OSD RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

APPROPRIATION/ BUDGET ACTIVITY	PE NUMBER AND TITLE
RDTE, Defense Wide BA 05	**0604709D8Z - Joint Robotics EMD**

COST ($ in Millions)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
P609 Joint Ground Robotics Enterprise (JGRE) SDD	9.721	6.851	5.725	5.212	4.245	3.242	3.111

A. Mission Description and Budget Item Justification: (U) This Program Element (PE) was established in response to Congressional guidance to consolidate DoD robotic programs on unmanned ground systems and related robotic technologies in order to increase focus of the Services' robotic programs on operational requirements. Technologies in the PE support the continued development of technologies in Budget Activity 4 (PE 0603709D8Z) in order to continue to make technology transitions and transformations to close the warfighter requirement capability gap. The program ensures coordination between the Services and places emphasis on interoperability and commonality among unmanned ground systems. This PE continues the effort to overcome technology barriers in the thrust areas of unmanned ground system technologies to include Autonomous & Tactical Behaviors, Manipulation Technologies, Collaborative Operations, Interoperability, Man-portable Unmanned Ground System Technologies, and Technology Transition/Transformation. The vision of this support is for the Joint Ground Robotics Enterprise (JGRE) to support the development and fielding of a family of affordable and effective mobile ground robotic systems; develop and transition technologies necessary to meet evolving user requirements, and serve as a catalyst for insertion of robotic systems and technologies into the force structure. The PE supports the need to integrate technologies into representative models or prototype systems in a high fidelity and realistic operating environment and expedite technology transition from the laboratory to operational use. Emphasis is on proving component and subsystem maturity prior to integration in major and complex systems and may involve risk reduction initiatives. Within this PE, funded projects will continue the delivery of responses to advanced technology needs directed at enhancing the warfighters' capabilities identified during concept development, operational assessments and field feedback of current unmanned systems.

All actions under this PE are within BA 5 and are identified with one project number.

B. Program Change Summary	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008)	9.947	2.911	
Current BES/President's Budget (FY 2009)	9.721	6.851	5.725
Total Adjustments	-0.226	3.940	5.725
Congressional Program Reductions			
Congressional Rescissions			
Congressional Increases			
Reprogrammings			
SBIR/STTR Transfer			
Other	-0.226	3.940	5.725

C. Other Program Funding Summary	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013

PE0603711D8Z (BA3) Joint Robotics Program/Autonomous Systems	7.700	11.256	8.477	9.414	10.580	11.782	14.120
PE 0603709D8Z (BA4) Joint Ground Robotics Enterprise (JGRE) ACD&P	22.978	11.860	11.867	12.119	12.389	12.711	13.041

Comment:

D. Acquisition Strategy The Joint Ground Robotics Enterprise (JGRE) utilizes several contracting and management strategies to achieve its objectives. JGR has established relationships with the several agencies to include the National Center for Defense Robotics (NCDR) and the Army s Rapid Equipping Force (REF) to support the rapid acquisition and evaluation of promising unmanned system technologies.

Funding is provided to Service lab partners and other developers to promote common technology solutions across platforms and Services.

Beginning in FY08, JGRE will encourage the establishment of a robotics consortium to broaden the research and development of robotics technologies.

E. Performance Metrics:

FY	Strategic Goals Supported	Existing Baseline	Planned Performance Improvement / Requirement Goal	Actual Performance Improvement	Planned Performance Metric / Methods of Measurement	Actual Performance Metric / Methods of Measurement
08						

Comment: Metrics for the Joint Ground Robotics Enterprise (JGRE) funded Research, Development, Test & Evaluation (RDT&E) are articulated in individual project plans used to form the basis of funding justification and program assessment. These decisions are supported by the JGRE Technology Advisory Board (TAB). The TAB provides technology to capability matrix assessments to inform funding decisions, provide inputs to unmanned system (UMS) roadmaps and ensure technology transitions. In all document sets, project descriptions include task schedules with associated milestones, against which progress toward end goals can be measured. At the level of the performer, efforts are tracked using project technical and management milestones that have been appropriately defined and agreed upon in the project plans. At the enterprise level, the JGRE management structure and process tracks deliverables and examines the transition of technologies and ideas from the performer to DoD programs. The JGRE management structure and process includes a mid-year in progress review (IPR), annual funding justification and prioritization, technology assessments, a senior Military Council and a Senior Steering Group (SSG) overview. These DoD participant reviews include cost, schedule, and technical progress assessment against the project milestones. Metric evaluations for the funded actions include, where appropriate, controlled trials, demonstrations, quasi-experimental evaluations, and direct/indirect analysis.

