Robotic Systems Joint Project Office

Unmanned Ground Systems Roadmap

ADDENDUM

July 2012

1.0 Introduction

The Robotic Systems Joint Project Office (RS JPO) has developed the Unmanned Ground Systems (UGS) Roadmap as a tool to share information with external stakeholders including the User community, Science & Technology base, and Industry. The intent of the Roadmap is to provide the stakeholders much needed insight into the current and future state of the Army and Marine Corps UGS development, procurement, and sustainment. The Roadmap will also provide our stakeholders insight into emerging capabilities relative to the current and future programs.

The Senate report accompanying S. 1235 (S. Rept. 112-26) of the National Defense Authorization Act (NDAA) for Fiscal Year 2012 highlighted the importance of robotic ground vehicle technologies and acknowledged that the Army leadership was in the process of determining operational and technical requirements for ground robotics vehicles that will guide the development of a long-term research, development, and acquisition strategy. Both the Secretary of Defense strategic guidance (January 2012), and Congressional FY13 NDAA language continue to advocate an integrated force and enhanced protection of our all-volunteer force through increased investment in unmanned systems. RS JPO takes this direction seriously, especially in the current challenging environment where we are asked to balance our national security with fiscal responsibility.

An integral part of the RS JPO's strategies has always been its Joint approach. The RS JPO is both Warfighter-focused, regardless of service, and an economically smart investment. With its widespread presence and efficient support capabilities, RS JPO is poised to be the lead in implementing the congressional goal of one third of all ground systems unmanned by 2015 as outlined in the Section 220 of the FY2001 defense authorization act (H.R. 4205/P.L. 106-398 of October 20, 2000). In an environment of economic austerity, educating stakeholders of the fiscal value of leveraging RS JPO as the materiel developer for the joint service community as well as informing industry of emerging requirements has become more important than ever.

The RS JPO UGS Roadmap is published biennially in odd-numbered years. The next publication will be 2013. This addendum is an interim update to the 2011 biennial publication, and it is published during even-numbered years. The intent of this addendum is to summarize key events, developments, challenges and opportunities that have occurred in the UGS community since the July 2011 Roadmap publication, and describe how RS JPO plans to address the challenges presented by these developments. Specifically, this addendum will concentrate on how the RS JPO is focusing its resources to create strategies and align priorities in the areas of Acquisition, Technical Management, Test & Evaluation, Process Management, and Logistics & Sustainment, to continue to meet the needs of the Warfighters within an increasingly fiscally challenging environment.

2.0 Key Events

Since the last biennial publication of the RS JPO roadmap, key DoD-wide policies and events continue to affect how the RS JPO and UGS community conduct business, and these are summarized below. The follow-on sections discuss how these policies and events 1) impact various RS JPO-managed functions and their stakeholders; 2) present challenges and opportunities to the UGS community; and 3) have driven RS JPO to modify its strategies to adapt to the changes. Specifically, these events and developments are as follows:

- **On 21 October 2011, President announces complete drawdown of U.S. troops from Iraq by year's end. As a result, RS JPO Joint Robotic Repair Detachment-Iraq (JRRD-I) operations at Victory Base Complex (VBC) officially moved operations to JRRD-Kuwait (JRRD-K), Camp Arifjan, Kuwait, as of 01-Oct-2011.**

  Excerpt: In Oct 2011, the President declared an end to the Iraq war - one of the longest conflicts in U.S. history, announcing that all U.S. troops would be withdrawn from the country by year's end. The RS JPO JRRD-I was closed on 31 Oct 2011 in preparation for this withdrawal. The administration officials felt confident that the Iraqi security forces were well prepared to take the lead in their country, and the US officially turned over Camp Victory in Baghdad to the Iraqis on December 2, 2011.

