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<b>Exhibit R-2, PB 2010 Office of Secretary Of Defense RDT&amp;E Budget Item Justification</b>								<b>DATE:</b> May 2009		
<b>APPROPRIATION/BUDGET ACTIVITY</b> 0400 - Research, Development, Test & Evaluation, Defense-Wide/BA 3 - Advanced Technology Development (ATD)					<b>R-1 ITEM NOMENCLATURE</b> PE 0603711D8Z Joint Robotics Program/Autonomous Systems					
<b>COST (\$ in Millions)</b>	<b>FY 2008 Actual</b>	<b>FY 2009 Estimate</b>	<b>FY 2010 Estimate</b>	<b>FY 2011 Estimate</b>	<b>FY 2012 Estimate</b>	<b>FY 2013 Estimate</b>	<b>FY 2014 Estimate</b>	<b>FY 2015 Estimate</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
Total Program Element	18.734	9.198	9.110						Continuing	Continuing
P710: Joint Robotics Program/Autonomous Systems	18.734	9.198	9.110						Continuing	Continuing

**A. Mission Description and Budget Item Justification**

This program supports the advanced 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 4, 5, or 6 with transition and transformation activities critical to closing the warfighter requirement capability gap.

**B. Program Change Summary (\$ in Millions)**

	<b><u>FY 2008</u></b>	<b><u>FY 2009</u></b>	<b><u>FY 2010</u></b>	<b><u>FY 2011</u></b>
Previous President's Budget	19.585	8.449	9.276	
Current BES/President's Budget	18.734	9.198	9.110	
Total Adjustments	-0.851	0.749	-0.166	
Congressional Program Reductions				
Congressional Rescissions		-0.051		
Total Congressional Increases		0.800		
Total Reprogrammings	-0.500			
SBIR/STTR Transfer	-0.312			
Undistributed Reductions	-0.039			
Other			-0.166	

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**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

**Congressional Increase Details (\$ in Millions)**

**Project: P710, Joint Ground Robotics Enterprise Modeling, Simulation, Analysis Project**

<b>FY 2008</b>	<b>FY 2009</b>
	0.800

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<b>APPROPRIATION/BUDGET ACTIVITY</b> 0400 - Research, Development, Test & Evaluation, Defense-Wide/BA 3 - Advanced Technology Development (ATD)				<b>R-1 ITEM NOMENCLATURE</b> PE 0603711D8Z Joint Robotics Program/Autonomous Systems					<b>PROJECT NUMBER</b> P710	
<b>COST (\$ in Millions)</b>	<b>FY 2008 Actual</b>	<b>FY 2009 Estimate</b>	<b>FY 2010 Estimate</b>	<b>FY 2011 Estimate</b>	<b>FY 2012 Estimate</b>	<b>FY 2013 Estimate</b>	<b>FY 2014 Estimate</b>	<b>FY 2015 Estimate</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
P710: Joint Robotics Program/Autonomous Systems	18.734	9.198	9.110						Continuing	Continuing

**A. Mission Description and Budget Item Justification**

This program supports the advanced 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 4, 5, or 6 with transition and transformation activities critical to closing the warfighter requirement capability gap.

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

	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
Autonomous & Tactical Behaviors and Collaborative Operations	8.514	3.642	3.767	
<i>FY 2008 Accomplishments:</i> <ul style="list-style-type: none"> <li>* Evaluated Software Integration Lab (SIL) connection to the Virtual Autonomous Navigation Environment (VANE).</li> <li>* Demonstrated deliberative navigation and obstacle avoidance for unmanned surface vehicles using digital nautical charts, marine radar and AIS sensor fusion.</li> <li>* Developed detection and exploration behavior for enhanced autonomous navigation and more efficient search patterns in urban environments.</li> <li>* Demonstrated human presence detection based on fused thermal and color cameras, and investigated performance when integrated with navigation and change-detection behaviors.</li> <li>* Optimized 3-D augmented virtual interfaces for multiple robot control.</li> </ul>				

