Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Office of Secretary Of Defense	DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 4: *Advanced Component Development & Prototypes (ACD&P)*	R-1 ITEM NOMENCLATURE PE 0603709D8Z: *Joint Robotics Program*

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
Total Program Element	9.673	10.954	-	-	-	-	-	-	-	Continuing	Continuing
P709: *Joint Robotics Program*	9.673	10.954	-	-	-	-	-	-	-	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 the focus of the robotic programs on operational requirements. Technologies in the PE support the continued development of technologies beyond Budget Activity 3 (PE 0603711D8Z) for technology transition and transformation to close warfighter requirement capability gaps. By exercising its oversight role through a technology advisory board, senior military Council and Senior Steering Group (Flag level), Joint Ground Robotics (JGRE) applies this PE to enable coordination between the Services and places emphasis on interoperability and commonality among unmanned ground systems. This PE funds efforts to overcome technology barriers in thrust areas of unmanned ground system technologies to include Autonomous & Tactical Behaviors, Collaborative Operations, Interoperability, Man-portable Unmanned Ground System Technologies, Manipulation Technologies, and Technology Transition/Transformation. This PE funds unmanned ground system technologies and 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 projects will continue the delivery of advanced technology directed at enhancing the warfighter's capabilities identified during new concept development, operational assessments and field feedback of current unmanned systems. The technologies are generally at TRL 4 or 5 with the intent to mature them through JGRE efforts to TRL 6.

B. Program Change Summary ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Previous President's Budget	9.878	11.129	11.218	-	11.218
Current President's Budget	9.673	10.954	-	-	-
Total Adjustments	-0.205	-0.175	-11.218	-	-11.218
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.116	-			
• Economic Assumptions	-0.050	-	-	-	-
• FFRDC	-0.036	-	-	-	-
• Other Adjustments	-0.003	-0.175	-11.218	-	-11.218

