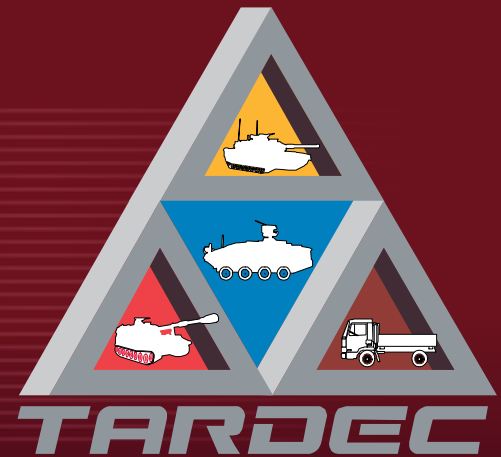




RDECOM



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Opportunities within the Tech Base

Dr. Dave Thomas
Associate Director, Intelligent Ground Systems (IGS)

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Report Documentation Page

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Furthering Unmanned Systems Autonomy

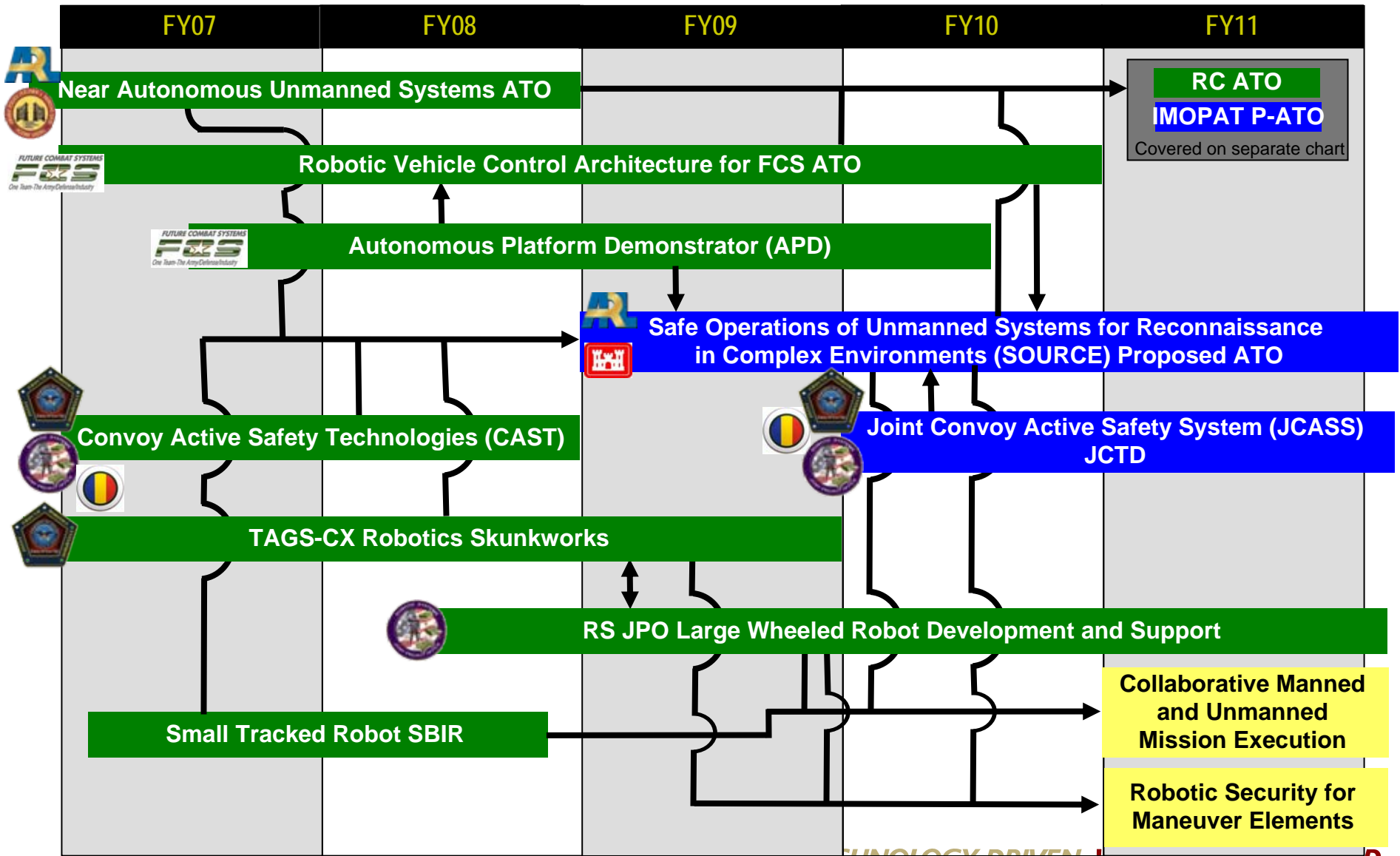
- Unmanned Ground Vehicle Platforms
- Vehicle Intelligence and Control
- Mission Payload Integration
- Embedded Simulation



