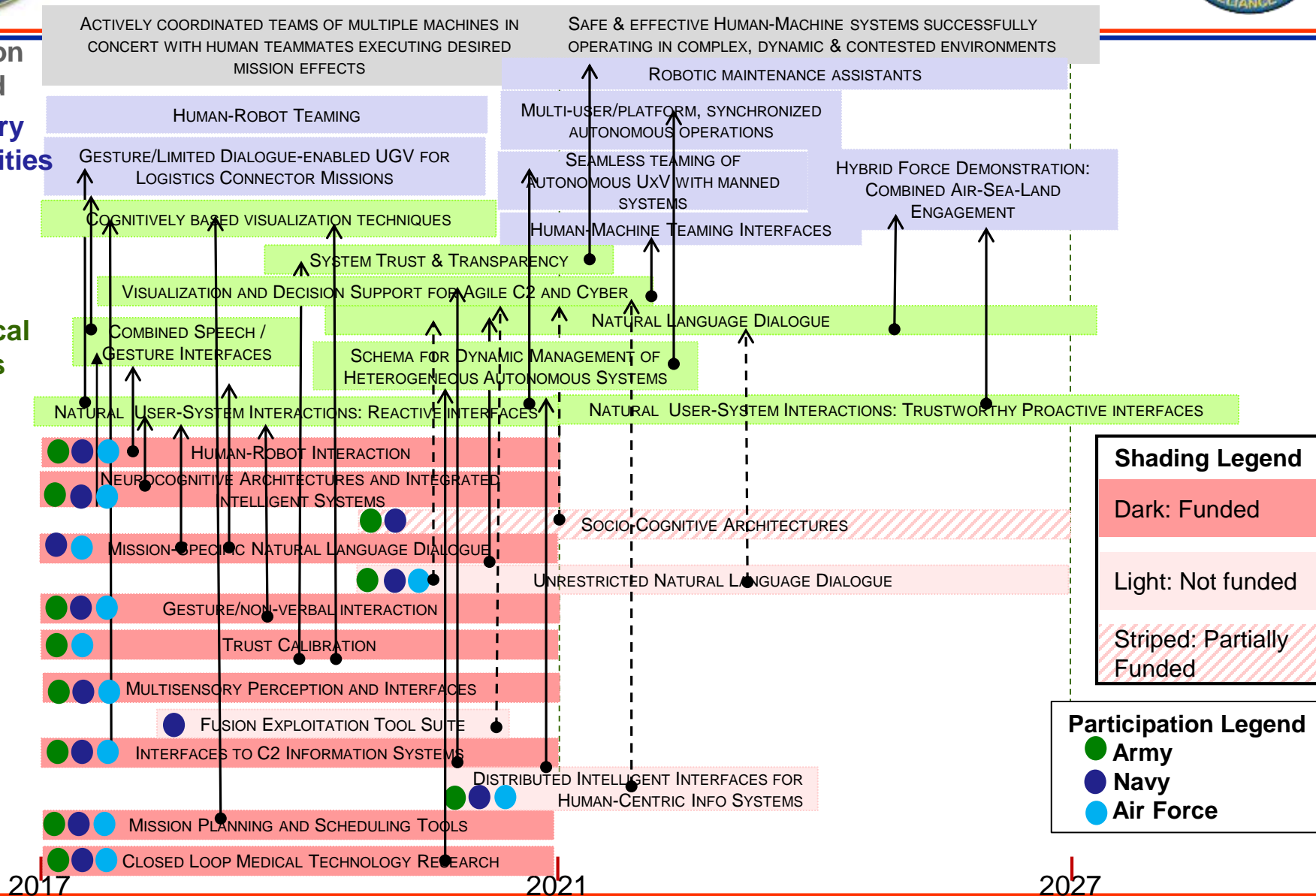- Supervisory Control Technology Integration and Demonstration

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31

Human-Machine Teaming

Mission Need

ACTIVELY COORDINATED TEAMS OF MULTIPLE MACHINES IN CONCERT WITH HUMAN TEAMMATES EXECUTING DESIRED MISSION EFFECTS

SAFE & EFFECTIVE HUMAN-MACHINE SYSTEMS SUCCESSFULLY OPERATING IN COMPLEX, DYNAMIC & CONTESTED ENVIRONMENTS

Military Capabilities

HUMAN-ROBOT TEAMING

GESTURE/LIMITED DIALOGUE-ENABLED UGV FOR LOGISTICS CONNECTOR MISSIONS

ROBOTIC MAINTENANCE ASSISTANTS

MULTI-USER/PLATFORM, SYNCHRONIZED AUTONOMOUS OPERATIONS

SEAMLESS TEAMING OF AUTONOMOUS UxV WITH MANNED SYSTEMS

HUMAN-MACHINE TEAMING INTERFACES

HYBRID FORCE DEMONSTRATION: COMBINED AIR-SEA-LAND ENGAGEMENT

Technical Goals

COGNITIVELY BASED VISUALIZATION TECHNIQUES

SYSTEM TRUST & TRANSPARENCY

VISUALIZATION AND DECISION SUPPORT FOR AGILE C2 AND CYBER

COMBINED SPEECH / GESTURE INTERFACES

NATURAL LANGUAGE DIALOGUE

SCHEMA FOR DYNAMIC MANAGEMENT OF HETEROGENEOUS AUTONOMOUS SYSTEMS

NATURAL USER-SYSTEM INTERACTIONS: REACTIVE INTERFACES

NATURAL USER-SYSTEM INTERACTIONS: TRUSTWORTHY PROACTIVE INTERFACES

S&T Focus

HUMAN-ROBOT INTERACTION

NEUROCOGNITIVE ARCHITECTURES AND INTEGRATED INTELLIGENT SYSTEMS

SOCIO COGNITIVE ARCHITECTURES

MISSION-SPECIFIC NATURAL LANGUAGE DIALOGUE

UNRESTRICTED NATURAL LANGUAGE DIALOGUE

GESTURE/NON-VERBAL INTERACTION

TRUST CALIBRATION

MULTISENSORY PERCEPTION AND INTERFACES

FUSION EXPLOITATION TOOL SUITE

INTERFACES TO C2 INFORMATION SYSTEMS

DISTRIBUTED INTELLIGENT INTERFACES FOR HUMAN-CENTRIC INFO SYSTEMS

MISSION PLANNING AND SCHEDULING TOOLS

CLOSED LOOP MEDICAL TECHNOLOGY RESEARCH

Shading Legend

Dark: Funded

Light: Not funded

Striped: Partially Funded

Participation Legend
- Army
- Navy
- Air Force

2017   2021   2027

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Human-Machine Teaming
Program Detail