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Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2011**	**FY 2012**
Project: P709: *Joint Robotics Program*		
Congressional Add: *Autonomous Machine Vision for Mapping and Investigation of Remote Sites*	-	-
Congressional Add: *Joint Robotics Training Program*	-	-
Congressional Add Subtotals for Project: P709	-	-
Congressional Add Totals for all Projects	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2013 Office of Secretary Of Defense			DATE: February 2012
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COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
P709: *Joint Robotics Program*	9.673	10.954	-	-	-	-	-	-	-	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 the focus of the robotic programs on operational requirements. Technologies in the PE support the continued development of technologies beyond Budget Activity 3 (PE 0603711D8Z) for technology transition and transformation to close war fighter requirement capability gaps. By exercising its oversight role through a technology advisory board, senior military Council and Senior Steering Group (Flag level), Joint Ground Robotics (JGRE) applies this PE to enable coordination between the Services and places emphasis on interoperability and commonality among unmanned ground systems. This PE funds efforts to overcome technology barriers in thrust areas of unmanned ground system technologies to include Autonomous & Tactical Behaviors, Collaborative Operations, Interoperability, Man-portable Unmanned Ground System Technologies, Manipulation Technologies, and Technology Transition/Transformation. This PE funds unmanned ground system technologies and 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 projects will continue the delivery of advanced technology directed at enhancing the war fighter's capabilities identified during new concept development, operational assessments and field feedback of current unmanned systems. The technologies are generally at TRL 4 or 5 with the intent to mature them through JGRE efforts to TRL 6.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Title: Command, Communication & Control	0.829	1.609	-
Description: Development of data delivery, control and display, or task execution technologies which will enhance unmanned ground vehicle operations, reduce operator loads and improve effectiveness. Development and integration of communication, mission planning, human-robot interface technologies, and advanced intelligence capabilities to support robotic operations.			
FY 2011 Accomplishments: 1) Human Robot Interface (HRI) for Explosive Ordnance Disposal (EOD) Unmanned Ground Vehicles (UGVs) - The purpose of this project is to develop an intuitive user interface (UI) for the family of UGV systems to be fielded under the Advanced EOD Robotic Systems (AEODRS) program. This project will focus specifically on the usability and human robot interface (HRI) design issues. The end result will be a UI that provides a common look and feel across the family of UGVs, fully supports the operator in accomplishing the most common EOD mission tasks and functions, and in general makes the EOD operator's job easier rather than more difficult. Although this effort is focused on the EOD mission, many of the resulting lessons, UI design techniques, and the underlying software will be applicable to a wide range of UGV systems and missions. - Identified and documented Human-Robot Interface software requirements			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Define user interface screens and controls - Update Multi-robot Operator Control Unit (MOCU) - Usability test for HRI system - Final Delivery of MOCU 2) High Speed Small Tele-operation Command & Control - The purpose of this project is to develop and demonstrate an advanced system to employ UGV-based stability technologies, low latency operator control and feedback, and necessary autonomy to support high speed assisted-tele-operation for small UGVs. High speed tele-operation is defined here as greater than 25 kph on improved surfaces and 15 kph on unimproved surfaces. This project addresses the problem of sub-optimized robotic performance during military operations due to a lack of operator situational awareness. - Capstone Demonstration of the system 3) Automated Mobile Communication Relay - This project will develop an automated communications relay on a man-portable robot. The lead robot will be outfitted with sensors that detect pertinent elements in the environment, and communicate them to the communications robot, all transparent to the EOD technician. The initial effort will focus on a robust single relay and then explore extending the approach to include additional relays, perhaps on smaller platforms. This project is expected to start in FY2012. 4) Non-Radio Frequency Communication for Small UGVs – This project will research, develop, and evaluate alternative methods to RF communications small UGV. - Completed Interrogator Fabrication - Completed Interrogator field tests - Completed Interrogator Demonstrations - Completed Modulating Retro-Reflector Fabrication - Finalized Pod Relay Fabrication - Finalized Pod Relay Mount Fabrication - Held System Demonstration and Delivery			
FY 2012 Plans: 1) Automated Mobile Communication Relay - Integrate sensors and processing payload onto man-portable robots (both EOD and communications robots) - Develop software components required to conduct automated relay mission - Conduct experimental assessment system concept utilizing COTS components and radios to validate concept feasibility - Terrain and road estimation module development - Prediction moduel development - Prototype hardware development and construction - Perform prototype hardare validations and test			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Technology demontstration 1 - Critical Design 2 4) Longe Range Vision for Obstacle Detection from a moving ground vehicle (LROD) project is to increase the capability of unmanned ground vehicles (UGVs) to respond to postiive, negative and moving obstacles. Project previously funded from PE 0603711D8Z - Continue early performance testing - prototype development - Unmanned ground vehicle integration - Performed verification testing - Hold final demonstration - Provide final report ***FY 2013 Plans:*** 1) Automated Mobile Communication Relay - Further develop system components, and conduct experimental assessment in a relevant environment 2) Other projects for this area will be determined by 4QFY12			