Increasing Crew Interface and Control Capabilities

- Human-Robot Interaction
- Advanced Soldier Machine Interfaces
- Embedded Simulation





Current
Proposed
Planned
unclassified

Intrinsic Mobility



Intelligent Mobility



Autonomous street following

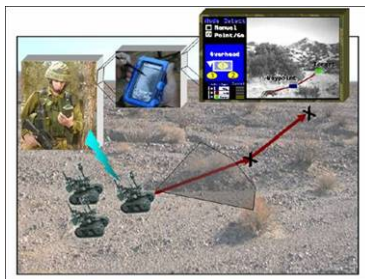
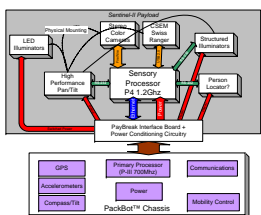


Autonomous perimeter following demonstration

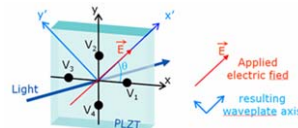
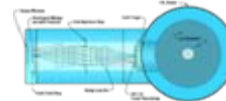
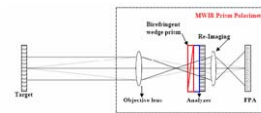
Innovative Control



Sensor positioning for sub-vocal speech detection



Advanced Sensors



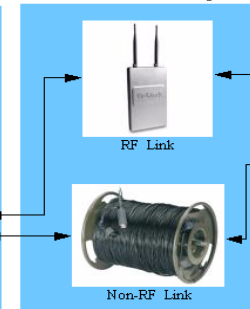
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Adaptive Payloads

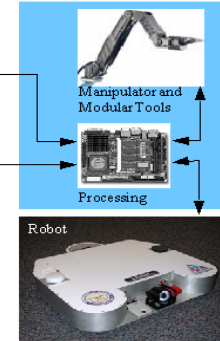
Adaptive OCU and Controller



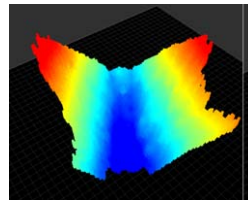
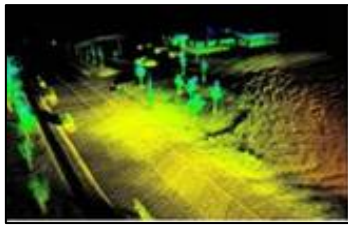
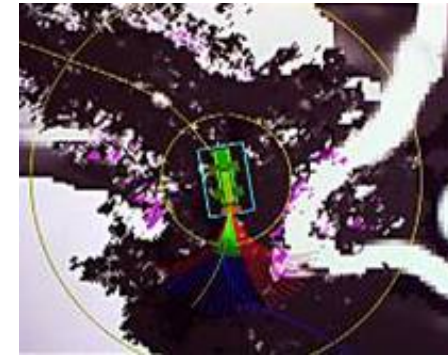
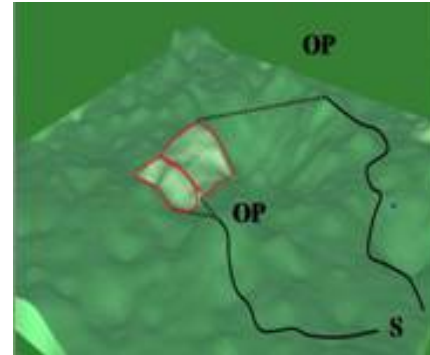
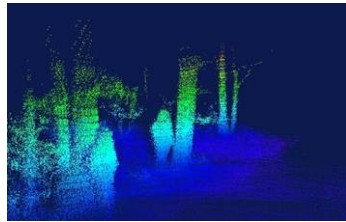
Dual Communications Package



