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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 3: Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603711D8Z: Joint Robotics Program/Autonomous Systems							
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	8.385	11.020	9.943	0.000	9.943	11.048	11.343	11.526	11.733	Continuing	Continuing
P710: Joint Robotics Program/ Autonomous Systems	8.385	11.020	9.943	0.000	9.943	11.048	11.343	11.526	11.733	Continuing	Continuing
A. Mission Description and Budget Item Justification											
This program supports the technology development activities of the Joint Ground Robotics Enterprise (JGRE) with a focus on the development of subsystems and components, and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in simulated environments. Projects deliver advanced technology with direct relevance to enhancing warfighters' capabilities that have been identified during operational assessments and field feedback of current unmanned systems. By exercising its oversight role through a Technology Advisory Board, O-6 Council and Senior Steering Group (Flag level), Joint Ground Robotics applies this program to enable coordination between the Services and places emphasis on interoperability and commonality among unmanned ground systems. The primary purpose of this program is to support efforts 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 Systems, and Technology Transition/Transformation. Development and integration of technologies within the thrust areas of unmanned ground system technologies will expedite technology transition from the laboratory to operational use. The technologies are generally at Technology Readiness Levels (TRL) of 3 or 4 with the intent to mature them through JGRE efforts to TRL 6.											

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APPROPRIATION/BUDGET ACTIVITY		R-1 ITEM NOMENCLATURE			
0400: Research, Development, Test & Evaluation, Defense-Wide		PE 0603711D8Z: Joint Robotics Program/Autonomous Systems			
BA 3: Advanced Technology Development (ATD)					
B. Program Change Summary (\$ in Millions)					
	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Previous President's Budget	8.449	9.110	0.000	0.000	0.000
Current President's Budget	8.385	11.020	9.943	0.000	9.943
Total Adjustments	-0.064	1.910	9.943	0.000	9.943
• Congressional General Reductions		0.000			
• Congressional Directed Reductions		0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds		2.000			
• Congressional Directed Transfers		0.000			
• Reprogrammings	-0.717	0.000			
• SBIR/STTR Transfer	-0.147	0.000			
• Congressional Distribution	0.800	0.000	0.000	0.000	0.000
• Other Adjustments	0.000	-0.090	9.943	0.000	9.943
Congressional Add Details (\$ in Millions, and Includes General Reductions)					
Project: P710: Joint Robotics Program/Autonomous Systems				FY 2009	FY 2010
Congressional Add: Joint Ground Robotics Enterprise Modeling, Simulation, Analysis Project				0.800	0.000
Congressional Add: Autonomous Control and Video Sensing for Robots				0.000	0.800
Congressional Add: Battle-Proven Packbot				0.000	1.200
Congressional Add Subtotals for Project: P710				0.800	2.000
Congressional Add Totals for all Projects				0.800	2.000

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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
P710: <i>Joint Robotics Program/ Autonomous Systems</i>	8.385	11.020	9.943	0.000	9.943	11.048	11.343	11.526	11.733	Continuing	Continuing

A. Mission Description and Budget Item Justification

This Joint Robotics program/Autonomous Systems program supports the technology development activities of the Joint Ground Robotics Enterprise (JGRE) with a focus on the development of subsystems and components, and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in simulated environments. Projects deliver advanced technology with direct relevance to enhancing warfighters' capabilities that have been identified during operational assessments and field feedback of current unmanned systems. By exercising its oversight role through a Technology Advisory Board, O-6 Council and Senior Steering Group (Flag level), Joint Ground Robotics applies this program to enable coordination between the Services and places emphasis on interoperability and commonality among unmanned ground systems. The primary purpose of this program is to support efforts 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 Systems, and Technology Transition/Transformation. Development and integration of technologies within the thrust areas of unmanned ground system technologies will expedite technology transition from the laboratory to operational use. The technologies are generally at Technology Readiness Levels (TRL) of 3 or 4 with the intent to mature them through JGRE efforts to TRL 6.