Title: Interoperability ***Description:*** 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 throughout the DoD. ***FY 2011 Accomplishments:*** 1) Interoperability Challenges - Development of a set of interoperability profile documents based on SAE AS 4.0 messages, open standards and interfaces for platforms, payloads, control, and communications data links along with video/audio standards. The immediate need for more complex systems such as unmanned Applique Kit(s) that can turn systems designed to function with soldiers at specific control stations into unmanned systems, and the desire for more autonomy in general will require IOP documents to be more complex with more variable solutions. - Conducted Architecture Trade Studies - Developed and staffed Interoperability Profiles guidance document - Create Robotic System Integration Lab and Virtual System Integration Lab Validation Plan - Analyzed Robotic Operating System and Joint Architecture for Unmanned Systems - Conducted meeting with NATO Industrial Advisory Group Study Group - Publish Interoperability Profile	-	1.134	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Conducted Robotic System Integration Lab and Virtual System Integration Lab Validation - Delivered Robotic System Integration Lab and Virtual System Integration Lab Validation Report ***FY 2012 Plans:*** 1) Interoperability Challenges - Extend IOP V0 to autonomous systems, specifically those with Applique Kits ***FY 2013 Plans:*** 1) Interoperability Challenges - Develop testing capability/environment associated with the IOPs for autonomous systems - Verify test environment/procedures, an Applique Kit prototype solution will be provided and tested			
Title: Manipulation ***Description:*** Incorporation of new or existing technologies to enable a 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 war fighters in extremely vulnerable and dangerous situations. ***FY 2011 Accomplishments:*** 1) Conformal End Effectors - The purpose of this project is to develop a conformal end effector with adjustable compliance that is targeted for use on a mobile manipulator on a small UGV. The direct benefit to the warfighter is increased performance and capability over the current state-of-the-art which will translate into reduced mission time. The project directly supports the requirement for a conformal three-jaw gripper contained in the Capability Development Document (CDD) for Advanced Explosive Ordnance Disposal Robotic System (AEODRS). - Assembly and bench testing - System testing - Mod of end effector interface - Integration with manipulator - Review and final reports - Assembly and Bench testing of the conformal end effector. - System testing ***FY 2012 Plans:*** 1) Projects for this area will be determined in 1QFY12 ***FY 2013 Plans:***	0.153	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
1) Projects for this area will be determined by 4QFY12			
Title: Mission/Platform Specific	1.623	5.678	-
Description: Development of a technology to address the requirements of a particular mission or to be integrated with a specific platform. ***FY 2011 Accomplishments:*** 1) Robotic Range Clearance Competition - Conduct research and experiments to develop, design, and support a robotic vegetation clearance competition. Purchase necessary equipment to support experimental activities for the vegetation clearance competition design. - Completed Environmental Assessment - Finalized Rules and Metrics for the Competition - Held In Progress Reviews with competitor teams - Final Competition held in Guernsey, Wyoming - Complete report on the competition and filed with Congress 2) Counter Tunnel Exploitation/Mapping - The scope of this effort is to develop and demonstrate robotic system technologies that will enable insertion of a robotic system through a small bore hole into a suspect tunnel cavity for the purpose of conducting precision mapping and characterization operations in the austere tunnel environments (hand-dug border tunnels, caves, etc.). - Finalized and delivered snakebot platform - Started development with sensor suite for the platform - Continued development of the Bore Hole Support Apparatus 3) Maritime Interdiction Operations - This project aims to develop a throwable robot (throwbot) that can be tossed on to the deck of a ship (from a boat alongside), or down a hatch (from the deck of the ship), to provide advance reconnaissance for boarding personnel. - Produced system specifications - Developed maritime interdiction operations UGV prototype - Conducted final testing - Produced final report 4) Cargo Unmanned Ground Vehicle - The goal of this project is to determine the feasibility of reducing the exposure of Marines to lethal attacks by replacing a portion of the manned vehicles in logistics convoys with unmanned vehicles. Two Medium Tactical Vehicle Replacements (MTVRs) will be autonomized, and a third MTVR will be equipped with an Operator Control Unit (OCU). This project is advancing the current state of robotics through the development of its perception technology (including methods of sensor data fusion and object classification) and methods of GPS-denied navigation. - Completed system build for initial MTVR as a UGV			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Completed system build for initial MTVR with Operator Control Unit - Conducted Limited User Assessment - Conducted Limited Objective Experiment - Initiated system build for second MTVR as UGV 5) Virtual Autonomous Navigation Environment - This project will assist in developing a Virtual Autonomous Navigation Environment (VANE) computational testbed with standard APIs/interfaces and environmental representation to facilitate assessment of UGV semi-/autonomous navigation performance. The ANVEL is a desktop application designed to run in real-time with the capability to interact with the HPC constructive geo-environmental CTB for sensor evaluations. No work was performed in FY2011.			