S&T Focus Area	Near-term					Mid/ Far-term	Operational Opportunities
	FY 15	FY 16	FY 17	FY 18	FY 19		
Mission Planning and Scheduling Tools	Visual Interactive Exploratory Data Analysis						Mission planning and scheduling tools that simplify COA generation and enhance mission efficiency.
	Soldier-Centered Design Tools						
	Mission Planning and Scheduling Tools						
Interfaces to C2 Information Systems	Supervisory Control Technology Integration and Demonstration						Operator-centered interfaces to C2 Information Systems that enhance/multiply mission effectiveness.
	Soldier-Centered Design Tools						
	Interfaces to C2 Information Systems						
Multisensory Perception and Interfaces	Multisensory Perception and Data Presentation Interfaces						Novel multi-modal human-system interfaces that enhance operator performance.
	Human-Robot Interaction						
	Advanced Technologies for Battlefield Airmen						
Neurocognitive Architectures and Integrated Intelligent Systems	ONR Computational Neuroscience						Neurocognitive architectures that maximize human-machine team performance.
	Brain-Computer Interaction						
	Human Insight and Trust						
Human-Robot Interaction	Human-Robot Interaction						Human-machine teams that can successfully operate in an agile fashion in an operational environment.
	Novel-Human-Intelligent Agent Interactions						
	Human Interaction with Adaptive Automation						
Closed Loop Medical Technology Research	Closed-Loop Oxygen Generation and Delivery						Maximize patient care through autonomous technologies in operational environments

Thrust 2: Intelligent, Adaptive Aiding

Delivering the Mission

- Maintain mission effectiveness despite fluctuating demands: No mission degradation in a high tempo environment

- Optimized human-machine teaming: Dynamic workload allocation to improve mission efficiency

- Provides shared situation awareness and transparency between the operator and the weapon system platform: Appropriate level of operator trust

- Optimized warfighter readiness and enhanced training: Identification of relevant biomarkers indicative of operator cognitive and physiological state

Delivering Capability

Enhance warfighter effectiveness by coupling humans and machines through the use of intelligent adaptive aids to protect from being overwhelmed by complexity and workload.

- Develop models of perception and cognition

- Assess the functional state of the operator

- Real-time measurement and assessment of warfighter performance

Key Technical Challenges

- Immature tools for individual and team functional state assessment

- Fragile cognitive models

- Operationalize minimally invasive sensor suites

- To Identify the appropriate biomarkers for determining operator performance

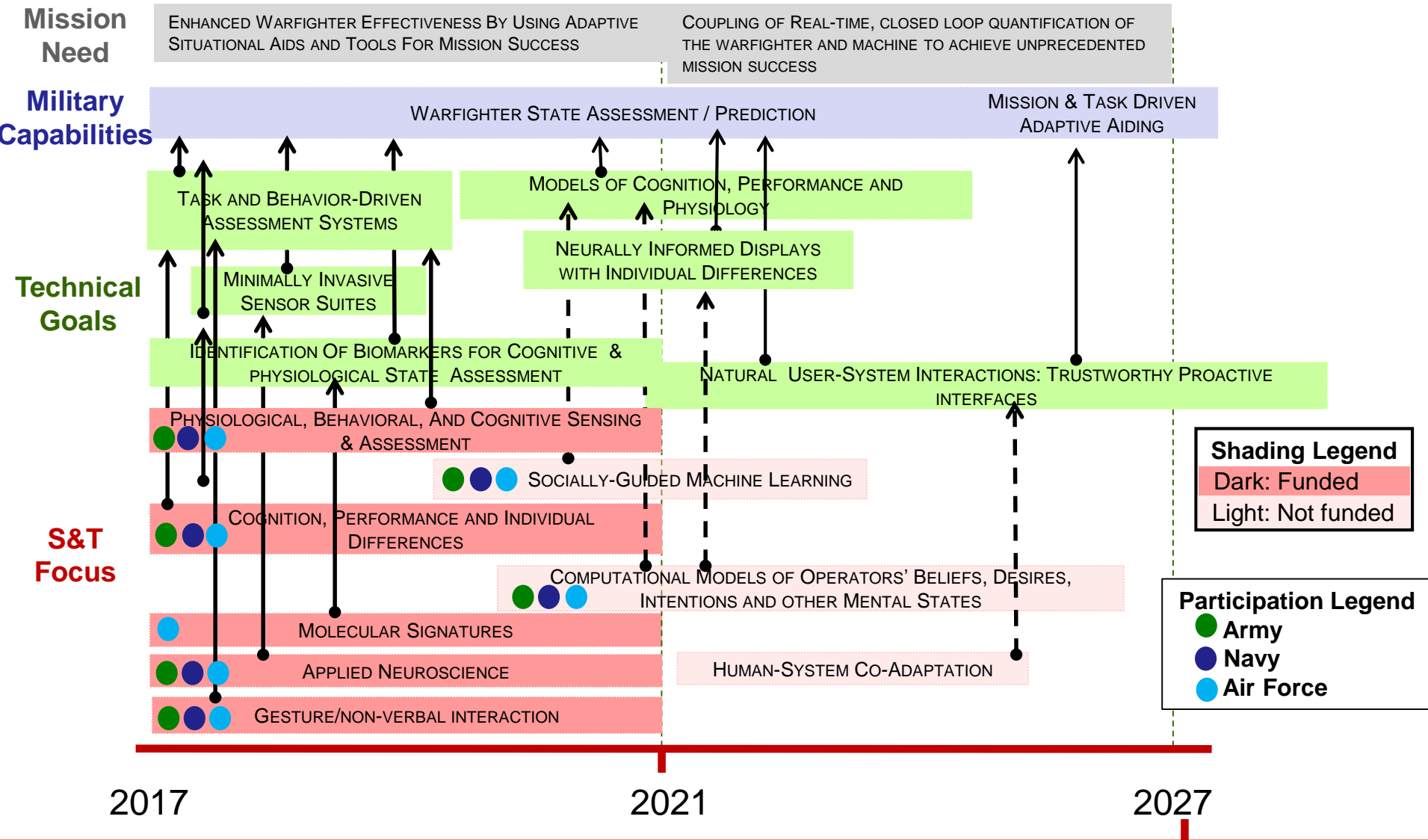- Absence of effective gesture/non-verbal interfaces