OSD RDT&E BUDGET ITEM JUSTIFICATION (R2a Exhibit)

February 2008

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RDTE, Defense Wide BA 05	**0604709D8Z - Joint Robotics EMD**	**P609**

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All actions under this PE are within BA 5 and are identified with one project number.

B. Accomplishments/Planned Program:

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
(U) Autonomous & Tactical Behaviors	1.677	1.687	0.923

FY2007 Accomplishments:

* Continued development of MDARS-Expeditionary as the Unmanned Ground Vehicle (UGV) for the Family of Rapid Response Equipment (FIRRE) - provide a semi-autonomous, high speed, cross-country, detection, persistent surveillance and response capability for forward deployed forces.
* Established a structured procedure for the assessment of existing modeling and simulation (M&S) tool sets supporting robotics development and fielding
* Initiated tasks to automate functions necessary for activating robotic response to sensor stimuli: increase sensor data fusion for system automation and platform autonomy and reduce operator reaction requirements.
* Initiated effort to develop a Detection on the Move - capability for employment of ground robots in the defensive battle space: increase system autonomy and effectiveness and enhance the system situational awareness (SA).
* Demonstrated UGV technology maturity for teleoperation, semi-autonomous operation and full autonomous operations for logistics support allowing unmanned on- and off-road reconnaissance, unmanned medical evacuations, or unmanned perimeter patrolling operations.
* Continued development of advanced mission planning and programming via Robotics for Agile Combat Support.
* Continued development and implementation of JAUS compliance - Integrate JAUS into Simulation Systems for experimentation/validation.

* Continued development of autonomous unmanned ground robotic vehicles via the 2007 Intelligent Ground Vehicle Competition (IGVC).
* Developed UAV autonomous positioning algorithms for optimizing extended communications between the operator, UAV, and multiple UGVs
* Battlefield Extraction Assist Robot (BEAR) - completed titanium steel upper torso and upper limbs to included hydraulics and JAUS compliant control algorithms for Operational Prototype: tracked laboratory prototype 4 completed.
* Demonstrated Convoy Active Safety Technologies (CAST)

FY 2008, 2009 and 2010 Plans: Support the development of vehicle onboard intelligence and tactical behaviors to allow the fielding of advanced autonomous unmanned systems. Baseline user identified mission scenarios to develop operational behaviors enabling unmanned operations within the conduct of mission tasks. Increase the warfighter's capability by transferring and developing technologies that will have an immediate impact on the autonomy and functional capabilities of current and future robotic systems. Enable transitioning of technologies appropriate for small robots from the technology transfer program to fielded systems. Plans include:

* Support development of specifications for a standardized modeling and simulation (M&S) tool suite to support DoD robotics programs.
* Human Presence and Detection
* Covert Tracking Robots/Sensors
* Tactical Behaviors for EOD Robots - Cooperative Robotics
* Battlefield Extraction - Assist Robot (BEAR)
* Autonomous Robotics Countermine Experiment 2 (ARC2)
* Convoy Active Safety Technologies (CAST)
* Decon II - Joint Forward Area Automated Decontamination (JDAAD)

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
(U) Manipulation Technologies	1.624	0.664	0.721

FY2007 Accomplishments:
* Initiated robotic program to integrate a manipulator and commercially available tools to automate the five stages of vehicular decontamination, a manpower intensive, dirty and dangerous mission for military units.
* Continued development of manipulation and navigation maturity via the 2007 IGVC.
* Continued development the Joint Architecture Unmanned System (JAUS) manipulator capability beyond core capabilities to advanced manipulation control support via Robotics for Agile Combat Support.
* Continued support for concept exploration and demo, and ongoing technical and operational assessment for systems deployed.
* Supported limited objective experiments, feasibility demonstrations, and concept exploration projects.
* Continued robotic payload development.
* Battlefield Extraction Assist Robot (BEAR) - Completed initial design and modeling of independently articulated lower tracked/wheeled limb combinations
* Completed MTRS Hand Tool design, drawing package, testing, and produced two production representative model kits.