Manipulator and Modular Tool Attachments



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Perception

Intelligence

- Vehicle intelligence
- Tactical behaviors
- Collaboration
- Mission specific behaviors



Safety

- Vehicle safety
- Weapon safety



Platform

- Mobility maturation
- SWaP

Command & Control

- Operator control interface
- Battle command integration

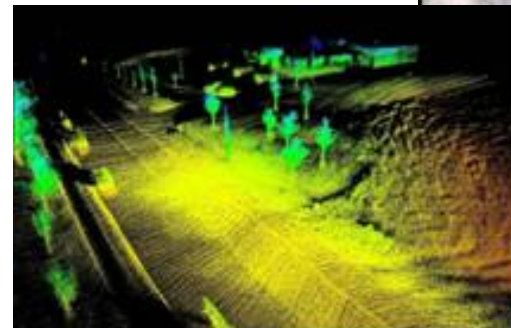
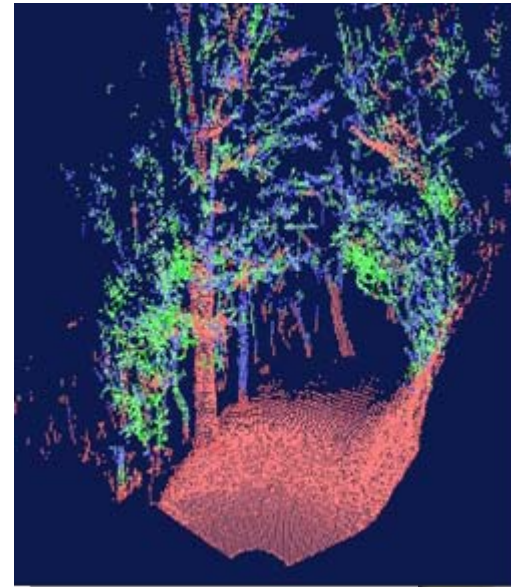
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Sensors

- Extended range & resolution
- All weather sensing/obscurants
- Reduced size

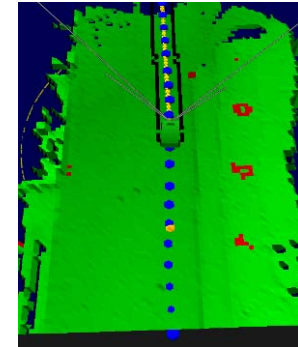
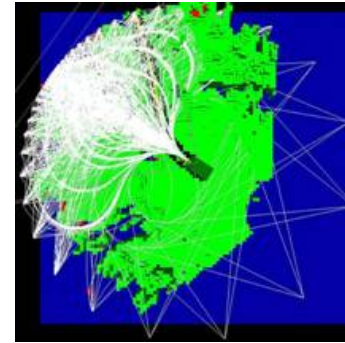
Software

- Terrain/Feature classification at extended range
- Detection, classification, tracking of moving vehicles, people, & animals from a moving vehicle (object association/partial obscuration)
- Detection of moving & stationary people, often partially obscured or camouflaged
- Stand-off classification of mud or water – estimate of surface supportability/trafficability



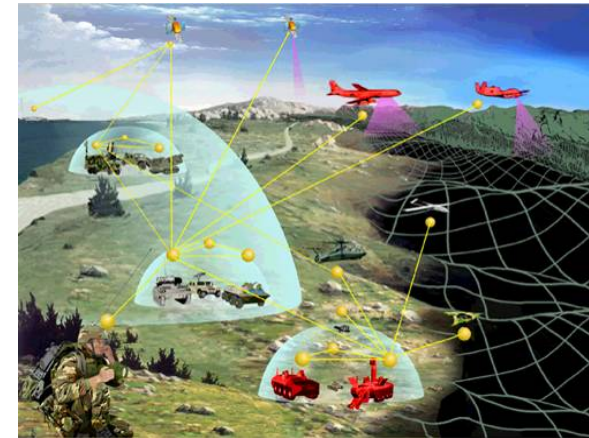
Vehicle Intelligence

- Ability to adapt to changing environment & learn from prior experience or act based upon general guidance
- Ability to project future activity or courses of action by others and plan accordingly
- Ability to understand vehicle health and modify plans accordingly



Tactical Behavior

- Mimic the behavior of Soldiers under similar conditions
- Continue autonomous operation during prolonged communications outages
- Self-protection