Program Overview

- Applied Computational Neuroscience

- Cognitive Performance Optimization

- Monitoring, Predicting, and Optimizing Battlespace Awareness

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34

Intelligent, Adaptive Aiding

Mission Need

Enhanced Warfighter Effectiveness By Using Adaptive Situational Aids and Tools For Mission Success

Coupling of Real-time, closed loop quantification of the warfighter and machine to achieve unprecedented mission success

Military Capabilities

Warfighter State Assessment / Prediction

Mission & Task Driven Adaptive Aiding

Technical Goals

Task and Behavior-Driven Assessment Systems

Models of Cognition, Performance and Physiology

Minimally Invasive Sensor Suites

Neurally Informed Displays with Individual Differences

Identification Of Biomarkers for Cognitive & physiological State Assessment

Natural User-System Interactions: Trustworthy Proactive interfaces

S&T Focus

Physiological, Behavioral, And Cognitive Sensing & Assessment

Socially-Guided Machine Learning

Cognition, Performance and Individual Differences

Computational Models of Operators' Beliefs, Desires, Intentions and other Mental States

Molecular Signatures

Applied Neuroscience

Human-System Co-Adaptation

Gesture/non-verbal interaction

Shading Legend
Dark: Funded
Light: Not funded

Participation Legend
- Army
- Navy
- Air Force

2017   2021   2027

Intelligent, Adaptive Aiding
Program Detail

S&T Focus Area	Near-term					Mid/ Far-term	Operational Opportunities
	FY 15	FY 16	FY 17	FY 18	FY 19		
Gesture/Non-Verbal Interaction	Gesture and Non-verbal Interaction						Human-machine interaction using gestures and/or other non-verbal means to communicate/execute mission intent.
	Brain-Computer Interaction						
	Applied Adaptive Aiding						
Applied Neuroscience	Applied Computational Neuroscience						Real-time, omnipresent-sensing technology, signatures of brain networks that capture changes in task performance and brain-based technologies to aid the operator and optimize team performance.
	Monitoring, Predicting, and Optimizing Battlespace Awareness						
	Molecular Signatures						
	Soldier Focused Neurotechnologies						
Cognition, Performance, and Individual Differences	Cognition, Performance and Individual Differences						Advanced technology to sense, measure and quantify individual warfighter cognition and performance parameters to predict and augment warfighter performance.
	Cognitive Performance Optimization						
	Soldier Centered Design Tools						
Physiological, Behavioral, and Cognitive Sensing and Assessment	Applied Computational Neuroscience						On-line operator monitoring and assessment technology, integrating multiple and concurrent data streams to predict and augment warfighter performance.
	Soldier Focused Neurotechnologies						
	Continuous Multi-faceted Soldier Characterization for Adaptive Technology Advancements						
	Molecular Signatures						
	Cognitive Performance Optimization						
	Applied Adaptive Aiding						

Protection, Sustainment, and Warfighter Performance

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37

HUMAN SYSTEMS COI SUB-AREA:
Protection, Sustainment, and Warfighter Performance

VISION

Enable superiority of Warfighters by understanding and overcoming operational stressors, and providing protection from threats in their environment.

DARPA Warrior Web early prototype

Wearable sensor technology

This will be achieved through:

1. Understanding the factors that influence individual performance
2. Developing the ability to measure performance in the operational environment
3. Developing strategies to mitigate the effects of critical stressors on performance

Achieving this vision will enable:

1. Increased ability to perform at a higher stress level without a performance decrement or increase in injury
2. The ability to measure performance in training and operational environments
3. Warfighter protection aligned to mission specific threat, environment, and region allowing for optimal performance while maintaining protection
4. New technology capable of measuring current Warfighter state and predicting current and near term performance, resulting in 20% increase in task performance
5. Load mitigation strategies resulting in 25% decrease in metabolic cost

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38

Protection, Sustainment, and Warfighter Performance Scope

Research and development in this area will produce better understanding of the critical environmental stressors and the human factors yielding individual performance differences in operational environments in order to enhance performance and mitigate the effects of stressors. This includes designing systems that support and exploit individual differences, and developing operationally relevant metrics to monitor and assess performance.

Thrust Area 1:

Understanding and Quantifying Warfighter Variability

S&T Focus Areas on Roadmap:

- Ability to Conduct Warfighter Assessment in All Environments
- Mechanisms and Effects of Individual Differences and Critical Stressors on Warfighter Performance
- Real-Time Data Analysis and Performance Prediction

Thrust Area 2:

Enhancement and Mitigation Strategies

S&T Focus Areas on Roadmap:

- Tool(s) for conducting trade off studies between protection/load, performance, and individual differences.
- Development of Augmentation Technologies and Techniques
- Design and Development of Models and Methods for Understanding Effects of Mitigation Strategies

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39

Thrust 1: Understanding and Quantifying Warfighter Variability

Delivering the Mission

- Data analysis and performance prediction will enable improved resilience by providing critical information on Warfighter readiness.

- Understanding the underlying mechanisms through which critical stressors influence performance will enable greater performance and protection methodologies.

- Understanding individual differences in the effect of critical stress on performance will enable greater Warfighter resilience.

Delivering Capability

- Developing technology capable of objectively measuring warfighter performance in operational environments to enable real-time monitoring of Warfighter performance.

- Understanding the underlying mechanisms through which performance is influenced will provide a pathway to optimizing Warfighter performance.

- Modeling individual responses to critical stressors will enable the leveraging of individual variability as a means of improving Warfighter performance and protection.

Key Technical Challenges

- Sensors needed that are non-invasive, don't influence performance, and provide meaningful data.