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<b>B. Accomplishments/Planned Program (\$ in Millions)</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
<ul style="list-style-type: none"> <li>* Evaluated various speech recognition engines for multi-modal robot control interfaces.</li> <li>* Implemented demonstrations of realistic autonomous capabilities to EOD users.</li> </ul> <p><i>FY 2009 Plans:</i> Support the development of platform onboard intelligence and tactical behaviors to allow the fielding of advanced autonomous unmanned ground systems support. Baseline user identified mission scenarios to develop operational behaviors enabling unmanned operations.</p> <p><i>FY 2010 Plans:</i> 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. Integrate communication, mission planning, interface technologies, and advanced intelligence capabilities to support collaborative operations between manned and unmanned systems.</p>				
<p>Interoperability</p> <p><i>FY 2008 Accomplishments:</i></p> <ul style="list-style-type: none"> <li>* Completed transition to fully Joint Architecture for Unmanned Systems (JAUS) Level 2 software architecture for small UGV semi-autonomous navigation (Man-Portable Robotic Systems [MPRS]).</li> <li>* Developed new JAUS components to enable USV path planning and reactive obstacle avoidance within the JAUS architecture.</li> <li>* Expanded generic behavior architecture (Autonomous UAV Mission System [AUMS]) to include generic classes of perceptions, mission payloads, behaviors, and communication protocols (JAUS included).</li> <li>* Optimized a navigation package consisting of obstacle avoidance, mapping and path planning, GPS waypoint following, adaptive localization, and seamless indoor/outdoor navigation and enhanced dead reckoning.</li> <li>* Successful hardware validation of Joint Collaborative Technologies Experiment (JCTE)-Joint Architecture for Unmanned Systems (JAUS) Interface Design Document.</li> <li>* Refined, maintained and transitioned documentation for the Joint Architecture for Unmanned Systems (JAUS) reference architecture to an industry standard via the Society of Automotive Engineers (SAE).</li> </ul>	1.779	1.039	1.027	

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<b>B. Accomplishments/Planned Program (\$ in Millions)</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
<p><i>FY 2009 Plans:</i> Promote and guide technology development to meet joint requirements and promote ground as well as air unmanned systems interoperability. Optimize best features of prior/ongoing architecture efforts into a maturing, standardized system that can be easily ported to robotic platforms used DoD-wide. * Rapid Prototyping &amp; Integration of Robotic Systems - A systems engineering approach to the design and implementation of software for prototyping robotic systems. * Robotic Systems Technical &amp; Operational Metrics Correlation. * Joint Collaborative Technologies Experiment (JCTE). * Joint Architecture for Unmanned Systems (JAUS).</p> <p><i>FY 2010 Plans:</i> 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.</p>				
<p>Man-Portable Unmanned Ground System Technologies and (U) Manipulation Technologies</p> <p><i>FY 2008 Accomplishments:</i> * Evaluated Software Integration Lab (SIL) connection to the Virtual Autonomous Navigation Environment (VANE). * Demonstrated stereovision based obstacle avoidance and guarded tele-operation under Man-Portable Robotic Systems (MPRS) projects. * Initiated improvement program for integration of UGV in combat. * Completed transition of selected JAUS Level 2 software architecture for small UGV semi-autonomous navigation. * Initiated engineering change proposals (ECP) for manipulator technologies - manipulator strengthening.</p> <p><i>FY 2009 Plans:</i> Enable transitioning of technologies appropriate for small robots from the technology transfer program to fielded systems, including support to the identification of a modeling &amp; simulation (M&amp;S) architecture and specifications with EOD robot specific mission-application. Specific technologies include obstacle</p>	4.679	3.244	3.103	

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<b>B. Accomplishments/Planned Program (\$ in Millions)</b>	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>
<p>detection/obstacle avoidance (ODOA), collaborative behaviors for small vehicles, and the ability to transport equipment and supplies through various terrains and environments.</p> <p><i>FY 2010 Plans:</i> 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.</p>				
<p>Technology Transition/Transformation</p> <p><i>FY 2008 Accomplishments:</i></p> <ul style="list-style-type: none"> <li>* Transitioned unmanned vehicle technologies from unmanned ground vehicles to unmanned surface vehicles (USV) to rapidly increase USV autonomous navigation software development.</li> <li>* Demonstrated robotic search behaviors with a radiological sensor.</li> <li>* Demonstrated stereovision based obstacle avoidance and guarded tele-operation.</li> <li>* Ported integration navigation package consisting of obstacle avoidance, mapping and path planning, GPS waypoint following, adaptive localization, and seamless indoor/outdoor navigation, enhanced dead reckoning, and 3-D visualization tools to a ruggedized payload on an iRobot PackBot for user evaluation in a relevant environment.</li> <li>* Evaluated and integrated robotic search behavior with radiological sensor from industry.</li> <li>* Evaluated acoustic sensor into a detection system, a video contrast enhancement module on iRobot PackBot and leave behind sensors.</li> </ul> <p><i>FY 2009 Plans:</i> 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 and Robot to Robot Interaction), Autonomous Operations (Information Fusion, Tele-operation and Non-line of Sight Perception, and Navigation), and Autonomous Technologies (Tactical Behaviors and Positioning).</p>	3.762	1.273	1.213	

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<b>C. Other Program Funding Summary (\$ in Millions)</b>										
	<b>FY 2008</b>	<b>FY 2009</b>	<b>FY 2010</b>	<b>FY 2011</b>	<b>FY 2012</b>	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
(BA4) PE 0603709D8Z / Joint Robotics Program	23.251	11.782	11.803						Continuing	Continuing
(BA5) PE 0604709D8Z / Joint Robotics Program	6.710	5.694	5.127						Continuing	Continuing
<b>D. Acquisition Strategy</b>										
N/A										
<b>E. Performance Metrics</b>										
N/A										

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