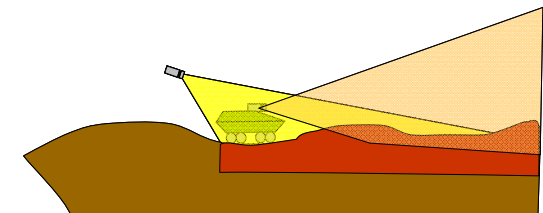
Collaboration

- Shared situational awareness
- Teaming – robot/robot and robot/Soldier



Mission Specific Behaviors

- RSTA
- Force Protection
- Material handling/delivery



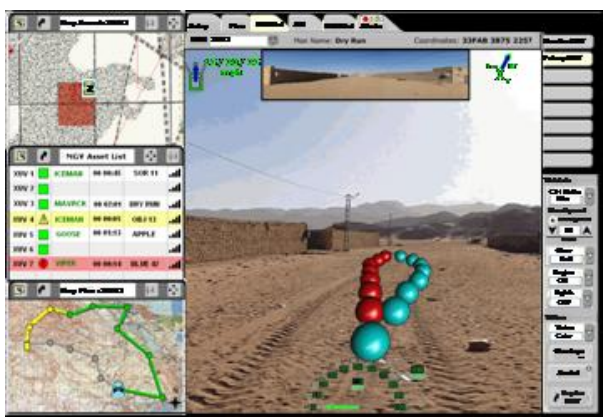
Operator Control

- Situational awareness of what's going on around the robot/operator intervention
- Scalable interfaces – from MGV to dismount
- Operator workload in realistic tactical environments
- Operator span of control
- Alternative control modes (voice/gesture)
- Hands free, heads up display and control



Command Integration

- Fusion of local situation awareness information with the Common Operating Picture



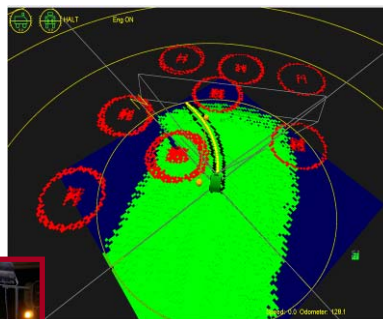
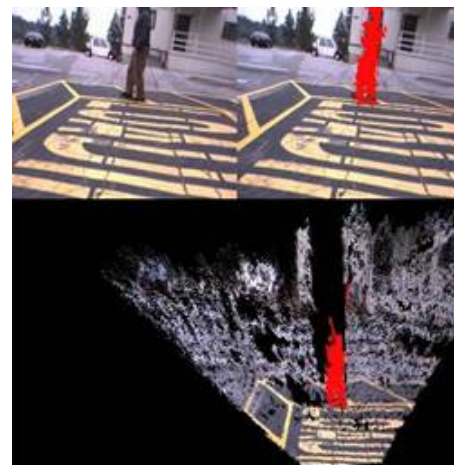
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Safe Operations