FY 2012 Plans: 1) Counter Tunnel Exploitation/Mapping - Develop Autonomy Architecture - Develop 3D Mapping Capability - Integrate 1st generation Sensor Suite - Miniaturize Sensor Suite - Conduct experiments of the Bore hole apparatus and the snakebot 2) Cargo Unmanned Ground Vehicle - Finalize system build for second MTVR as UGV - Conduct second Limited User Assessment - Conduct Limited Objective Experiment for Logistics Mission 3) Virtual Autonomous Navigation Environment - Complete the development of a high-impact, releasable version of the ANVEL - Develop scenario setup and mission plan assignment - Create runtime scene modifications for rapid scenario variations - Develop geo-specific environments for virtual UGV performance evaluations - Integrate sensor models for lower-fidelity desktop simulations - Implement and verify high-fidelity vehicle terrain interface with deformable ground effects - Update technical documentation and user guide			
FY 2013 Plans: 1) Counter Tunnel Exploitation/Mapping - Integrate sensor suite onto the platform - Conduct user assessment of the system - Finalize report on system progress and development			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
2) Other projects for this area will be determined by 4QFY12			
Title: Navigation	1.868	2.533	-
Description: Development of reliable motion planning, path planning, obstacle detection/obstacle avoidance, characterization, and decision analysis capabilities based on the perceived environment and specific missions outlined for the robot. ***FY 2011 Accomplishments:*** 1) Autonomous Navigation for Small Unmanned Ground Vehicles - The ANSU program focuses on moving technologies from the laboratory to a realistic operational environment, specifically technologies that will advance the autonomy of small systems in a practical and robust manner. Specific technologies to be addressed include obstacle detection/obstacle avoidance (OD/OA), autonomous navigation, retro-traverse, non-GPS waypoint navigation, guarded tele-operation and other tactical behaviors for small vehicles. - Developed algorithm to stitch successive 3D lidar scans - Developed algorithm for enhanced obstacles detection - Fused stereo vision data with lidar data - Developed algorithm for enhanced obstacle avoidance - Developed and integrate illuminator - Developed algorithm for vegetation classification - Refined control and behavior algorithms - Demonstrated enhanced behaviors 2) Adaptive Navigation Systems - The purpose of this project is to develop and demonstrate an advanced modular and adaptive inertial navigation system for small UGVs. The target use of the system is to aid small UGV navigation in GPS-denied, nighttime environments, where little to no structure exists in the environment to use as an external reference. The effort will result in an inexpensive, small, modular and robust inertial navigation system appropriate for small UGVs that is adaptable to numerous different platforms and external sensor inputs. - Phase II system design document, including modular open architecture, software and hardware reference design, documented communication interface - A fully functional prototype system, software and hardware - Source code delivered for all software 3) Collision Prediction Utilizing Traversability - The purpose of this project is to develop, demonstrate, and deliver two (2) prototype systems to detect, classify, track, and predict the motion of objects from a moving vehicle. The prototypes will include sensors, computing, power distribution, and software to sense the environment and generate predictions as to the expected path of the sense objects of to 10 seconds into the future. This project is advancing the state of robots by developing predictive tools to track objects based on only on object dynamics but also on the environment around the objects.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Algorithm design and created software architecture - Software Development - Algorithm hardening and hardware selection review - Test readiness Review - System Qualification Review - Technology demonstration 4) Long Range Global Positioning System-Denied Localization - This project will provide localization and navigation in an off-road environment for vehicles in GPS-denied areas by fusing features from internal and external sensors. To achieve global localization, the robot will match aerial imagery, digital elevation, road network maps, and other sources of data with features from on-board sensors such as 3D lidar and/or stereo cameras. As an added benefit of this collaboration, objects classified as obstacles from the internal sensors can be matched with objects from aerial imagery, so that the robot can infer obstacles with increased probability in the images at much farther ranges. This project is expected to start in FY2012. 5) Autonomous Assisted Mobility for Small UGVs - Development, integration, and demonstration of an autonomy package / payload to provide mobility assist functionalities during UGV operation. Specific capabilities will be enabled through the utilization of onboard sensors and vision systems and will assist the operator in navigating challenging terrains and obstacles by autonomously reconfiguring the robotic system to maintain stability and intended course. This project is expected to start in FY2012. 6) Tipover Prevention Behaviors - This project will produce tip-over prevention behaviors for unmanned ground vehicles. The behaviors will provide an operator or autonomous controller with the stability feedback necessary to avoid a tip-over event. This project will set a precedent for how future payloads will communicate their inertial properties to a host platform. - Hardware selection and integration - Prediction algorithm evaluations - Prediction algorithm optimization - JAUS message 1st draft - Algorithm integration real-time on robot - Tip-over early warning demonstrates on OCU - Tip-over warning tested on large UGV			