FY 2008, 2009 and 2010 Plans: Incorporate existing technologies into systems representative to those in use, demonstrate ease of robotic manipulation, support the development of mobile manipulation, expedite the transition and integration of corresponding robotic technologies to enhance the current fielded systems with more functionalities, autonomy and state-of-the-art behavior with interface methods from the RTD&E environment. Plans include:

* Warfighter Experimentation/Exercises
* Mobile Robot Knowledge Base (MRKB)
* MTRS Continuous Improvement Program

* Autonomous Robotic Countermine System Capability (ARCS2)

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
(U) Collaborative Operations	1.511	0.852	0.665

FY2007 Accomplishments:

* Initiated program to extend the JAUS world model message specification to incorporate true three dimensional information to enable UAV and UGV JAUS compliant collaborative capabilities.
* Initiated research to extend the dynamic discovery of JAUS to support UAV and UGV collaborations. This functionality will support a mission planner module in the performance of centralized automated mission decomposition and tasks allocations.
* Continued development and implementation of JAUS as a set of standardized messages suitable for controlling all types of unmanned systems, and becoming an Aerospace Standard of the Society of Automotive Engineers (SAE) via the 2007 IGVC.
* Continued development of JAUS-based technologies for collaborative missions using semi-autonomous unmanned assets.
* Integrated JAUS into Simulation Systems for experimentation/validation.
* Demonstrated and validated support for all unmanned system types.
* Demonstrated Convoy Active Safety Technologies (CAST)
* Initiated CAST-FMTV Robotic System computing architecture upgrades
* Battlefield Extraction Assist Robot (BEAR) - Completed General Mechanical Interface (GFI) to enable BEAR to attach itself to TAGS-CX UGV for transportation to battle and for battery recharging.

FY 2008, 2009 and 2010 Plans: Integrate communication, mission planning, interface technologies, and advanced intelligence capabilities to support collaborative operations between manned and unmanned systems. Develop and assess several strategies to enhance tele-operation of current UGVs and collaborative UAV teams. Collaborative and tactical behaviors include system convoying, teamed obstacle avoidance, area perception and relative position information sharing. Plans include:

* Expeditionary Mobile Detections and Response System (MDARS)
* Maritime and Perimeter Security Systems
* Warfighter Experimentation/Exercises
* Mobile Robot Knowledge Base (MRKB)
* Convoy Active Safety Technologies (CAST)

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
(U) Interoperability	1.676	1.057	0.810

FY2007 Accomplishments:

* Established a structured procedure for the assessment of existing modeling and simulation (M&S) tool sets supporting robotics development and fielding
* Furthered the integration of future sensors and weapons.
* Continued research and experimentation of unmanned vehicles, sensors, simulation, training, demonstration, and information distribution.
* Initiated a joint exercise effort to aid in producing ground robotic lessons learned and draft tactics, techniques and procedures for the operation of multiple robotic platforms.

* As part of the joint exercise effort, began to leverage funded AMRDEC project to develop autonomous collaborative behaviors between teamed unmanned ground robots in movement to observe, challenge and engage intruders into protected zones.
* Continued JAUS compliance within projects such as Family of Rapid Response Equipment (FIRRE).
* Supported refinement of and transition of documentation for Joint Architecture for Unmanned Systems (JAUS) to a Society of Automotive Engineers (SAE) standard.
* Initiated joint program to integrate the NASA developed Robonaut dual manipulator modeling, simulation and control software, Actin, onto the Battlefield Extraction Assist Robot (BEAR).
* Initiated program to integrate BEAR robot with UGV TAGS-CX to demonstrate marsupial transport and collaborative operations.
* BEAR - completed integration of Anthrotronix Isometric Controller Grip (IGC) (M4 rifle) and Instrumented Glove (iGlove) Tactile glove robot controller.
* BEAR - completed design and initial lab prototype of tri-band ultra wide band (UWB) chip to enable connection to a secure mesh network for tactical wireless communications.
* BEAR - Initiated design and development of stand-off casualty assessment and remote triage sensors.