- **On 05 March 2012, Deputy Chief of Staff of the Army mandated "*Directed Requirement for Retention and Sustainment of Non-Standard Equipment (NS-E) Robotic Warfighting Capabilities Beyond Operation Enduring Freedom (OEF)*."**

  Excerpt: John F. Campbell, LTG, Deputy Chief of Staff issued a memorandum that validates the operational need for continued support and sustainment of selected NS-E, Commercial-Off-the-Shelf (COTS) robotic systems beyond OEF and Operation New Dawn (OND). These systems have been approved for wartime sustainment; recommended as an acquisition program candidate through the Capabilities Development for Rapid Transition process, or purchased as COTS acquisitions in lieu of an adopted Naval Operational Requirements Document. This memorandum validates the requirements to use this equipment to bridge the capability gap of robotic systems until Program of Record robotic systems are fielded to the Army.

- **On 28 June 2010, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD (AT&L)) issued a mandate for "*Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending*."**

  Excerpt: The USD AT&L memo to all DoD acquisition professionals entitled "Better Buying Power: Mandate for Restoring Affordability and Productivity in Defense Spending", reiterated the department's commitment to supporting our forces at war and reforming the acquisition system, including continued implementation of the 2009 Weapon Systems Acquisition Reform Act. It goes on to outline direction on another important departmental priority, namely "delivering better value to the taxpayer and improving the way the Department does business" through continuous process improvement. The mandate requires organizations to take the specific steps to reduce nonproductive processes and bureaucracy and costly and unneeded overhead activities and reports.

- **On an ongoing basis, the U.S. Army Forces Command (FORSCOM) has been campaigning for the Home Station Training Initiative to better integrate robotics training into the force.**

Excerpt: The FORSCOM initiative emphasizes application of doctrine and emerging technologies, incorporating simulation, home station training, Combat Training Center (CTC) experience, and joint exercises. As part of these initiatives, the Army has established training cells at home-stations around the country to train soldiers with their robotic equipment before going to national training centers or theater. If soldiers are trained and ready to operate the latest equipment when they arrive at the Joint Readiness Training Center, they can go to a higher level of training by actually deploying and using it in scenarios they are likely to face down range. This vision aligns well with the Army chief of staff theme, "Sustaining America's force of Decisive Action," for the 2012 Forces Command G-4 Sustainment Seminar.

- **On 21 December 2011, the inaugural baseline of the Unmanned Ground Vehicles Interoperability Profiles (IOPs) Version 0 was established and published by RS JPO after staffing with government & industry partners.**

  Excerpt: The RS JPO has been developing IOPs to support the fielding of unmanned systems while improving competition, availability, affordability, and flexibility in the acquisition process. The near term application of the IOPs is to validate their implementation as part of technology risk reduction efforts, and to mandate compliance to these interface standards in all future Programs of Record.

- **On 30 September 2011, former Future Combat Systems (FCS) program under Program Executive Office-Integration (PEO-I) Unmanned Ground Systems re-aligned as part of the the RS JPO and Program Executive Office, Ground Combat Systems (PEO GCS).**

  Excerpt: On 7 March 2011, the Army Acquisition Executive (AAE) signed the Acquisition Decision Memorandum giving formal direction for PEO GCS to assume responsibility for the development and integration of the Small Unmanned Ground Vehicle (SUGV) XM-1216 and the Autonomous Navigation System (ANS) XM-155/Common Mobility Platform (CMP) in support of the Multi-Mission Unmanned Ground Vehicle (MM-UGV). In effect, this was a directive to implement the 3 January 2011 Product Manager Unmanned Ground Vehicles transition plan.

- **On 31 May 2011, the Vice Chief of Staff of the Army (VCSA) UGV Capability Portfolio Review (CPR) reprioritized requirements for dismounted squad support resulting in discontinuation of MM-UGV (including CMP and ANS).**

  Excerpt: The VCSA-led UGV CPR concluded that the user's priorities have changed to an air assault mission equipment transport for dismounted squad support.

- **On 29 July 2011, the Army Acquisition Executive (AAE) announced conclusion of all efforts associated with the MM-UGV (to include CMP and ANS).**

  Excerpt: The Army said it conducted a comparative assessment of existing autonomous navigation system technologies and determined that "ANS development progress did not warrant continued investment," according to the letter to Congress. All work on these efforts concluded by 30 September 2011. The Army also concluded, "The system's Counter-Improvised Explosive Device focus and weight limited the Common Mobility Platform's mobility.