FY 2012 Plans: 1) Collision Prediction Utilizing Traversability - Advanced module development and hardware upgrades - Phase 2 validation and tests - Technology demonstration and End User Support 2) Long Range Global Positioning System-Denied Localization			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Complete study and evaluation of possible external data sources (aerial imagery, DTED, road/route networks, aerial lidar libraries, etc.). That study will include a evaluation of how well those data sources can be match to a like set of multi-modal onboard sensors. An initial design will be development and implemented on a relevant UGV. Different combinations of external data sources and onboard sensors may be evaluated to determine that best combination. 3) Autonomous Assisted Mobility for Small UGVs - Development of autonomy package and payload to provide mobility assist functionalities during UGV operations. - Development and integration of onboard sensors and vision systems. - Development of behaviors such as auto CG adjustment, automatic flipper and manipulator configurations. 4) Tipover Prevention Behaviors - Reactive behavior software integrated on a robot with static payloads in rough and sloped terrain. ***FY 2013 Plans:*** 1) Long Range Global Positioning System-Denied Localization - Develop the algorithms to match the external data to the onboard sensor data - Reference design and software will be delivered with full Government rights and as open source so that the larger UGV community can make use of and build on it 2) Autonomous Assisted Mobility for Small UGVs - Combination of separate capabilities to enable autonomous reconfiguration of the platform to maximize the mobility performance of the UGV. - Technology demonstrations and assessments of the technology will be performed to examine utility of the technology in operational contexts. 3) Tipover Prevention Behaviors - Reactive behavior software integrated on a robot with dynamic payload in rough and sloped terrain. - Report recommending a JAUS message format for inertial and kinematic properties of robots and payloads. 4) Other projects for this area will be determined by 4QFY12			
Title: Perception ***Description:*** Development of post-processing software technologies (proprioceptive and/or exetroceptive) which will enhance unmanned ground vehicle perception capabilities for navigation, manipulation, and general unmanned ground vehicle situational awareness in a wide range of environments and conditions. ***FY 2011 Accomplishments:*** 1) Urban Environment Exploration - This project is developing a suite of behaviors that enable UGVs to navigate and explore an urban environment with multiple building structures and where GPS is unreliable. The suite of behaviors are developed to be	3.170	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
modular and independent of one another within the Autonomous Capability Suite (ACS) autonomy framework, so that any subset of capabilities can be combined and ported to different vehicle configurations. - Develop/integration of multi-story mapping behavior and stair climbing behaviors. - Large-scale, multi-story mapping optimization - Refinement of enhanced dead reckoning and adaptive localization, simultaneous localization and mapping, frontier-based exploration, goal generation, goal selection, and path planning behaviors. - Total behavior fusion and optimization - User performance testing and evaluations - Results analyzed and close out report created 2) Urban Environment Modeling - The purpose of the UrbEM program is to develop, mature, and demonstrate technologies that will provide rich 3-dimensional models of complex urban environments. The models will be used for path/mission planning, navigation, and localization and possibly by the Warfighter as a mission planning and training tool. The UrbEM project seeks to harness sophisticated algorithms and readily-available cameras to generate similarly accurate results at much lower cost and sensor complexity. - Sensor development, integration, and modeling - Software integration and testing - Demonstration of a 2x2 city block model - Demonstration 10x10 city block model - Project final report and final software delivery 3) Real Time Radio Modeling - The goal of the Real Time Radio Modeling for Robotics project for FY11 is to integrate and demonstrate the capability to perform tradeoff analysis of different radios and waveform technologies in performance of the tele-operation functionality in a simulated relevant mission environment. - Integrate PEO-I Communication Effects Server with Joint Tactical Radio System (JTRS) - Integrate JTRS with TARDEC Image Generator (IG) - Integrate JTRS with TARDEC UGV - Development/Integration of COFDM: Qualnet developers from SNT have offered to provide COFDM models. These models can be updated and integrated into the Qualnet tool as needed to measure their performance on streaming video. RS JPO is interested in evaluating COFDM performance on streaming video - Development of Common Data Link (CDL) Model - Development of Digital Data Link (DDL) Model - COFDM/CDL/DDL JTRS Comparison Analysis - Integration of Building Properties of the systems into the model 4) Long Range Obstacle Detection - Develop vehicle intelligence, behavior, and sensor payloads to field an autonomous long-range obstacle-detection and avoidance capability. Result will increase the capability of unmanned ground vehicles (UGVs)			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
to respond to positive, negative, and moving obstacles. The target use of the system is to aid UGV navigation when moving at speeds of 60-100 kph, in both daylight and nighttime environments on primary and secondary roads. - Determined Sensor Solution - Initiated sensor processing algorithm development - Initiated prototype development - Conducted early performance testing - Initiated system integration onto UGV platform ***FY 2012 Plans:*** 1) Real Time Radio Modeling - Integration with Building Properties into the model - Integration of Building Properties with TARDEC IG - Integration of Building Properties with TARDEC UGV - Development of Urban Canyon Models - Building Clearing/Urban Canyon Comparison Analysis - Development of rain, snow, wind, and smoke models 2) Long Range Obstacle Detection - Finalize sensor processing algorithm development - Finalize prototype system development - Complete system integration onto UGV platform - Conduct performance verification testing - Conduct final demonstration - Compile/deliver final report ***FY 2013 Plans:*** 1) Real Time Radio Modeling - Development of rain, snow, wind, and smoke models - Integration with TARDEC IG - Integration with TARDEC UGV - Weather Comparisons Analysis 2) Other projects for this area will be determined by 4QFY12			
Title: Vision/Sensors	2.030	-	-

