Opportunities within the Tech Base

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**Opportunities within the Tech Base**

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Approved for public release, distribution unlimited

Intelligent Ground Systems Overview

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
Autonomous Systems Programs

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<thead>
<tr>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
<th>FY10</th>
<th>FY11</th>
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<tbody>
<tr>
<td>Convoy Active Safety Technologies (CAST)</td>
<td>TAGS-CX Robotics Skunkworks</td>
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<td>Small Tracked Robot SBIR</td>
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Current | Proposed | Planned

RC ATO
IMOPAT P-ATO
Covered on separate chart

Collaborative Manned and Unmanned Mission Execution
Robotic Security for Maneuver Elements
Intelligent Ground Systems
Research Focus Areas

Intrinsic Mobility

Intelligent Mobility

Autonomous street following

Autonomous perimeter following demonstration

Innovative Control

Sensor positioning for sub-vocal speech detection

Advanced Sensors

Adaptive Payloads

unclassified
S&T Activities - Technical Capability Areas

Perception
- Vehicle intelligence
- Tactical behaviors

Intelligence
- Collaboration
- Mission specific behaviors

Command & Control
- Operator control interface
- Battle command integration

Safety
- Vehicle safety
- Weapon safety

Platform
- Mobility maturation
- SWaP

unclassified
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
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
Notional Timeline for TARDEC S&T Investment in Unmanned Systems

**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!
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

Schedule

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<thead>
<tr>
<th>Milestones</th>
<th>FY06</th>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
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<tbody>
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<td>Longer range, higher resolution perception (ARL)</td>
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<td>Personnel &amp; vehicle detection &amp; avoidance (ARL)</td>
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<td><strong>Tactical Behaviors</strong> (ARL/TARDEC)</td>
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<td>System self security (TARDEC)</td>
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<td>Remote weapon station (ARDEC)</td>
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<td>Integrated reduced workload human interface (ARL)</td>
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<td>Autonomous unmanned vehicle field exercises (ARL)</td>
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<td>Capstone Experiments (TARDEC)</td>
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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
**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

**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

**Schedule**

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<th>MILESTONES</th>
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<td>UV autonomy &amp; task distribution algorithms</td>
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Focus on Platoon and below operations
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

Schedule

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<th>MILESTONES</th>
<th>FY09</th>
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<td>M&amp;S and Field Experiments</td>
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<td>Local 360 SA</td>
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<td>- Task Analysis</td>
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<td>- Integrate Detection Algorithms</td>
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<td>- Integrate Digital Recording</td>
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<td>- Integrate Dismount System</td>
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<td>Improved Mobility</td>
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<td>- Soldier Task Balancing</td>
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<td>- Assisted Mobility</td>
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<td>Soldier Monitor/State CS System</td>
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<td>- Sensor Integration</td>
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<td>- Algorithm Integration</td>
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<td>- Integration Technique</td>
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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

unclassified
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

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<th>09</th>
<th>10</th>
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<th>12</th>
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<tbody>
<tr>
<td>Technology/Requirements Assessment</td>
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<td>Perception &amp; Control Technologies</td>
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<td>- Safe Operations, Situational Awareness</td>
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<td>Engineering Evaluation</td>
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TARDEC
- Integration of technology & payloads into testbed platform
- Development & conduct of warfighter assessment & engineering evaluations (capstone events)
- Conduit to Battlelabs for TTP developments & integration of appropriate technology into testbeds
- Technology maturation prior to integration (e.g., enhanced robustness, functionality, reliability)
- Technology transition to acquisition partners

ARL/VTD
- Develop perception sensors & algorithms for navigation and mission execution in dynamic urban environments
- Develop planning algorithms for use by heterogeneous UMS in dynamic environments with adversaries and non-combatants, includes collaboration by UMS & Soldiers
- Develop tactical behavior for focused upon manned-unmanned teaming in urban operations
- Develop a hard-ware-in-the-loop simulation to encompass vision based/LADAR sensing

ARL/HRED
- Conduct simulations to evaluate soldier-robot teaming; trust in automation; tolerance to system failure;
- Evaluate intuitive interface concepts for supervisory control - optimization of task allocation

ARL/CISD
- Develop autonomous behavior for a SUGV class vehicle, including assisted teleoperation

ERDC
- Develop a physics-based, multiscaled, terrain-enriched virtual testing capability.
- Evaluate algorithms for sensor fusion
- Develop and evaluate algorithms for UGV autonomous tactical behaviors