- **Over the last year, the RS JPO achieved key program milestones decisions for multiple programs, further reinforcing the DoD's commitment to UGS.**

Excerpt: Key program milestones were achieved as outlined in section 3.2 for several programs including Materiel Development Decisions (MDDs) and other acquisition milestones. The MDDs formalize the programs within the Defense Acquisition system as Programs of Record; while the ongoing milestone achievements show the DoD's commitment to ensuring UGS remain an enduring capability within the DoD.

- **In January 2012, the RAND Corporation published the "Assessing the Impact of Autonomous Robotic Systems on Army Force Structure" report.**

  Excerpt: The Army Capabilities Integration Center (ARCIC) asked RAND Arroyo Center to conduct a short-timeframe study that examined the manpower implications of autonomous robotics for the future Army. The study areas examined the following key mission areas 1) combat logistic patrols, 2) support to dismounts, and 3) reconnaissance. The study concluded that the application of robotic systems had a net positive impact on the Army operations including significant cost savings, effectiveness improvements, manpower reductions, and casualty reductions or avoidance. Advanced future robotics capabilities have the potential for even greater savings but will need to be fully vetted through careful modeling, simulation, testing, and evaluation processes. These processes will also need to address the development of safety and policy guidelines.

- **Alignment of RS JPO and PEO GCS strategic planning as part of continuous improvement.**

  Excerpt: RS JPO was a part of the development of the PEO GCS Strategic Plan and continues to support its development as objective measures are developed. These measures will allow the organization to define effectiveness and focus continuous improvement efforts to areas requiring the most urgent needs while leveraging best practices across the PEO.

- **Implementation of the Process Excellence Program (PEP) initiative within RS JPO.**
  Excerpt: This RS JPO effort is focused on implementing a business operating system that will allow the organization to manage for results using data-driven decisions aligned with the organization's mission, vision, goals, and strategies. Organizational processes and procedures will form the basis for approach. The effort has been labeled the Process Excellence Program (PEP) and encompasses the tenets of International Standards Organization (ISO) 9000 and Capability Maturity Model Integration (CMMI). The PEP effort supports and aligns with the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD (AT&L) "Better Buying Power" mandate that talks to continuous process improvement.

3.0 RS JPO Priority and Strategy Developments

Acquisition of robotics for military use continues to be a technology-driven but capability-balanced initiative with the life-cycle management and sustainment requirements of today's military forces. As a Joint Project Office under the direction of both US Army Program Executive Office, Ground Combat Systems (PEO GCS) and US Marine Corps Systems Command (MCSC), the RS JPO continues to adjust priorities and re-align strategies in order to meet the needs of the Warfighter.

3.1 Organizational Strategy Alignment

The Product Manager, Unmanned Ground Vehicle (PdM UGV), in 2QFY11, was formally transitioned from PEO-Integration to PEO-Ground Combat Systems. As a result, RS JPO has incorporated the former PEO-I programs and personnel into its strategic planning in alignment with the PEO GCS strategies. RS JPO will continue to look into how this development transforms or affects the RS JPO engineering, programs, and business groups.

Based on these events, the RS JPO has updated its Mission and Vision statements as well as established its priorities as follows;

Mission
Lead the development, systems engineering, integration, acquisition, testing, fielding, sustainment and improvement of unmanned systems for the Joint Warfighter to ensure safe, effective and supportable capabilities are provided while meeting cost, schedule and performance.

Vision
An integrated family of robotic systems by 2020 that multiplies force effectiveness, improves Warfighter survivability, and assures battlefield dominance.