FY 2008, 2009 and 2010 Plans: Promote and guide technology development to meet joint requirements and promote ground as well as air unmanned systems interoperability. Support the bridging of currently incompatible robots and controllers from various manufacturers, using different communications channels and hardware. Optimize best features of prior/ongoing research efforts into a maturing, standardized system that can be easily ported to robotic platforms used DoD-wide. Plans include:

* Conduct a comprehensive assessment of modeling and simulation (M&S) tool sets supporting robotics development and fielding.
* Support development of specifications for a standardized modeling and simulation (M&S) tool suite to support DoD robotics programs.
* Advanced Control Schemes for EOD Robotics
* Tactic, Techniques and Procedures (TTP) and Lessons Learned - Identification, documentation, and distribution of information regarding best practices for employment of ground robotic systems.
* Large UGV (LUGV) Standard Robotic System
* Warfighter Experimentation/Exercises
* Mobile Robot Knowledge Base (MRKB)

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
(U) Man-Portable Unmanned Ground System Technologies	1.668	1.351	1.261

FY2007 Accomplishments:

* Continued the Analysis of Alternatives (AoA) for a Next Generation EOD Robotic System (NGEODRS) acquisition program - operational effectiveness, suitability, and life-cycle cost of alternatives.
* Continued development of the Man Transportable Robotic System (MTRS) as a acquisition program of record (ACAT IV-M).
* Supported testing on distributed communications system targeted for a Man-Portable Robotic System (MPRS).
* Continued development and implementation of JAUS compliance.
* Supported development, fielding and life cycle development of systems deployed for IED defeat missions.
* Provided support to multiple joint acquisition programs, technology development and assessment programs, and COTS spiral fielding and assessment programs to support current military operations.
* Continued concept exploration and demo and continuing technical and operational assessment for systems deployed and in spiral.

FY 2008, 2009 and 2010 Plans: Increase the warfighter's capability by transferring and developing technologies that will have an immediate impact on the functional capabilities of man-portable robotic systems. Enable transitioning of technologies appropriate for small robots from the technology transfer program to fielded systems. Specific technologies include obstacle detection/obstacle avoidance (ODOA) and collaborative behaviors for small vehicles. Plans include:

* Robotic EOD Technologies
* Advanced Control Schemes for EOD Robotics
* Robotic for Airbase Operations and Support
* Warfighter Experimentation/Exercises
* Mobile Robot Knowledge Base (MRKB)

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
(U) Technology Transition/Transformation	1.565	1.240	1.345

FY2007 Accomplishments:

* Facilitated development and maintenance of the Robotic Systems Pool (RSP).
* Provided robotic platforms and technical support to leverage several research and development projects across DoD and supportive of unmanned system developments, including: EOD robot range extension; Automatically Deployed Communication Relay (ADCR); RedOwl sniper detection; JAUS software integration; PackBot health-monitoring and ultracell fuel-cell for small unmanned ground vehicles.
* Provided robotic systems and technical support to the Joint Training and Evaluation Center, Camp Guernsey Robotic Outreach Program
* Provided robotic platforms to support Warfighter Experimentation and Concept Development including: RDECOM-TARDEC Dismounted Controller Experimentation and Product Manager, Force Protection Systems (PM-FPS) Family of Integrated Rapid Response Equipment (FIRRE) demonstration.
* Initiated development of the Ground Robotics Web Portal for technology transfer.
* Continued upgrades/improvements that focus on the capabilities of disruption, disposal, and render-safe procedures and nuclear, chemical, and biological agent detection.
* Supported the conduct of research to determine the feasibility of implementing robotics in military logistic systems and to explore potential applications for exploiting agile robotic technologies in military logistics.
* Supported continued development and implementation of JAUS compliance.
* Continued technology development and transition efforts within industry and academia for sensors, artificial intelligence, processors, and human/computer interaction, and defining a strategy for early research and development.
* Provided support to multiple joint acquisition programs, technology development and assessment programs, and COTS spiral fielding and assessment programs to support current military operations.
* Continued Current Operations Repair Analysis (CORA) for deployed systems.
* Continued to support fielding and support of RCSS COTS systems to War on Terrorism forces.