- The underlying mechanisms by which specific stressors influence performance are poorly understood.

- The influence of human variability on the effects of stress on warfighter performance is difficult to predict.

- High fidelity models that predict performance and injury and/or the impact of protection strategies on performance are lacking

Program Overview

- Determinants of hazardous biomechanics
- Ubiquitous and unobtrusive Real-World Assessment
- Impact of individual differences

Understanding and Quantifying Warfighter Variability

Mission Need

Improved readiness through quantifying and understanding the effects of critical stressors on individual warfighter state and performance

Military Capabilities

First Generation real time monitoring of Warfighter performance

Optimized warfighter performance based on understanding critical stressors

Understanding and leveraging individual variability in response to stress

Technical Goals

Define and validate operationally relevant test capabilities, metrics and measurement methods.

Near term performance prediction based on real-time data

Integrated sensors and advanced models enabling near term performance prediction

Modeling of individualized response to critical stressors on warfighter performance

Develop sensors capable of real-time performance monitoring

Shading Legend
Dark: Funded
Light: Not/partially funded

S&T Focus

Physical Performance and Individual Differences

Real-Time Data Analysis and Performance Prediction

Warfighter Assessment in All Environments

Participation Legend
● Army
● Navy / Marine Corps
● Air Force

2016   2019   2021   2023   2026

Understanding and Quantifying Warfighter Variability
Program Details

	Near-term					Mid/ Far-term	Operational Opportunities
	FY 15	FY 16	FY 17	FY 18	FY 19		
Physical Performance and Individual Differences *Understanding the effects of physical stress and of individual variability on the effects of that stress on performance.*	Determinants of hazardous biomechanics and injury Bioeffects:toxic particles, nanomaterials, directed energy exposures Effects of operational environment on pilot toxicology Human Integrated Performance Optimizer Advanced Research focusing on Individual Differences						*An understanding the individualized effects of critical stressors on physical performance will enable greater warfighter resilience.*
Real-Time Data Analysis and Performance Prediction *Developing the ability to predict near and far term performance decrements before they happen.*	High resolution, wearable kinematic sensor and real-time algorithms development → Feedback to improve Warfighter Performance → Sustainment Technologies for Enhanced Performance of Soldiers (STEPS) Real-Time Bioeffects analysis						*Real-Time information on Soldier state and impending performance decrements will provide critical information on Soldier readiness.*
Warfighter Assessment in All Environments *The development of metrics and tools for quantifying Warfighter states in any environment.*	IMU Arrays for Warfighter Kinematic Measurement Omnipresent Real-World Soldier Assessment Aerospace Toxicology Human on a Chip → Integrated Sensor Suite Development → Probabilistic Risk Assessment Tools for Weapons Developers →						*The ability to collect information on Warfighter state in the operational environment. This information can be used to prevent performance decrements.*

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42

Pilot Physiological Monitoring and Warning System
(PPMAWS) Technology Demonstration
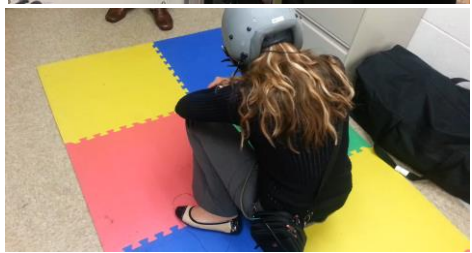

Next Gen JHMCS

PPMAWS Demonstration Altitude and High-G Acceleration

Foreign Comparative Test PPMAWS integration into Joint Helmet Mounted Cuing System

International CRADA Elbit/LifeBeam Helmet Testing

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2013 **2015** **2016** **2019** 43

Thrust 2: Enhancement and Mitigation Strategies

Delivering the Mission

- Physical augmentation to reduce metabolic cost by up to 25%

- Modeling and Simulation tools capable of predicting physical stress on the Warfighter to within 5%.

- Optimized load configurations and route planning leading to a 10% reduction in metabolic cost and 10% increase in operational performance.

Delivering Capability

- Develop methods of lessening the effects of critical stressors on Warfighter performance
- Understand the underlying mechanisms by which physical augmentation and protection technologies affect performance. Set system requirements.
- Provide the tools (M&S, route planning, etc.) necessary to understand the relationship between new technology, mission requirements and operational effectiveness.

Key Technical Challenges

- Tools to model effects of augmentation on physical performance and injury potential are still in development.

- Route planning tools require high fidelity models of human physiological response to critical stressors.

- Individual variability influences the extent to which physical augmentation can mitigate physical loads