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APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 4: *Advanced Component Development & Prototypes (ACD&P)*	R-1 ITEM NOMENCLATURE PE 0603709D8Z: *Joint Robotics Program*	PROJECT P709: *Joint Robotics Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Description: Development of technologies (hardware and software) which will enhance unmanned ground vehicle sensory (visual, audible and/or tactile) capabilities for navigation, manipulation, and general unmanned ground vehicle situational awareness in a wide range of environments and conditions. ***FY 2011 Accomplishments:*** 1) Miniature 3D Spatial Phase Sensor - Mature, miniaturize and further develop the 3D Spatial Phase Imaging (SPI) technology. SPI technology addresses fundamental limitations of other sensor technology such as stereo-vision and lidar. The SPI Sensor is not a range sensor but does provide 3D surface detail in far greater resolution than any other technology currently identified. When combined with a ranging technique like stereovision or lidar the SPI Sensor will greatly enhance the perception capabilities of unmanned ground vehicles. - Receive relevant data from 2nd generation sensor at SSCPAC for Government evaluation and algorithm development. - 3rd generation sensor development is currently ahead of schedule but still contains risk due the significant design effort required to miniaturize the Hyper-X processing board to the desired size. 2) Very Low Cost Light Detection and Ranging System - The development of a low-cost sensor capable of providing textured 3D range maps with automatic terrain classification provides significant new capabilities for the Warfighter. This device can be used in the automation of ground vehicles or the data can be directly used by the Warfighter to improve situational awareness. - Obstacle Detection and Classification - Range data with per-point terrain classification (output machine readable) - Situational Awareness - Texture mapped 3D model of environment (output human readable) - Teleoperation - Low Latency video stream (output human interpretable) ***FY 2012 Plans:*** 1) Very Low Cost Light Detection and Ranging System - Improve warfighter agility, survivability, lethality, and effectiveness by enabling lower-cost UGVs/SUGVs with superior situational awareness. - Integrate a set of existing technologies with minimal modification to realize a sensor package capable of generating 3D depth/ image models of the environment. ***FY 2013 Plans:*** 1) Projects for this area will be determined by 4QFY12			
Accomplishments/Planned Programs Subtotals	9.673	10.954	-

