Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Office of Secretary Of Defense										DATE: February 2010	
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 5: *Development & Demonstration (SDD)*				R-1 ITEM NOMENCLATURE PE 0604709D8Z: *Joint Robotics EMD*							
COST ($ in Millions)	**FY 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base Estimate**	**FY 2011 OCO Estimate**	**FY 2011 Total Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	5.420	5.086	4.155	0.000	4.155	3.126	2.986	3.028	3.157	Continuing	Continuing
609: *Joint Robotics EMD*	5.420	5.086	4.155	0.000	4.155	3.126	2.986	3.028	3.157	Continuing	Continuing

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 3 and 4 (PEs 0603711D8Z and 0603709D8Z) for technology transitions and transformations and closing warfighter requirement capability gaps. By exercising its oversight role through a technology advisory board, O-6 Council and Senior Steering Group (Flag level), Joint Ground Robotics applies this PE to enable coordination between the Services and places emphasis on interoperability and commonality among unmanned ground systems. This PE supports the effort to overcome technology barriers in 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 purpose is to further 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. Through application of funds against the thrust areas of unmanned ground system technologies, in execution this PE supports the integration of technologies into representative models or prototype systems in a high fidelity and realistic operating environment and expedites 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 efforts 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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Office of Secretary Of Defense	DATE: February 2010
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B. Program Change Summary ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Previous President's Budget	5.694	5.127	0.000	0.000	0.000
Current President's Budget	5.420	5.086	4.155	0.000	4.155
Total Adjustments	-0.274	-0.041	4.155	0.000	4.155
• Congressional General Reductions		0.000			
• Congressional Directed Reductions		0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds		0.000			
• Congressional Directed Transfers		0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-0.037	0.000			
• Other Program Adjustments	-0.237	-0.041	4.155	0.000	4.155

Exhibit R-2A, RDT&E Project Justification: PB 2011 Office of Secretary Of Defense			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 5: *Development & Demonstration (SDD)*	R-1 ITEM NOMENCLATURE PE 0604709D8Z: *Joint Robotics EMD*	PROJECT 609: *Joint Robotics EMD*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
609: *Joint Robotics EMD*	5.420	5.086	4.155	0.000	4.155	3.126	2.986	3.028	3.157	Continuing	Continuing
Quantity of RDT&E Articles											

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 3 and 4 (PEs 0603711D8Z and 0603709D8Z) for technology transitions and transformations and closing warfighter requirement capability gaps. By exercising its oversight role through a technology advisory board, O-6 Council and Senior Steering Group (Flag level), Joint Ground Robotics applies this PE to enable coordination between the Services and places emphasis on interoperability and commonality among unmanned ground systems. This PE supports the effort to overcome technology barriers in 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 purpose is to further 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. Through application of funds against the thrust areas of unmanned ground system technologies, in execution this PE supports the integration of technologies into representative models or prototype systems in a high fidelity and realistic operating environment and expedites 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 efforts 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.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Autonomous and Tactical Behaviors	1.389	1.709	1.703	0.000	1.703
Development of vehicle onboard intelligence and tactical behaviors for greater autonomy. These technologies will increase the warfighters' ability to accomplish military task with greater effectiveness, while simultaneously reducing their risk to exposure and harm.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Office of Secretary Of Defense		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2009 Accomplishments: * Robotic Firefighting Technologies established ability to approach, access, and extinguish fires from a safe stand-off location while providing firefighters safety. * Project renew funded ongoing tactical robotic demining efforts releaving humans from dangerous and manpower efforts. * Autonomous and Tactical Range Clearance developed technologies that allowed for range clearance operations at the Massachusetts military reservation. Technology allowed ranges to be cleared at significantly less cost and time as well as removing human personnel from the physical and hazardous work. *FY 2010 Plans:* * Human Presence Detection (HPD) will incrementally improve detection rate and detection range from small vehicle by detecting human presence at a minimum range of 20 m at 90 percent detection rate and 5 percent false alarm rate. This project has transitioned from PE0603709D8Z as the TRL level matured. * Tactical Behaviors for EOD will complete technologies transitioned to Man Transportable Robotics System (MTRS) Continuous Improvement Program (CIP) program. * Remote Check point will demonstrate, using an Operator Control Unit (OCU), an unmanned grounded vehicle can be controlled to perform a remote inspection and take action from a safe distance. Using the Landshark midsized UGV, we will develop a rugged, low cost, remote check point system that can be used for stop and search, identification, visual inspection and (if needed) using a non-lethal weapon system to extracate suspects from the vehicle.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 Base Plans: * Autonomous Navigation for Small Unmanned Ground Vehicles will demonstrate 3rd generation sensor suite capable of being tightly integrated w/ host platforms and additional capability of nighttime operations. This project has moved from PE0603709D8Z as the TRL level has matured. * Human Presence Detection (HPD) from a Moving Platform will conduct tests to detect human presence at a minimum range of 25 m at 95 percent detection rate and 3 percent false alarm rate using a semi-rugged prototype from a small-sized vehicle at a MOUT training site.					
Collaborative Operations 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 Unmanned Ground Vehicles (UGV) and collaborative Unmanned Air Vehicles (UAV) teams. Development of these technologies will enable unmanned systems to support warfighter concepts of operation that are envisioning unmanned systems working in collaboration across domains (air, ground, and maritime) to execute tactical missions and complex military tasks. *FY 2009 Accomplishments:* * Autonomous Navigation Environment (VANE) identified existing modeling processes and integration with VANE simulation. Identified transition paths for VANE computational testbed products. Developed dynamic scene generation for dense vegetation. Initiated development of ANVEL software in tandem with preparing ANVEL software for release as an open source product. *FY 2010 Plans:* * Combat ID for Unmanned Robotic Systems will conduct limited tech demo I: demonstrate friend-foe identification at minimum range of 50 meters; demonstrate system immunity to jamming; demonstrate system reliability at 95 percent.	0.475	1.000	0.000	0.000	0.000