B. Accomplishments/Planned Program (\$ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Autonomous & Tactical Behaviors	3.297	2.490	2.945	0.000	2.945
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.					
<i>FY 2009 Accomplishments:</i> Supported the development of platform onboard intelligence and tactical behaviors to allow the fielding of advanced autonomous Unmanned Ground Vehicles (UGV) support. Baselined user					

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B. Accomplishments/Planned Program (\$ in Millions)						
		FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
identified mission scenarios to develop operational behaviors enabling unmanned operations. Accomplishments include: - Successful evaluation of the utility of unmanned ground vehicle to conduct supply distribution and casualty evacuation for small units. - Autonomous Control Development. - Program delivered software for automonous control of high speed navigation, mission planning and execution, and world model capabilities. FY 2010 Plans: 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. Examples of the systems that will be matured are: - Long Range Vision for Obstacle Detection. - High Speed Small Teleoperation Robotic Command & Control. FY 2011 Base Plans: Develop and assess technology to provide greater fidelity of autonomous behaviors for unmanned systems. Will build upon past technical performance and provide the warfighter with higher level resolution with regard to visual capabilities. New autonomous capabilities will be pursued and developed. - Long Range Vision for Optical Detection. - Autonomous navigation for small UGVs. - 3D Visualization for Explosive Ordanance Disposal.						
Collaborative Operations		0.760	1.200	1.194	0.000	1.194

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B. Accomplishments/Planned Program (\$ in Millions)						
		FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. <i>FY 2009 Accomplishments:</i> Improved repeatability of the increased interoperability of unmanned systems through integration of Joint Architecture for Unmanned Systems teaming messages. Participated in definition and planning process for warfighter experiment. <i>FY 2010 Plans:</i> Integrate communication, mission planning, interface technologies, and advanced intelligence capabilities to support collaborative operations between manned and unmanned systems. - Night Operations for Unmanned Ground Vehicles. - Combat ID for Unmanned Robotic Systems. <i>FY 2011 Base Plans:</i> Develop and assess technologies to enable greater collaborative operations in Unmanned Ground Vehicle (UGV) and Unmanned Aerial Vehicle (UAV) teams. Collaborative operations and tactical behaviors include system convoying, teamed obstacle avoidance, area perception and relative position information sharing. Plans for developing specific technologies include: - Metric Map In Rough Urban Terrain. - Counter Tunnel Mapping & Characterization.						

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B. Accomplishments/Planned Program (\$ in Millions)						
		FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- 3D Spatial Phase Sensors.						
Interoperability 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: Promoted and guided technology development meeting joint requirements and promote ground as well as air unmanned systems interoperability. Optimized best features of prior/ongoing architecture efforts into a maturing, standardized system that can be easily ported to robotic platforms used DoD-wide. 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. Automated Payload Deployment System has developed deployment modules that carry a variety of payloads and can drop relays that can transmit radio signals back to command and control stations. FY 2010 Plans: Support the bridging of currently incompatible robots and controllers from various manufacturers, using different communications channels and hardware. Promote the adoption of these standards by commercial standards organization. FY 2011 Base Plans: Promote and demonstrate the collaborative operations of unmanned systems across domains.		0.745	1.027	1.233	0.000	1.233

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B. Accomplishments/Planned Program (\$ in Millions)						
		FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Combat ID for Unmanned Robotic Systems.						
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 2009 Accomplishments: Enabled transitioning of technologies appropriate for small robots from the technology transfer program to fielded systems, including support to the identification of a modeling & simulation (M&S) architecture and specifications with EOD robot specific mission-application. Specific technologies include obstacle detection/obstacle avoidance (ODOA), collaborative behaviors for small vehicles, and the ability to transport equipment and supplies through various terrains and environments. FY 2010 Plans: Evaluate performance and effectiveness of alternative power sources, communication, methods, and platform/mobility alternatives through user trials and conduct of warfighthter experimentation. FY 2011 Base Plans: Continue to develop technologies for Man-portable systems funded in previous years. Focus will be on transitioning transport capabilities to programs of record. Plans include: - Remote Checkpoint. - Robotic Gripper with Adjustable Passive Compliance. - High Speed Small Tele-Operation Robotic Command and Control.		1.410	1.200	1.000	0.000	1.000