Program Overview

- Lower Extremity motor adaptations to actuation
- Effects of physical augmentation on walking efficiency
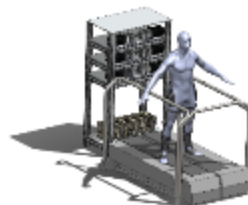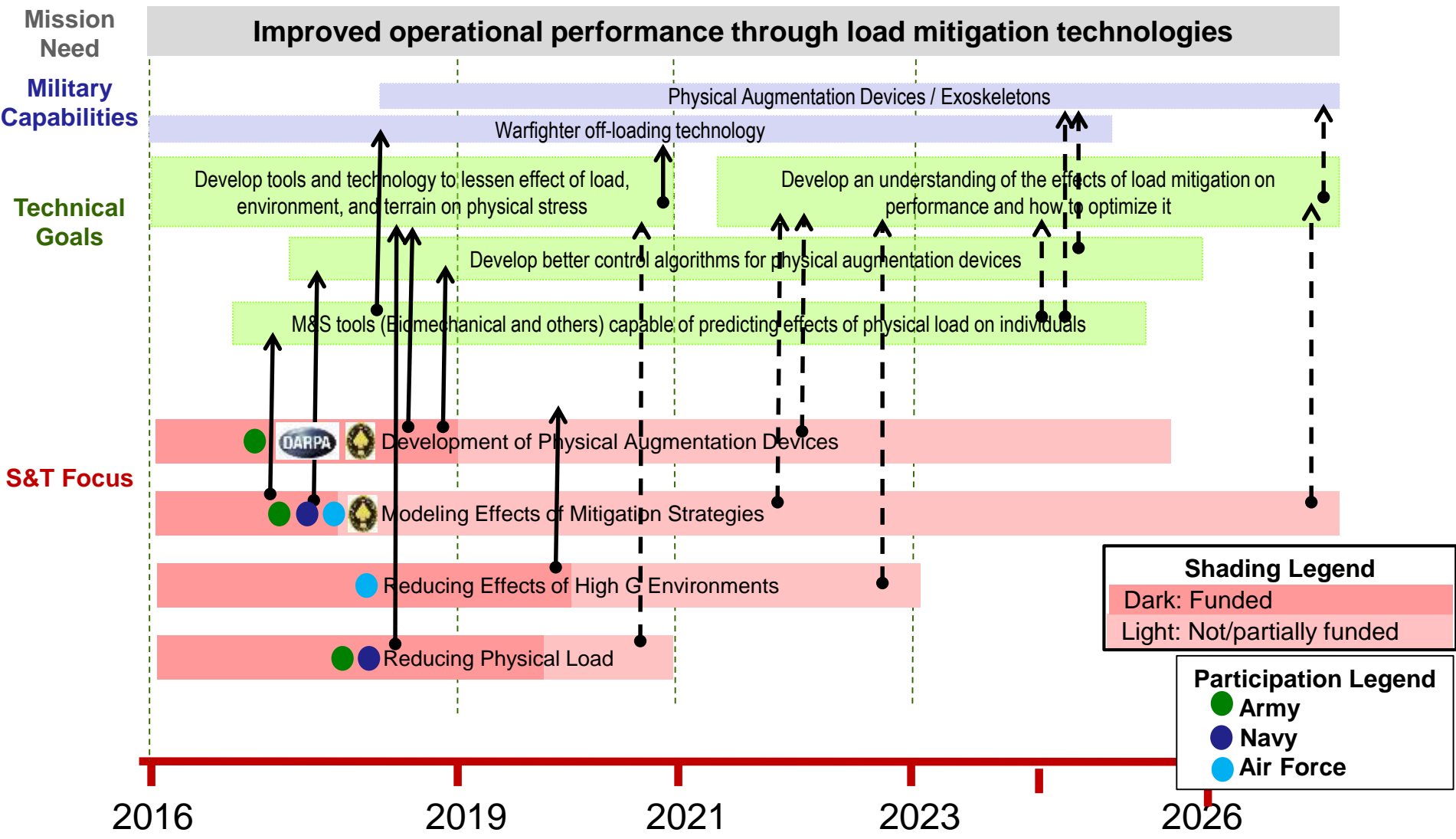- Enhanced Technologies for Optimization of Warfighter Load

Photo property of MIT Prof. Hugh Herr 75 Amherst St., Rm. E14-374L, Cambridge, MA, 02139, (t) 617-258-6574, hherr@media.mit.edu

# Enhancement and Mitigation Strategies

Mission Need

Improved operational performance through load mitigation technologies

Military Capabilities

Physical Augmentation Devices / Exoskeletons

Warfighter off-loading technology

Technical Goals

Develop tools and technology to lessen effect of load, environment, and terrain on physical stress

Develop an understanding of the effects of load mitigation on performance and how to optimize it

Develop better control algorithms for physical augmentation devices

M&S tools (Biomechanical and others) capable of predicting effects of physical load on individuals

S&T Focus

DARPA — Development of Physical Augmentation Devices

Modeling Effects of Mitigation Strategies

Reducing Effects of High G Environments

Reducing Physical Load

Shading Legend
Dark: Funded
Light: Not/partially funded

Participation Legend
- 🟢 Army
- 🔵 Navy
- 🔵 Air Force

2016   2019   2021   2023   2026

	Near-term					Mid/ Far-term	Operational Opportunities
	FY 15	FY 16	FY 17	FY 18	FY 19		
Development of physical augmentation *Devices designed to lessen the effects of physical load on the Warfighter*	DARPA Warrior Web Tactical Assault Light Operator Suit (TALOS) Lower Extremity Adaptations to Joint Actuation Human Body adaptations to physical augmentation The Effects of Training on the Efficacy of a Physical Augmentation Device Advanced control algorithms for enhanced augmentation Ankle Exoskeletons to assist Load Carriage						*Increased endurance, decreased physical fatigue, improved performance.*
Modeling effects of mitigation *M&S aimed at improving augmentation devices and better understanding their effects*	Joint Biomechanical Modeling and Simulation Initiative Enhanced Technologies for Optimization of Warfighter Load 3-D Modeling & Spinal Injury Assessment Advanced Human Whole-Body Response Model						*Augmentation devices that are better suited to the user, resulting in increased physical performance, and less cognitive decrement resulting from physical fatigue*
Reducing Effects of High G Environment *Efforts aimed at reducing the effects of high G environments for pilots*	Hypersonic Escape Next Gen Escape Systems Concepts for Pilots Repetitive G-Loading mitigation for Pilots						*Increased pilot performance in high G environments, decreased injury*
Reducing Physical Load *Technology aimed at reducing the physical load (actual weight, 'easier' terrain, etc.) a warfighter needs to traverse.*	NSRDEC Route Planning Tool Energy Harvesting BackPack Load Carriage / Novel Load Mitigation studies						*The ability to reduce Warfighter physical load while maintaining capability and performance.*

Accomplishments

- **OBOGS – Mil Standard 3050 developed (Bi-service Air Force/Navy). OBOGS' oxygens systems and their standards (operating and contamination standards).**

- **Multiple wearable robots are showing reduced metabolic cost during walking (treadmill and overground)**

- **Warfighter variability within field based settings**
  - IMUs from lab to field, now instrumenting Warfighters with IMUs and getting kinematics and more in depth performance metrics in the field. Providing more in depth information than that which is gained solely from SME opinion. Think dashboard. What value does this provide?