FY 2008, 2009 and 2010 Plans: Facilitate integration of and ensure the ultimate transfer or transformation of technologies to ongoing programs. Exploit the best features of past and on-going efforts while supporting the development of technologies that have low risk to transition. Technologies of interest include: Interface Technologies (Human Robot Interaction), Autonomous Operations (Information Fusion, Perception, and Navigation), Autonomous Technologies (Positioning), and Platform Technologies. Plans include:

* Conduct a comprehensive assessment of modeling and simulation (M&S) tool sets supporting robotics development and fielding.
* Mobile Robot Knowledge Base (MRKB)
* COCOM Ground Robotics Initiatives

* Battlefield Extraction _ Assist Robot (BEAR): Development and Testing of the BEAR operational prototype, demonstrate progress towards BEAR operational prototype, Milestone B decision, transition to Program of Record (POR).
* Autonomous Robotic Countermine System Capability (ARCS2)
* Man Transportable Robotic System (MTRS)
* Convoy Active Safety Technologies (CAST)
* Warfighter Experimentation/Exercises

C. Other Program Funding Summary	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
PE 0603711D8Z (BA3) Joint Robotics/Autonomous Systems	7.700	11.256	8.477	9.414	10.580	11.782	14.120
PE 0603709D8Z (BA4) Joint Ground Robotics Enterprise (JGRE) ACD&P	22.978	11.860	11.867	12.119	12.389	12.711	13.041

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D. Acquisition Strategy The Joint Ground Robotics Enterprise (JGRE) utilizes several contracting and management strategies to achieve its objectives. JGR has established relationships with the several agencies to include the National Center for Defense Robotics (NCDR) and the Army's Rapid Equipping Force (REF) to support the rapid acquisition and evaluation of promising unmanned system technologies.

Funding is provided to Service lab partners and other developers to promote common technology solutions across platforms and Services.

Beginning in FY08, JGRE will encourage the establishment of a robotics consortium to broaden the research and development of robotics technologies.

E. Major Performers

Category	Name	Location	Type of Work and Description	Award Date
Labs/Centers				
	Air Force Research Laboratory (AFRL)	Tyndall AFB, FL	Program Management, Systems Engineering.	
	AMRDEC	Redstone Arsenal, AL	Program Management, Systems Engineering. U.S. Army Aviation and Missile Research, Engineering, and Development Center (AMRDEC).	
	TARDEC	Detroit, MI	Program Management, Systems Engineering. U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC)	

Contractors				
	National Center for Defense Robotics (NCDR)	Pittsburg, PA	Program Management.	
Other				
	Program Manager Force Protection Systems (PM FPS)	Fort Belvoir, VA	Program Management, Systems Engineering.	
	Naval Explosive Ordnance Disposal Technology Div	Indian Head, MD	OSD Executive Agent for joint service EOD R&D. Program Management. Naval Explosive Ordnance Disposal Technology Division (NAVEODTECH).	
	Robotic Systems Joint Project Office (RS JPO)	Redstone Arsenal, AL	Joint Office Program Management.	
	SPAWAR	San Diego, CA	Program Management, Systems Engineering. Space and Naval Warfare [SPAWAR] Systems Center, San Diego (SSC San Diego).	

OSD RDT&E COST ANALYSIS (R3)

February 2008

BUDGET ACTIVITY
5 - System Development and Demonstration (SDD)

PE NUMBER AND TITLE
0604709D8Z - Joint Robotics EMD

PROJECT
P609

I. Product Development	Contract Method & Type	Performing Activity & Location	Total PYs Cost	FY 2007 Cost	FY 2007 Award Date	FY 2008 Cost	FY 2008 Award Date	FY 2009 Cost	FY 2009 Award Date	Cost To Complete	Total Cost	Target Value of Contract
Air Force				3019	1-4Q						3019	
Navy				1390	1-4Q						1390	
Army				1464	1-4Q	3940					5404	
Subtotal:				5873		3940					9813	

II. Support Costs	Contract Method & Type	Performing Activity & Location	Total PYs Cost	FY 2007 Cost	FY 2007 Award Date	FY 2008 Cost	FY 2008 Award Date	FY 2009 Cost	FY 2009 Award Date	Cost To Complete	Total Cost	Target Value of Contract
Joint Group Robotics Enterprise Support				1728		2911	1-4Q	5725	1-4Q		10364	
Subtotal:				1728		2911		5725			10364	