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B. Accomplishments/Planned Program (\$ in Millions)						
		FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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 accomplished manually, but currently place warfighters in extremely vulnerable and dangerous situations. FY 2009 Accomplishments: This effort improved the end-effector control capabilities and verified the performance of the BEAR robot for stable operation on and safe object/personnel recovery from a variety of terrains. As an interim check, algorithm verifications were done on low-cost Cyton arm integrated on the M2v2 biped platform. FY 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 advanced behavior. FY 2011 Base Plans: Continue to 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.		0.526	1.890	2.276	0.000	2.276
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		0.847	1.213	1.295	0.000	1.295

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B. Accomplishments/Planned Program (\$ in Millions)						
		FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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 into fielded systems. FY 2009 Accomplishments: Completed system design, modular payload framework, control module, hardware interface definition, and software interface definition. FY 2010 Plans: Will initiate IR illuminator payloads, sensor payloads, deployer modification, base station software mod, demonstrations, documentation, and reporting. Perform a task-oriented analysis of the human robot interface for the next generation Explosive Ordnance Disposal system leading to transition for a common controller for the next generation family of systems. FY 2011 Base Plans: Continue to transition previously funded programs into higher TRL levels such as: - Human Presence and Detection. - Modeling and Simulation for Explosive Ordnance Disposal (EOD) Robot Tactics Development. - Human Robot Interface for EOD Unmanned Ground Vehicles.						
Accomplishments/Planned Programs Subtotals		7.585	9.020	9.943	0.000	9.943
		FY 2009	FY 2010			
Congressional Add: Joint Ground Robotics Enterprise Modeling, Simulation, Analysis Project		0.800	0.000			

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B. Accomplishments/Planned Program (\$ in Millions)		
	FY 2009	FY 2010
<i>FY 2009 Accomplishments:</i> This project intends to provide a rapid, focused, cost effective, Modeling and Simulation (M&S) capability supporting unmanned system (UMS) development with autonomous tactical behaviors. M&S products will support Concept of Operations development; Tactics, Techniques, and Procedures (TTP) development; Joint Capabilities Integration and Development System requirements and analyses; Systems Development and Engineering; and Basis of Issue Planning. The current state-of-the-art in sensor perception and autonomous navigation fall short due to technology limitations in evaluating, fusing, and simulating the interaction of UMS ground vehicles with geoenvironmental factors for the development and assessment of intelligent autonomous navigation, tactical behaviors, and 360-degree situational awareness. Future UMS ground vehicles will require more from current sensor perception and onboard intelligent navigation capabilities than the current state-of-the-art for avoiding obstacles. The U.S. Army Engineer Research and Development Center (ERDC) recently initiated research to pursue the development of a Virtual Autonomous Navigation Environment (VANE) Computational Testbed (CTB). The Virtual Autonomous Navigation Environment (VANE) will facilitate virtual testing of unmanned systems for evaluation of autonomous navigation systems and their associated hardware/software subsystems.		
Congressional Add: Autonomous Control and Video Sensing for Robots <i>FY 2010 Plans:</i> Add details not yet provided	0.000	0.800
Congressional Add: Battle-Proven Packbot <i>FY 2010 Plans:</i> Add details not yet provided	0.000	1.200
Congressional Adds Subtotals	0.800	2.000

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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	
• (BA4) PE 0603709D8Z : Joint Robotics Program	11.782	15.279	9.878		9.878	12.175	12.392	11.675	11.299	Continuing	Continuing	
• (BA5) PE 0604709D8Z : Joint Robotics Program	5.420	5.086	4.155		4.155	3.126	2.986	3.028	3.157	Continuing	Continuing	
D. Acquisition Strategy N/A												
E. Performance Metrics												
1. Technologies to be funded & developed are reviewed by Joint Capabilitiy 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 Enterprises managment and technical staff for risk and progress.												
3. Project progress toward goals and milestones is assessed during mid-year and end-of-year reviews.												
4. Technologies developed by the Joint Robotics Ground Enterprises (JGRE) are tracked and documented using the DoD Technology 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.												

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