- **Laser Eye Protection ATD**

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47

Thank You

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48

Success Story: Autonomy Research Pilot Initiative
Realizing Autonomy via Intelligent Adaptive Hybrid Control

Operational Challenge

Autonomous control of multiple unmanned systems for military operations

Problem: Current fielded systems fall far short of desired advanced, highly reliable autonomous cooperative behavior

Objective: Increase the robustness and transparency of autonomous control for multiple unmanned systems

Outcome: Agile and robust mission effectiveness across a wide range of situations, and with the many ambiguities associated with the "fog of war"

S&T Accomplishments

- ❑ Refined tri-service "Base Defense" challenge scenario to include more unexpected, dynamic events
- ❑ New rapid joint human-machine "Course of Action" tool
- ❑ New Task Manager capability: system workload balancing
- ❑ IMPACT "DoD Virtual Lab" refined (Year 2)
  - ❑ 1 operator x 12 vehicles (simulation)
- ❑ IMPACT Year 2 full system evaluation underway with 8 op experts
- ❑ Co-development of R&D at ARL, NRL and SPAWAR
- ❑ To date, over 30 S&T publications produced

Return on Investment

Affordability

- Reduction in logistics footprint for equipment and personnel
- Risk Reduction: Opportunities to transition IMPACT technologies to other DoD programs

Readiness

- Force multiplier: Autonomous control of multiple weapon systems with fewer personnel

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49

Success Story:
Multi-Modal Communication Management Suite

Operational Challenge

Problem: C2 operators experience a high volume of perishable voice and chat communication across disparate systems leading to high workload and missed messages.

Objective: Provide comprehensive communication management software that improves real-time operator performance and workload in high comm situations.

Outcome: Net-centric software with integrated voice and chat, spatial audio, automatic speech recognition, keyword spotting, communication recording, search, and playback.

S&T Accomplishments

❑ Software prototype with licensed patent on IP

❑ Lab evaluations showing increased key-word spotting performance and reduced operator workload

❑ Integration into AFRL/FAA/Naval Undersea Warfare Center research testbeds

❑ Collaboration with Carnegie Mellon on custom speech recognition models for FAA and Domestic Event Network

❑ Integration and operational demonstration at Western Air Defense Sector

❑ Cooperative Research and Development Agreement with Global Flyte to tailor for emergency response scenarios
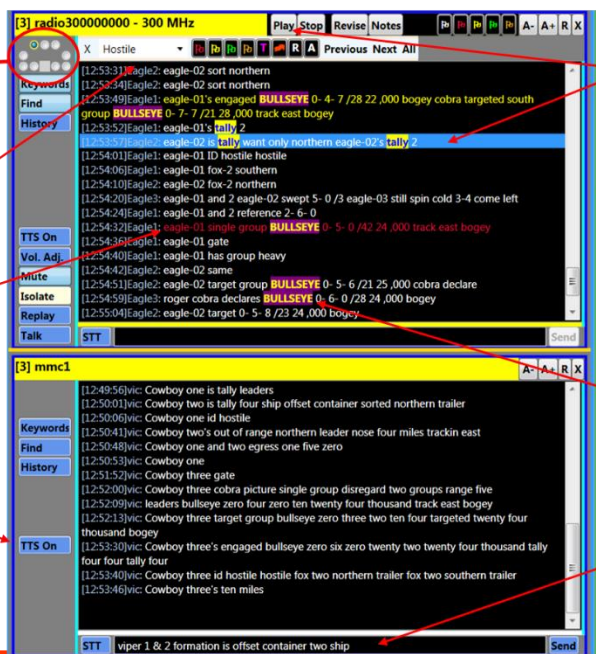
Search for words or Flagged items

Flag lines for later review

Text-to-Speech to listen to chat messages

Listen to past audio by selecting desired text

Radio communications are transcribed using ASR

Highlight Keywords - create alerts to critical words

Speech-To-Text sending chat messages

Return on Investment

Affordability: Intellectual Property protected; software based on open source tools and message protocols

Readiness: (TRL 4/5) Concept demonstrated in laboratory and operational settings; CRADA to improve readiness for emergency response domain

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50

Success Story: Capable Manpower
## Control Station Human Machine Interface (CaSHMI)

Operational Challenge

Problem:

1) Current UxV control paradigm is manpower intensive with inconsistent, proprietary HMIs.

2) A single UxV, vehicle-centric HMI metaphor does not scale for multi-UxV's, mission management & emerging autonomy

Objective: Develop a Navy Mission-centric HMI, that enables "Parallel management" of multiple UxVs, with intermittent warfighter engagement and will scale with expected automation and technology.

Outcome: Transition UxV supervisory control HMI & supporting software architecture to AN/BYG-1 Submarine Combat System; and PMA-281 Common Control System
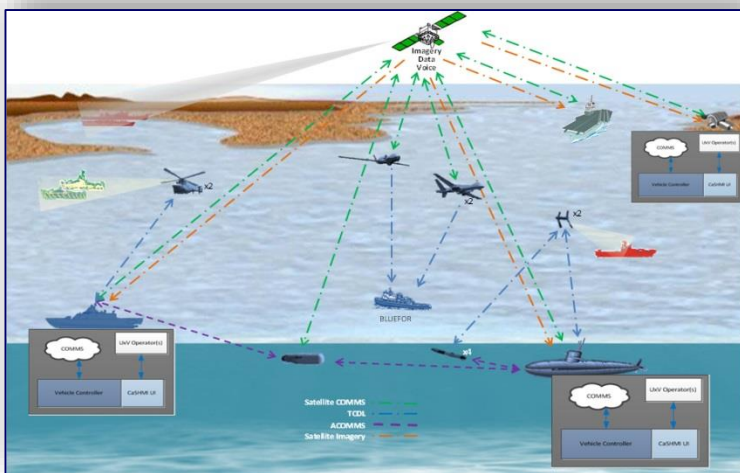
S&T Accomplishments

- User-Centered Design Process completed with Cross-Domain UxV operators
- Innovative software architecture defined separating vehicle control from business logic & HMI to enable scalable interface implementations
- Live demonstrations of AN/BYG-1 operators using CaSHMI to provide simultaneous supervisory control of a Blackwing UAS and multiple IVER UUVs concurrently.

Return on Investment

Affordability
- Reduction in manpower requirements for increasing UxV mission employment.
- Reduction in training costs with "common" mission management interfaces

Readiness
- Enable single operator management of 2+ UxVs for an ISR missions
- Flexible task management supports dynamic mission events / requirements
- Prototype for Common HMI & controls across UxVs & Navy platforms

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51

Operational Challenge

Closed-loop control of oxygen generation and delivery for military medical operations

Problem: Current military environments present significant challenges to patient care in operational settings (oxygen availability, situational awareness, etc.)