	FY 2011	FY 2012
Congressional Add: Autonomous Machine Vision for Mapping and Investigation of Remote Sites	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2013 Office of Secretary Of Defense		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 4: *Advanced Component Development & Prototypes (ACD&P)*	R-1 ITEM NOMENCLATURE PE 0603709D8Z: *Joint Robotics Program*	PROJECT P709: *Joint Robotics Program*

	FY 2011	FY 2012
FY 2011 Accomplishments: -Physical demonstration of the proposed system.		
Congressional Add: Joint Robotics Training Program	-	-
FY 2011 Accomplishments: Two year Robotics Manufacturing Degree: -DACUM for 2 Year Degree. -Develop national two year college network offering two year high tech / robotics manufacturing degree program. -Implement 2 Year Degree. -Develop online delivery of 2 year degree. Protégé Support & Transition Program: -Support Protégé product transition needs. -Expand MP program field support to other branches. -Develop Transition Training Program.		
Congressional Adds Subtotals	-	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
• 0603711D8Z : *Autonomous*	9.567	9.756	0.000		0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
• 0604709D8Z : *Robotics*	4.049	2.782	0.000		0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

1. Technologies 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 Enterprises management 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 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-4, RDT&E Schedule Profile: PB 2013 Office of Secretary Of Defense		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 4: *Advanced Component Development & Prototypes (ACD&P)*	R-1 ITEM NOMENCLATURE PE 0603709D8Z: *Joint Robotics Program*	PROJECT P709: *Joint Robotics Program*