- Autonomous Vehicle Mobility
- Autonomous Weapon Control

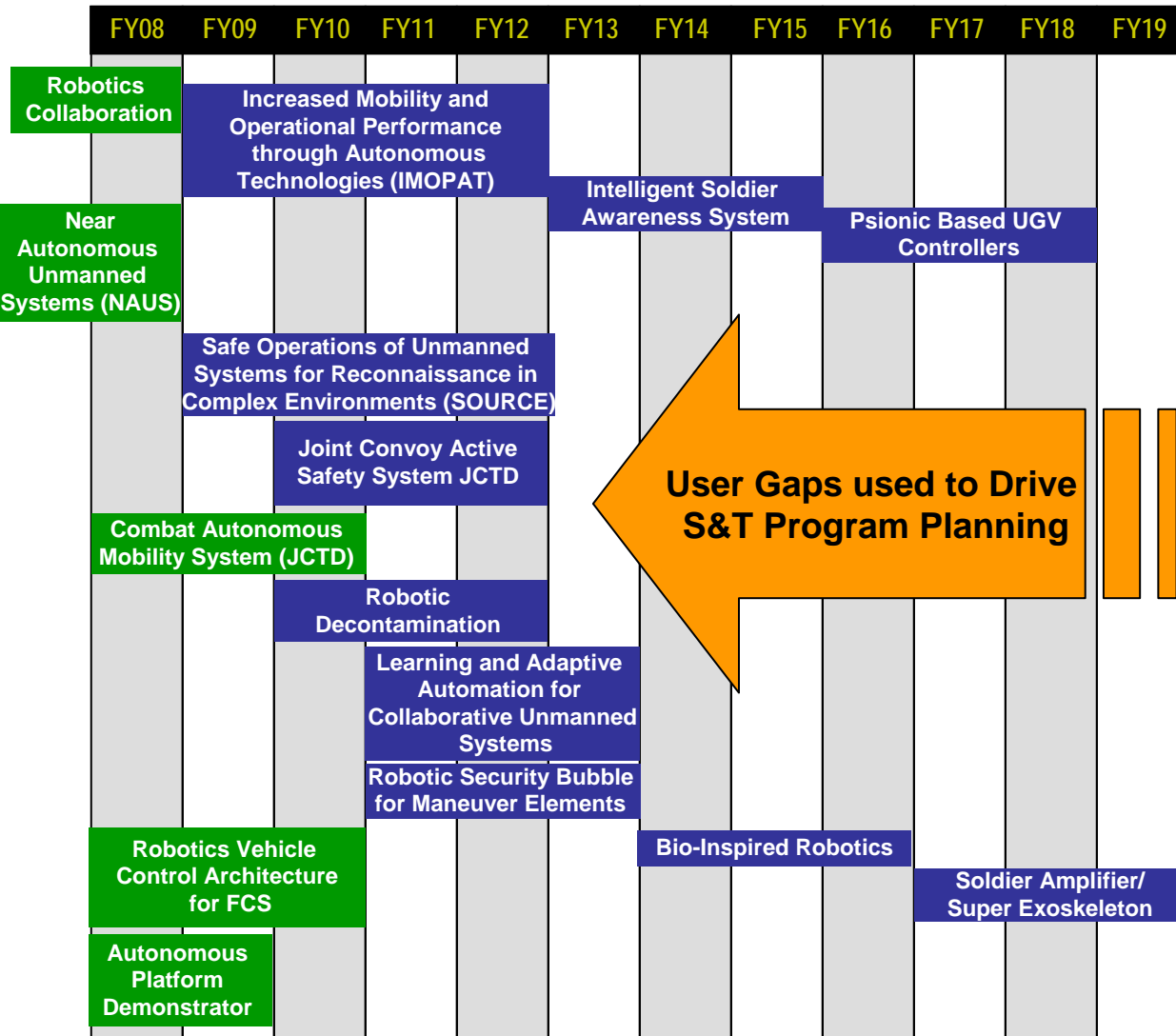
Platform Technologies

- High bandwidth data links and network integration
- High density power sources
- System modularity/shape shifting designs
- Micro/miniaturization and Bio-mimetic designs
- Condition Based Maintenance



Advancing Fielded Capabilities

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User Gaps used to Drive S&T Program Planning

- FCS Technology Gaps***
- Higher levels of autonomy
 - Complex terrain agility
 - Higher speed capability
 - Enhanced situational awareness
 - Improved navigational accuracy
 - Enable passive sensors for autonomous navigation
 - Enhanced feature classification
 - Vehicle detection, classification and tracking
 - Human detection, classification and tracking
 - Learning and adaptation in both static and dynamic environments
 - Mobility in dynamic environment
 - Situational understanding in dynamic environment
 - Network constraints

- TRADOC Technology Gaps***
- Current Force/Near Term Gaps**
- Ability to remotely clear dangerous areas with robots
 - Convoy protection platform to defend and secure
 - Common robotics controller
 - Unmanned system teaming
 - Autonomous layered self-defense for UMS
 - UAV autonomously launch and land from moving manned vehicles
- Future Force/Mid Term Gaps**
- Provide assured mobility.
 - Provide near-real time combat ID ... across the spectrum of operations.
- S&T/Far Term Gaps**
- Mobile & Fixed 360 Degree Hemispherical Area Protection
 - Area/route clearance at operating speeds
 - Increase Autonomy in control of unmanned systems
 - Future Force Multi-modal HCI
 - Detect, identify, and neutralize CBRN/TIM agent dispersal modes

* Not an all encompassing list!