Priorities
These priorities change as the needs of the Warfighter and the Organization evolve. As of 7 March 2012, the overarching organization's priorities are as follows:

- Support the Warfighter/Their Systems: both continental U.S. and Outside the continental U.S.
- Support Our People: through developmental opportunities, education, awards, feedback, proper staffing, etc.
- Continuous Process Improvement

3.2 Acquisition Strategy Developments & Priorities

Background
As the Army and Marine Corps acquisition and product lifecycle manager for Unmanned Ground Systems, the RS JPO must continually adapt its acquisition strategies to develop, engineer, procure, and field relevant capabilities to the Warfighter, as well as support the DoD vision of establishing an integrated manned/unmanned force. The DoD firmly believes that the integration of all the unmanned domains – air, ground and sea – are an essential part of the future of DoD integrated operations, not only from a systems perspective, but also from a joint-service and coalition perspective. This vision continues to be strengthened as the ground-based robots have proven their worth in Iraq and Afghanistan. The first wave of unmanned systems fielding resulted from rapid acquisition programs driven by urgent need requests in support of Operation Enduring Freedom and Operation New Dawn.

With an end to the Iraq war in Oct 2011, and the impending drawdown of forces in Afghanistan in the near-term, the Army and Marine Corps, and RS JPO as the life-cycle manager of ground robots for these services, have done an in depth analysis of current capabilities in the fleet and how those will be effected with the drawdown of forces. As systems acquired under rapid acquisition requirements, many currently fielded systems are contingency-funded and lack the enduring requirement of a program of record to remain an effective weapons system for the Army and Marines.

Directed Requirement
As a result of the recognized need to maintain the UGS capability beyond today's fight, and to serve as a bridge to the program of records, the Deputy Chief of Staff of the Army approved a Directed Requirement for continued support and sustainment of selected contingency systems. This directive authorizes the sustainment of specific capabilities beyond today's worldwide engagements, to bridge the capability gap until the enduring, program of record UGS are fielded to the Warfighter. In the short term, the result is that the RS JPO is charged with creating long term sustainment strategies for its fleet of COTS UGS, in an effort to institutionalize the capability within the Army and Marine Corps. A number of systems are authorized for retention and to compete for Army Operations and maintenance sustainment funding in Fiscal Years 2014-2018, based on the Cost-Benefit Analysis that considered costs to procure, reset, store, and sustain systems funded from contingency. These systems include Small Unmanned Ground Vehicles (*Packbot 500 Fastac, SUGV XM-1216 w/Tether, SUGV 310 (Mini-EOD)*), as well as Man Transportable Robotic Systems (*TALON III B, TALONG IV, Packbot 510*). The RS JPO expects more formalized evaluation of sustainment strategies and potential system modifications, based on the directed requirement, and the forthcoming Army's Unmanned Ground Vehicle Campaign Plan to be included in the publishing of the 2013 RS JPO UGS Roadmap.

Accomplishments
In addition to the Directed Requirement and its effect on current contingency systems, the RS JPO continues to initiate programs based on user requirements under the formal DoD acquisition system, which will be the ultimate, enduring capabilities that will be delivered to the Warfighter. As such, the RS JPO has a real and tangible opportunity to formulate its programs under the guidance of the recent "Better Buying Power" initiatives mandated by guidance from the Under Secretary of Defense for Acquisition, Technology & Logistics. This mandate is for the acquisition workforce, and industry by default, to continually do more without more. While the RS PJO continues to institutionalize these mandates, several immediate focus areas of the memo area targeted in the short term are: Target Affordability and Control Cost Growth; Incentivize Productivity & Innovation in Industry; and Promote Real Competition. Examples of recent program events that follow this guidance are as follows; they show the commitment of the DoD and RS JPO to Unmanned Ground Systems and their utility to the Warfighter, as well as show clear examples of efforts to gain efficiencies and leverage technology demonstrations as risk mitigation efforts. Events and accomplishments are described below; specific platform/system capabilities along with the APMs/PIs management and execution strategy are provided in greater details in Appendix-A, RS JPO Systems/Programs Portfolio.

- **M160 Anti-Personnel Mine Clearing System (APMCS):** The Program of Record achieved a Milestone C on 23 May 11 as certified by the Milestone Decision authority (MDA). This paves the way for Full Rate Production/Full Material Release in the 1st Quarter FY13.

- **XM-1216 Small Unmanned Ground Vehicle (SUGV):**
    - **Fielding:** The XM-1216 SUGV program has achieved procurement and delivery of all assets for brigades one, two and three. Fielding to 3rd Brigade/1st Armored

Division occurred in 3rd Quarter, FY11. Fielding to 4th Brigade/101st Division (Air Assault) is expected in 4th Quarter, FY12; while the fielding of the third brigade set is pending identification by the Department of the Army.