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Interoperability	0.946	0.937	1.339	0.000	1.339

Software algorithms and interface technologies will facilitate sharing of data across unmanned platforms and domains, and with C2 systems as well as interchangeability of mission payloads and unmanned chassis. Such interoperability will enable collaborative operations between manned and unmanned systems as well as among unmanned systems in differing domains.

FY 2009 Accomplishments:

* Convoy Active Safety Technologies (CAST) completed new vehicle acquisition, hard ware builds, dynamic vehicle loads, redundant communications development. Began current vehicle build upgrades. Project will participate in warfighter experiment.

* JAUS will obtain an approved OSD Position document with recommendations for standards changes to comply with the OSD position.

FY 2010 Plans:

* Automatic Payload Deployment System (APDS) will complete work on payload adaptors and carriers, modular sensor payload and Infrared (IR) illuminatior payloads. This project transitioned from PE 0603709D8Z as the TRL level matured.

* Robotic Systems Technical and Operational Metrics Correlation will complete a correlation of operational and technical scores.

FY 2011 Base Plans:

* 3D Visualization for EOD Robots will: (1) demonstrate generation of a 3D model of a complex object from sensors on an EOD class UGV that is > 95 percent complete and a max error of < 5 percent within 5 minutes of collecting the data; (2) demonstrate the localization of the manipulator relative to the object with an accuracy of 5 percent using the same sensors used to build the model; (3) demonstrate the real time localization of the manipulator relative to the object with an accuracy of

Exhibit R-2A, RDT&E Project Justification: PB 2011 Office of Secretary Of Defense		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
3 percent using the same sensors used to build the model; and (4) demonstrate an application that allows the operator to view the model and the manipulator/robot in its actual position from various perspectives and allows the operator to control the manipulator in an effective manner from the virtual scene.					
Man Portable UGS Technologies Increase warfighter capability by transferring and developing technologies of immediate impact on man-portable robotic systems - e.g., obstacle detection/obstacle avoidance (ODOA) and collaborative behaviors for small vehicles. Certain missions and mission environments (urban, unimproved surface, mountainous, subterranean) require the use of man-portable robots in support of dismounted operations. Technologies that can be scaled to low size, weight, space, and power density will enable robotic solutions to capability needs in dismounted operation areas and challenging environments. *FY 2010 Plans:* * Man-Portable Intelligence gathering, Surveillance, and Reconnaissance (ISR) Robot. will fabricate three additional replica prototypes, deliver prototype system(s) to no less than two separate users for early evaluation conduct user trials to evaluate concept, design, and functional performance, begin warfighter experiment, and deliver final report. This project has moved from PE0603709D8Z as the TRL level has matured. *FY 2011 Base Plans:* * Man-Portable (ISR) will participate in the warfighter experiment and deliver final report.	0.000	0.920	0.280	0.000	0.280
Manipulation Technologies Incorporate existing technologies, enable greater range of robotic manipulation, support the development of mobile manipulation, and improve manipulator performance. Development of these technologies will enable unmanned systems to conduct highly dexterous tasks that today are	0.000	0.000	0.400	0.000	0.400