Objective: Induces automatic changes in oxygenation delivery during mechanical ventilation in response to measured changes in patient physiology

Outcome: This technology has the potential to have a profound impact on the way the military medical system cares for critical care patients
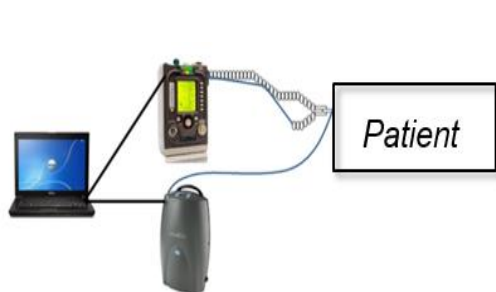
Accomplishments

- ❑ Technology has demonstrated, in pre-clinical/clinical models, successful mitigation of hypo/hyperoxemic events (both associated with worsening outcomes)
- ❑ Generated novel mechanical ventilation/oxygen concentrator interoperable system
- ❑ The research team has received an FDA Investigational Device Exemption (IDE) to conduct a first-of-its-kind clinical trial utilizing closed loop control of oxygen delivery during mechanical ventilation in trauma patients

Return on Investment

This technology would maximize safe oxygen delivery and minimize oxygen/power consumption

Affordability

- Conserves oxygen, potentially reduces logistical planning factors

Patient Safety

- Maintains clinician set target equivalent to/or more often than standard of care (demonstrated in previous trial)
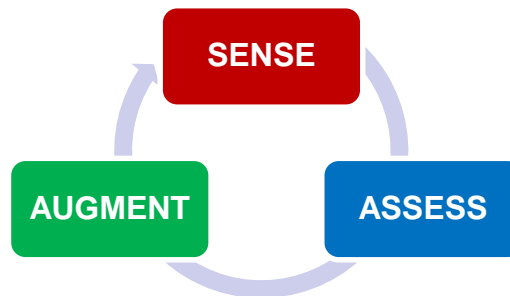
Readiness

- Force multiplier: Autonomous control of multiple patients with fewer personnel; enhanced care of wounded in austere/resource constrained environments

The Quantified Warrior

Multi-domain Operations

SENSE → ASSESS → AUGMENT

Available wearable sensors can be used to sense the cognitive and physical state of the soldier, sailor or airman.

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53

Operational Challenge

Identification of biomarkers predictive of performance under stress

Problem: Fatigue is an important concern throughout today's 24/7 operations – performance degradations cause mishaps, reduced accuracy & slow reaction time.

Objective: Evaluate efficacy of transcranial direct current stimulation (tDCS) to reduce cognitive declines caused by fatigue.

Outcome: Evidence suggests tDCS is twice as effective and lasts at least 3 times as long as caffeine. In addition, test subjects report feeling less fatigued and more energetic 24 hours post-stimulation.

S&T Accomplishments

- ❑ Successfully demonstrated large effects of tDCS on cognition and mood under sleep deprivation conditions
    - ❑ Evidence suggests tDCS could be a fatigue mitigation tool more powerful than caffeine.
- ❑ Study findings have been replicated within AFRL and outside of AFRL laboratory
    - ❑ Illustrates effects are large and robust
- ❑ Developed tDCS paradigm (electrode placement, current intensity, stimulation duration) effective for stimulant-like effects
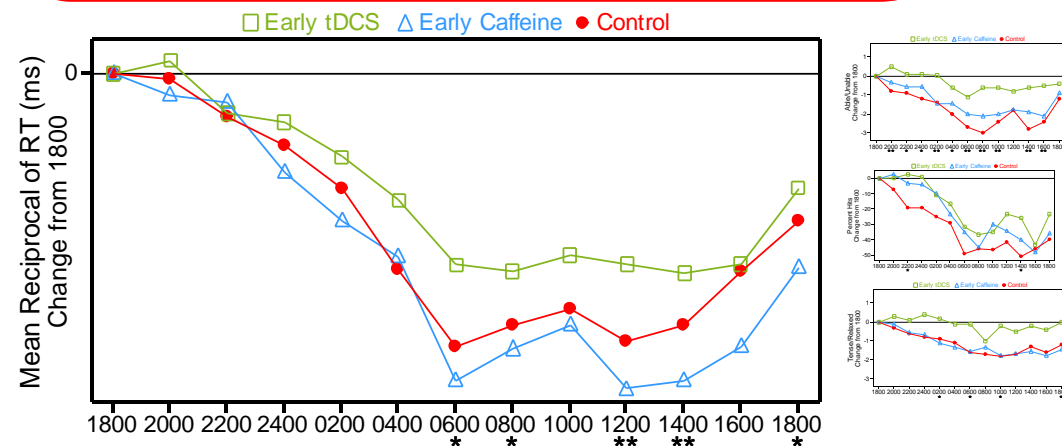
Return on Investment

Affordability

- Reduces risk of fatigue-related mishaps and injuries.

Readiness

- Provides Airmen with a tool to mitigate effects of fatigue for up to 24 hours during long duration missions – improves mission effectiveness and performance

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54

Operational Challenge

Dismounted operators require greater situational awareness (SA) and an integrated tactical ensemble.

Problem: Power/data cable hazards and responsive multiple patient monitoring

Objective: Increase the battlefield airman's SA: easily operate and increase interoperability of BAO & GAO kit components

Outcome: Medical responsiveness on the battlefield; minimize operator's need to "look-down"; and easily operate body-worn devices

BATDOK (Battlefield Airmen Trauma Distributed Observation Kit)

Mobile Device Integration

Optical Wireless Data Connection

S&T Accomplishments

☐ Developed personal area optical data connection to link head-worn devices with body-worn devices such as headsets, HMDs, tablets, radios, etc.

☐ Developed person-to-platform optical data connection to link untethered Airmen to mission platforms for wireless communications.