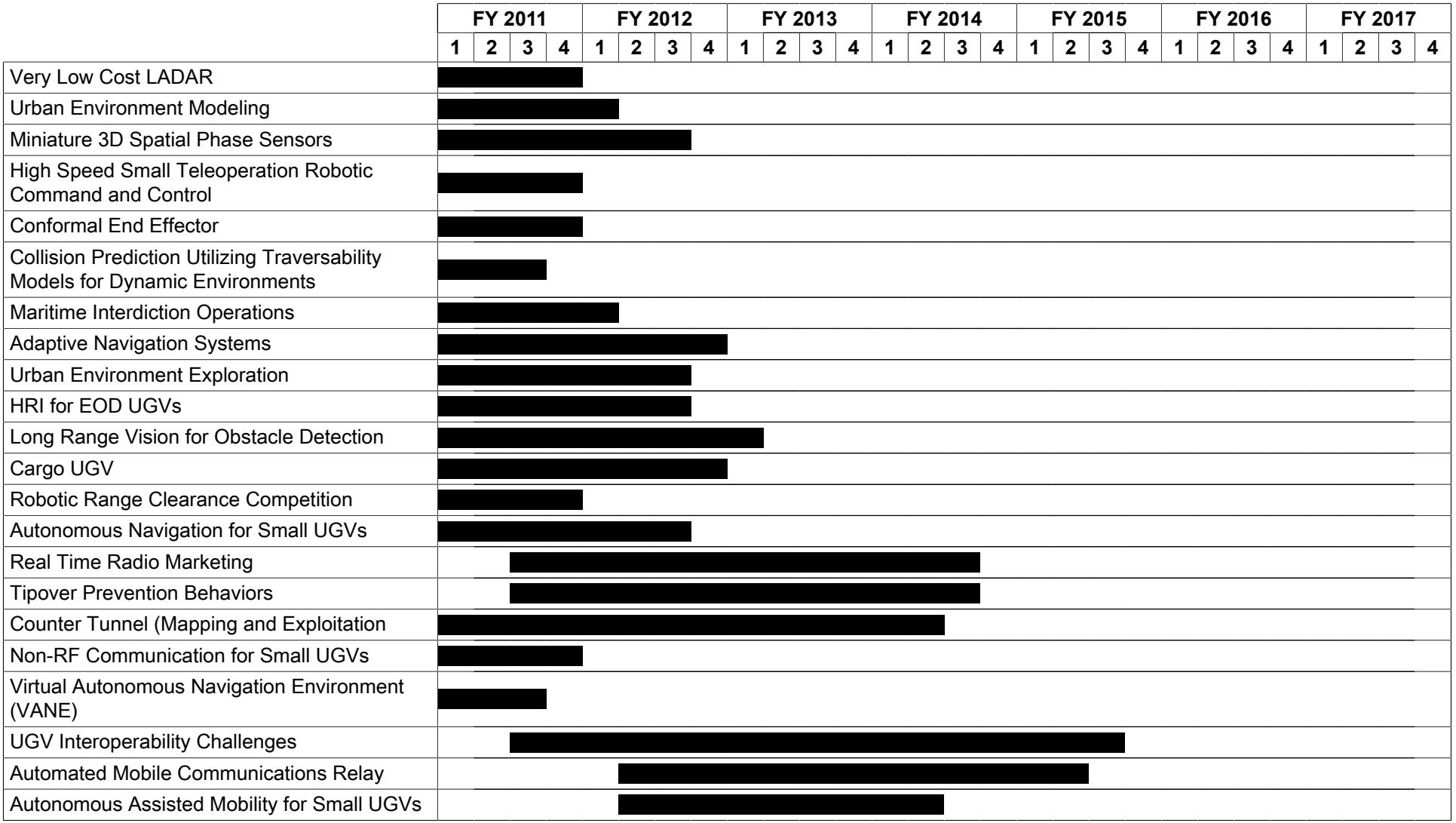

Exhibit R-4, RDT&E Schedule Profile: PB 2013 Office of Secretary Of Defense		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 4: *Advanced Component Development & Prototypes (ACD&P)*	R-1 ITEM NOMENCLATURE PE 0603709D8Z: *Joint Robotics Program*	PROJECT P709: *Joint Robotics Program*

	FY 2011				FY 2012				FY 2013				FY 2014				FY 2015				FY 2016				FY 2017			
	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
Long-Range GPS Denied Localization/ Navigation in Off-road Environments						[redacted]																						

Exhibit R-4A, RDT&E Schedule Details: PB 2013 Office of Secretary Of Defense		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 4: *Advanced Component Development & Prototypes (ACD&P)*	R-1 ITEM NOMENCLATURE PE 0603709D8Z: *Joint Robotics Program*	PROJECT P709: *Joint Robotics Program*

Schedule Details

	Start		End	
Events	Quarter	Year	Quarter	Year
Very Low Cost LADAR	1	2011	4	2011
Urban Environment Modeling	1	2011	1	2012
Miniature 3D Spatial Phase Sensors	1	2011	3	2012
High Speed Small Teleoperation Robotic Command and Control	1	2011	4	2011
Conformal End Effector	1	2011	4	2011
Collision Prediction Utilizing Traversability Models for Dynamic Environments	1	2011	3	2011
Maritime Interdiction Operations	1	2011	1	2012
Adaptive Navigation Systems	1	2011	4	2012
Urban Environment Exploration	1	2011	3	2012
HRI for EOD UGVs	1	2011	3	2012
Long Range Vision for Obstacle Detection	1	2011	1	2013
Cargo UGV	1	2011	4	2012
Robotic Range Clearance Competition	1	2011	4	2011
Autonomous Navigation for Small UGVs	1	2011	3	2012
Real Time Radio Marketing	3	2011	3	2014
Tipover Prevention Behaviors	3	2011	3	2014
Counter Tunnel (Mapping and Exploitation	1	2011	2	2014
Non-RF Communication for Small UGVs	1	2011	4	2011
Virtual Autonomous Navigation Environment (VANE)	1	2011	3	2011
UGV Interoperability Challenges	3	2011	3	2015
Automated Mobile Communications Relay	2	2012	2	2015
Autonomous Assisted Mobility for Small UGVs	2	2012	2	2014

Exhibit R-4A, RDT&E Schedule Details: PB 2013 Office of Secretary Of Defense		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 4: *Advanced Component Development & Prototypes (ACD&P)*	R-1 ITEM NOMENCLATURE PE 0603709D8Z: *Joint Robotics Program*	PROJECT P709: *Joint Robotics Program*

	Start		End	
Events	Quarter	Year	Quarter	Year
Long-Range GPS Denied Localization/Navigation in Off-road Environments	2	2012	2	2014