Ongoing Program
Planned Program

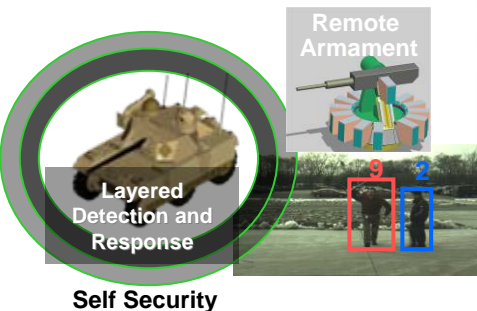
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Autonomous Mobility



Tactical Behaviors



Schedule

Milestones	FY06	FY07	FY08	FY09
Longer range, higher resolution perception (ARL)			5	
Personnel & vehicle detection & avoidance (ARL)			5	
Tactical Behaviors (ARL/TARDEC)			5	
System self security (TARDEC)			5	
Remote weapon station (ARDEC)				5
Integrated reduced workload human interface (ARL)			5	
Autonomous unmanned vehicle field exercises (ARL)	▲	▲	▲	▲
Capstone Experiments (TARDEC)			5	

Purpose:

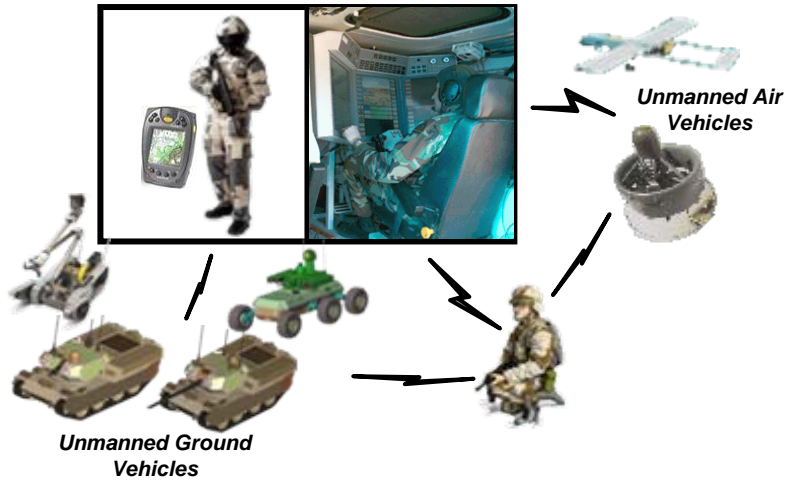
Develop and demonstrate key robotics technologies to reduce risk for PM FCS (BCT) and increase the utility of future unmanned systems.

Product:

- *Near-autonomous maneuver in environments relevant to FCS*
- *Validated tactical behavior methodology and integrated tactical behaviors*
- *System self security – fundamental technology for detection & tracking, and responding to incoming threats.*

Payoff:

- *Unmanned systems able to meet FCS threshold operational requirements*
- *Reduced burden on soldier & network*
- *Unmanned systems with greater survivability*



Focus on Platoon and below operations

Purpose:

Develop the tools, techniques, & autonomy to maximize mounted and dismounted control of ground and air unmanned systems and optimize Soldier-robot and robot-robot ground and air teams

Results:

- Increased OPTEMPO through coordinated Soldier-robot interactions during degraded autonomous modes
- Increased robot planning capability and understanding of UV intent and operational environment
- Unmanned Vehicles safety operational behavioral algorithms and recommendations for TTP development
- Software for UAV/UGV collaboration
- UAV autonomy and cooperative engagement capability

Schedule

MILESTONES	FY04	FY05	FY06	FY07	FY08	FY09
Common scalable interface dev't (ground & air)			5		6	
Intelligent agents and adaptive automation			5		6	
UV autonomy & task distribution algorithms	3	4	5	6		
UV collaborative behaviors	3	4	5	6		
Flight Demos			5	6		
Model Validation and Experimentation (FCS MG V UGV & UAV)			5	5	6	

Payoff:

- Increased mission performance through reduction of task timelines, robot interactions, and cognitive burden with increased adaptive automation & collaboration
- Reduced Soldier training burden through standardized interfaces
- Improved safety of operations around unmanned vehicles
- Optimized span of control for unmanned systems
- Increased Soldier/system engagement effectiveness

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360/90 Day/Night Near-field Sensor Coverage



Soldier Monitoring & State

Advanced Crew Stations



Integration Platform With IV System



**Integrate, Enhance, Demonstrate
360 LSA/Assist-Mob/Soldier Monitor & State
to Maximize Soldier-System
360 LSA and Mobility Capabilities
(Secure Mobility)**

Schedule

MILESTONES	FY09	FY10	FY11	FY12	
M&S and Field Experiments	▲	▲	▲	▲	
Local 360 SA			4	5	6
- Task Analysis					
- Integrate Detection Algorithms					
- Integrate Digital Recording					
- Integrate Dismount System					
Improved Mobility			4	5	6
- Soldier Task Balancing					
- Assisted Mobility					
Soldier Monitor/State CS System			4	5	6
- Sensor Integration					
- Algorithm Integration					
- Integration Technique					

Purpose

Enable indirect vision (IV) based Soldier-systems (manned/unmanned/Soldier) to move quickly and safely while maintaining 360 local situational awareness (LSA) to enhance operational performance.