☐ Developed sensor/wireless protocol agnostic casualty monitoring application and system

☐ Developed EUD multimodal covert/overt dismounted notifications alerting medics of patients' urgent conditions

Return on Investment

Affordability

- Reduction in BAO & GAO kit cost due to the elimination of cabling needed to connect with body-worn devices
- Casualty monitoring device and capability can save lives

Readiness

- Remote monitoring of multiple casualties
- Ease of operating body-worn devices
- Reduction in cable hazards
- Reduced training spin-up

Operational Challenge

Problem: New sensing technologies require Warfighters to make accurate decisions based on a myriad of data while operating in chaotic environments, but assessing human use of Situational Awareness (SA) technologies in standard mission sets has not been formalized.

Objective: Develop validated cognitive workload measures and metrics to assess the impact of SA technologies on Soldier cognitive workload. Develop initial standards for cognitive and mission performance for Dismounted Soldier tasks and select Mounted Soldier duty positions.

Outcome: Increased Situational Awareness during operational missions with minimized SA technology cognitive burden on Soldier and Small units.
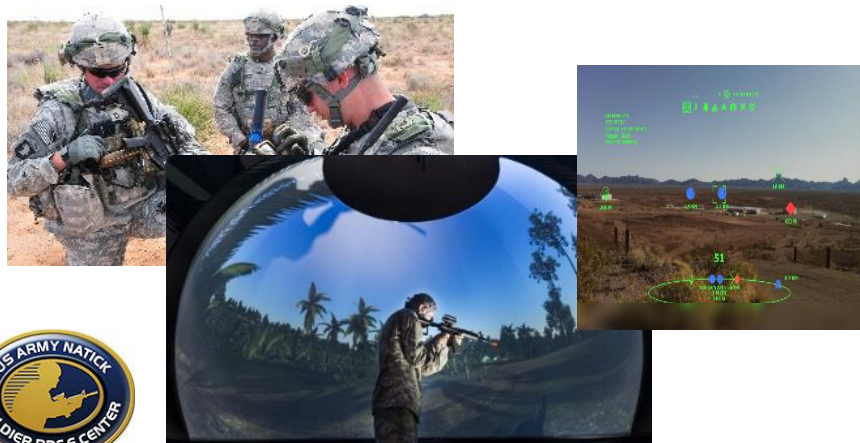
S&T Accomplishments

- ☐ Developed scenarios designed to variously tax cognitive workload and SA

- ☐ Developed a high-fidelity PACOM environment with local national and insurgent behavioral profiles, realistic weather, wildlife, and audio

- ☐ Completed pilot studies to establish test methodology for means to collect physiological metrics such as voice data, eye movements/pupillometry, and electroencephalogram

- ☐ Approved FY17 STO-R to develop standard documented test bed to assess impact of new SA systems on decision-making and workload during development cycle

Return on Investment

Affordability

Common Dismounted Soldier viewing and computer control experience across handheld, mounted, and thru-sight displays will reduce the costs of developing related technologies and training personnel

Readiness

SA technologies deployed more rapidly, with fewer unknown performance drawbacks, and reduced training time due to validated cognitive assessment and common viewing prior to fielding

Success Story: Computer Generated Forces
Training Executive Agent (TXA)

Operational Challenge

"An integrated LVC training environment with today's battle complexity is essential to improving proficiency across all current and future mission sets." (Naval Aviation Vision 2016-2025)

Problem: High manpower to run complex virtual training

Objective: Make Computer Generated Forces (CGF) more intelligent and adaptive to training objectives

Outcome: Transitioned the Training Executive Agent (TXA) into the Navy's Next Generation Threat System

S&T Accomplishments

- TXA monitors a training exercise and issues "directives" to other CGFs to modify behaviors according to a higher level scenario director (training objectives)

- TXA used in NIFC-CA training scenarios

- Exploring TXA usage on aviation pods, thus providing unique flexible embedded training capabilities
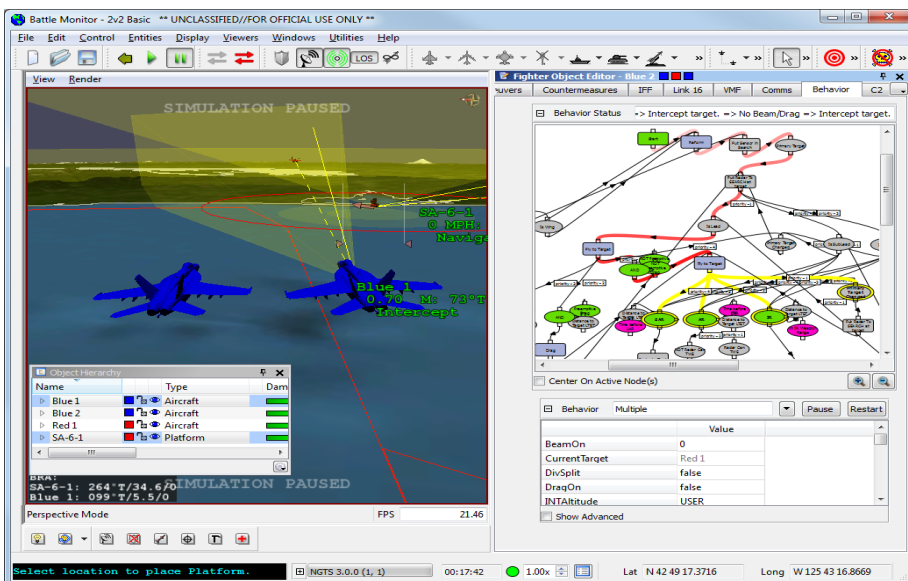
Return on Investment

Affordability

- Aid instructors and "pucksteers" who dynamically controls CGF during execution of a training scenario.

- Reduce number of required "pucksteers", reduce overall training costs

Readiness

- Provide trainees with tactically realistic entities, in realistic complex battle scenarios

- Allow instructors to focus on trainee, not on playing roll in scenario

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57

Oxygen Technology Evolution

Next Generation
OBOGS/
Solid State
OBOGS

F-22 On-Board
Oxygen Generating
System (OBOGS)

F-15E On-Board
Oxygen Generating
System (OBOGS)

Liquid Oxygen (LOX)
Systems

Gaseous Oxygen (GOX)
Systems

1920   **1950**   **1990**   **2000**   **2025**

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58