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
accomplished manually, but currently place warfighter's in extremely vulnerable and dangerous situations. *FY 2011 Base Plans:* Advanced Hydraulic Actuation will build a high-dexterity robot manipulator based on advanced hydraulic actuators that will significantly extend the mission capabilities over existing ground robotics. Specifically it will be able to easily manipulate objects over 100 pounds, it will be energy efficient, will achieve precise control both in terms of position and force, and will have at least 7 degrees of freedom providing the dexterity for complex tasks. Program transitioned from PE 0603709D8Z as TRL level matured.					
Technology Transition / Transformation Facilitate integration of technologies to ongoing programs: exploit best features of past and ongoing efforts, e.g., interface technologies (Human Robot Interaction) and autonomous operations. Robotics technologies are being matured with the express intent of transitioning them out of the laboratory to either development programs of record, licensing to industry to foster COTS solutions, or integration onto fielded systems. *FY 2009 Accomplishments:* Funding will be utilized to assist in transition or transformation of the following but not limited to: * Force and tactile sending based manipulators * MIMO-Enables communication links for non-line of sight robotic tele-operation missions * Architecture for rapid structure characterization * Improved depth perception for aid in tele-operations * Mapping in complex environments	2.610	0.520	0.433	0.000	0.433

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: Funding will be utilized to assist in transition or transformation of the following but not limited to: * Own the Night v2 * Convoy Active Safety Technologies (CAST) *FY 2011 Base Plans:* Funding will be utilized to assist in transition or transformation of the following but not limited to: * Remote Check point					
Accomplishments/Planned Programs Subtotals	5.420	5.086	4.155	0.000	4.155

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• 0603709D8Z: *Joint Robotics Program*	11.086	15.279	9.878		9.878	12.175	12.392	11.675	11.299	Continuing	Continuing
• 0603711D8Z: *Joint Robotics Program/Autonomous Systems*	8.535	11.020	9.943		9.943	11.048	11.343	11.526	11.733	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

1. Technolgies to be funded & developed are reviewed by Joint Capability Area focused working groups and the Joint Staff Functional Capabilities Boards to determine progress, transition plans, and relevance of each project.
2. Project plans are submitted, evaluated and analyzed by the Joint Robotics Ground Enterprise (JGRE) management and technical staff for risk and progress.

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3. Project progress toward goals and milestones is assessed during mid-year and end-of-year reviews.
4. Technologies developed by the JGRE are tracked and documented using the DoD Technical Readiness Level (TRL) scale for developing TRL 3 or 4 technologies to TRL 6 and adhearing to the integrated baselines with regard to cost and schedule.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2011 Office of Secretary Of Defense		DATE: February 2010
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Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Total Prior Years Cost	FY 2010 Cost	FY 2010 Award Date	FY 2011 Base Cost	FY 2011 Base Award Date	FY 2011 OCO Cost	FY 2011 OCO Award Date	FY 2011 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Joint Ground Robotics EMD	MIPR	TBD TBD	5.086	5.086	Jan 2010	4.155	Jan 2010	0.000		4.155	Continuing	Continuing	Continuing
		Subtotal	5.086	5.086		4.155		0.000		4.155			

Remarks

	Total Prior Years Cost	FY 2010		FY 2011 Base		FY 2011 OCO		FY 2011 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	5.086	5.086		4.155		0.000		4.155			

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2011 Office of Secretary Of Defense			DATE: February 2010
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	FY 2009				FY 2010				FY 2011				FY 2012				FY 2013				FY 2014				FY 2015			
	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
Advanced EOD Robot System					▮	▮	▮	▮																				
Convoy Active Safety Technology (CAST)					▮	▮	▮	▮																				
Autonomous Range Clearance					▮	▮	▮	▮																				
Robotic Firefighting					▮	▮	▮	▮																				
Human Presence and Detection					▮																							
VANE					▮	▮	▮	▮																				
JGRE Support					▮																							

Exhibit R-4A, RDT&E Schedule Details: PB 2011 Office of Secretary Of Defense		DATE: February 2010
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Schedule Details

	Start		End	
Event	Quarter	Year	Quarter	Year
Advanced EOD Robot System	1	2010	4	2010
Convoy Active Safety Technology (CAST)	1	2010	4	2010
Autonomous Range Clearance	1	2010	4	2010
Robotic Firefighting	1	2010	4	2010
Human Presence and Detection	1	2010	1	2010
VANE	1	2010	4	2010
JGRE Support	1	2010	1	2010