III. Test And Evaluation	Contract Method & Type	Performing Activity & Location	Total PYs Cost	FY 2007 Cost	FY 2007 Award Date	FY 2008 Cost	FY 2008 Award Date	FY 2009 Cost	FY 2009 Award Date	Cost To Complete	Total Cost	Target Value of Contract
Subtotal:												

IV. Management Services	Contract Method & Type	Performing Activity & Location	Total PYs Cost	FY 2007 Cost	FY 2007 Award Date	FY 2008 Cost	FY 2008 Award Date	FY 2009 Cost	FY 2009 Award Date	Cost To Complete	Total Cost	Target Value of Contract
Joint Group Robotics Enterprise Support				2120	1-4Q						2120	
Subtotal:				2120							2120	

OSD RDT&E COST ANALYSIS (R3)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
5 - System Development and Demonstration (SDD)	**0604709D8Z - Joint Robotics EMD**	**P609**

Project Total Cost:		**9721**		**6851**		**5725**			**22297**	

Schedule Profile (R4 Exhibit)

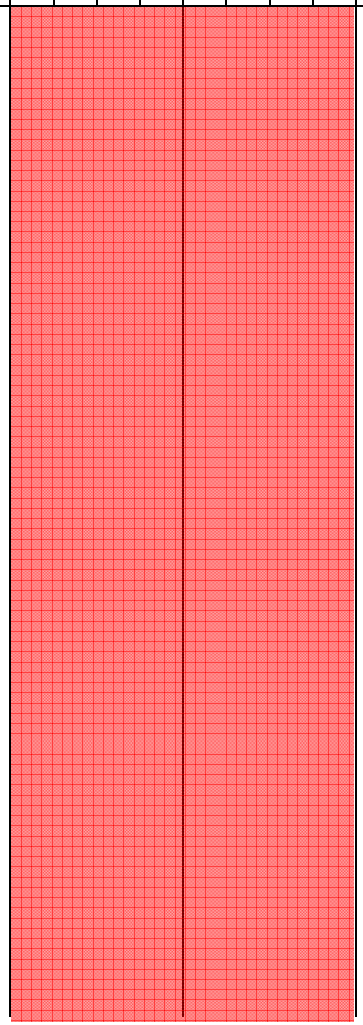
February 2008

BUDGET ACTIVITY
5 - System Development and Demonstration (SDD)

PE NUMBER AND TITLE
0604709D8Z - Joint Robotics EMD

PROJECT
P609

Event Name	FY 07				FY 08				FY 09				FY 10				FY 11				FY 12				FY 13			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



Schedule Detail (R4a Exhibit)

February 2008

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
5 - System Development and Demonstration (SDD)	**0604709D8Z - Joint Robotics EMD**	**P609**

Schedule Detail	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
MTRS PSVM T&E							
Human Presence and Detection		2Q - 4Q	1Q - 4Q	1Q - 4Q			
MTRS PRM T&E							
Battlefield Extraction - Assist Robot (BEAR)		1Q - 4Q	1Q - 4Q				
Battlefield Extraction - Assist Robot Proof of Concept Feasibility Demonstration			3Q				
Autonomous Robotic Countermine (ARCS2)		1Q - 4Q	1Q - 4Q				
Autonomous Robotics Countermine Experiment		3Q					
Covert Tracking Robots/Sensors		1Q - 4Q	1Q - 4Q	1Q - 4Q			
Tactical Behaviors for EOD Robots		1Q - 4Q	1Q - 4Q				
MTRS AAP PROD DEC							
RONS CIP							
Next Gen EOD RCV							
EOD Cooperative Robotics	1Q - 4Q	1Q - 4Q	1Q - 4Q				
Convoy Active Safety Tech. (CAST)		2Q - 4Q	1Q - 4Q				
Joint Forward Area Automated Decontamination (JDAAD)		2Q - 4Q	1Q - 4Q				
Joint Collaborative Technology Experiment		1Q - 4Q	1Q - 4Q				
Integration of Access and Forced Entry Tools on Small UGVs		2Q - 4Q	1Q - 2Q				