Product

- Advanced Crew Stations integrated with 360/90 Day/Night LSA, Assisted Mobility, and Soldier Monitoring / State technologies to improve Soldier performance.
- Quantitative understanding (performance levels) of future indirect vision operations for the movement and security of Soldier-systems at a platoon and below level when utilizing:
 - Assisted mobility
 - LSA system with aided target cueing
 - Digital video recording of 360/90 with intelligent tagging
 - Soldier monitoring and state based crew station (CS) design

Payoff

- Improvement in Vehicle & Soldier Survivability, Vehicle Lethality/Self-Defense & Control along with Greater Survivability/Lethality for Dismount Soldiers
- Two Mounted Soldier ability to maintain 360 LSA with IV
- One Mounted Soldier ability to move vehicle (manned or unmanned) quickly and safely with IV
- Data and Information to feed programmatic decisions
- Risk reduction for FCS

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TARDEC

- Develop Enhanced Indirect Vision Drive / Tele-operation Systems
- Develop Assisted Autonomy Systems
- Develop Warfighter Machine Interfaces
- Integrate and Evaluate
 - Vehicle LSA Systems (NVESD)
 - Soldier Monitoring & State Classification Systems (NSRDEC/ARL-HRED)
 - Assisted Mobility (Other TARDEC Programs)
 - Dismount LSA Systems (NSRDEC)
- Perform SIL and Vehicle/Field Experiments



ARL-HRED

- Define and Develop Experimentation Plans
- Work with TARDEC on Indirect Vision Drive and Assisted Autonomy Systems
- Provide HFE Support for Systems Development and Integration
- Develop Information Flow Requirements and Algorithms for Mobility and LSA
- Work with NSRDEC on Soldier Monitoring and Workload Management Systems



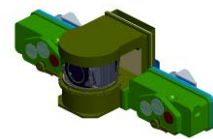
CERDEC NVESD

- Enhance DAS Sensor Systems / Threat Detection Algorithms
 - Pop-Up Targeting and Gun-Fire Detection (before/during/after shot)
- Develop Digital Vehicle LSA Recording and Cueing System



NSRDEC

- Enhance and Transition Mid-Maturity Dismount Soldier Monitoring Systems from Augmented Cognition Program
- Develop/Enhance Low-Maturity Soldier Monitoring System
- Work with ARL-HRED on Soldier Monitoring Systems
- Develop Dismount LSA System



Purpose:

Develop and demonstrate key robotic technologies that will be required for autonomous collaborative unmanned systems & Soldiers to conduct urban operations, permitting effective utilization of UMS for the full spectrum of warfare.

Products:

- **Integrated testbeds and Soldier experimentation providing quantitative performance data to enable development of TTPs & entry into future SDD programs**
- **Demonstration of Improved UMS performance software and algorithms for:**
 - **Operations in dynamic/urban environments**
 - **Collaborative persistent surveillance**
 - **Intuitive supervision of UMS by Soldiers**
 - **Tactical behavior for multi-mission applications**
 - **Small robot autonomy behaviors**

Payoff:

- **Safer operations of UGVs in proximity to pedestrians and vehicles**
- **Increase in vehicle autonomy to enable less supervisory burden**
- **Increased UGV situational awareness**
- **Robust Soldier/robot and robot/robot teaming behaviors**
- **Robust UGV performance in all environments/conditions**

Schedule

MILESTONE (FY)	09	10	11	12
Technology/Requirements Assessment	[Bar]		[Bar]	
Perception & Control Technologies - Safe Operations, Situational Awareness	[Bar] 5 6			
Tactical/Mission Behavior Technologies - Cooperative & Dynamic Behaviors	[Bar] 5 6			
Platform Integration	[Bar]		[Bar]	
Engineering Evaluation		▲	▲	▲
M&S Experiments	[Bar]		[Bar]	
Field Experiments		5		6

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