- **Contract actions:** Multiple contract actions are in the works to enable further development of the system:
  - XM-1216E1 Engineering and Manufacturing Development (EMD) Follow-on contract scheduled to be awarded in 4th Quarter FY12, consisting of seven pre-production prototypes, with the goal being achieving a successful Milestone C certification.
  - Additional contractual effort focusing on the following XM-1216 product enhancements: Explosive Ordnance Disposal (EOD) Turret Assembly; EOD Arch Camera w/Integrated Chassis Digital Signal Processor (DSP); complete and build 4 Manipulator Arms; integrate the Tether Spooler; complete integration of IR sensor; investigate/integrate use of alternative radio solution.

- **Man Transportable Robotic System (MTRS) Increment II:** The program plan to execute engineering trades to determine if platforms from previous efforts will form the basis for their requirements, or if a new platform needs to be procured to meet the capability requirements.

- **Route Reconnaissance and Clearance (R2C) Robot PoRs:** Based on engineering trades as well as a couple of years of COTS testing, the RS JPO down selected FasTac platform for R2C PoR Increment I. Increment 2 is planned to be full and open competition which will look at available COTS platforms including FASTAC.

- **R2C Robot:** Completed its Materiel Development Decision Review (MDDR) and Milestone Decision Authority (MDA) delegation from the Commander, Marine Corps Systems Command; the result is that the MDA for the program has been delegated to the Project Manager for RS JPO; and the program has formally entered the acquisition lifecycle.

- **Husky Mounted Detection System (HMDS) Program of Record:** Achieved Materiel Development Decision for the HMDS program on 21 March 2012, and the MDA assigned to Program Executive Office, Ammo.

- **Ultra-Light Reconnaissance Robots (ULRR):** Procured hundreds of new ULRR from four different vendors which were subsequently fielded to Afghanistan and home station training lanes for both the Army and Marine Corps. The users are assessing various ULRR robots down range across different regions of Afghanistan as well as home stations. The Army will then use those requirements to support a rapid, open competition, to then field the final solution or solutions to fulfill the Warfighter need. These Robots include Dragon Runner, Armadillo, First Look and Recon Scout, and their capabilities support the MCoE's "Squad: Foundation of the Decisive Force" initiative by advancing promising lightweight robotic technology solutions.

- **Manually-Deployable Communication Relay (MDCR):** The RS JPO, in collaboration with the Naval Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV), has produced the MDCR in response to a Joint Urgent Operation Need Statement (JUONS) which calls for extended line-of-sight (LOS) operations as well as non-line-of-sight (NLOS) capability to operate in culverts, caves and buildings. This

capability is achieved through a radio repeater kit that utilizes the native radio on multiple robot variants in conjunction with two separate radio bricks to extend robot communications. Fielding of the kits in support of Operation Enduring Freedom (OEF) is planned for early 4th QTR FY 12, with follow-on variants expected in FY13.

- **Interoperability:** The RS JPO-led Interoperability Profile (IOP) effort will ensure standardized system/sub-systems interfaces to increase competition, availability, and ease of integration of vendor specific products. The IOP V0 document is available to the industry on RS JPO website. The RS JPO is currently developing the IOP V1 with the help of industry and expects to release to the industry in December 2012. Section "3.3.3 Interoperability" provides additional information.

- **Emerging Requirements:** RS JPO actively supports and shapes capability documents for emerging and PoR systems to eliminate or leverage from redundant requirements across platforms and services.

- **Technology Integration:** RS JPO is well partnered with technology developers through a wide array of contractual mechanisms to develop technology/capability demonstration programs that reduce cost, performance, and schedule risks for emerging PoRs.

- **Market research:** Understanding and leveraging the Robotic industry is an integral part of the acquisition process to inform our Assistant Project Managers (APMs) of program risks, availability of products, and identify potential risk reduction programs to be worked through our technology partners.

- **Program Funding:** Established a direct funding line from the Marine Corps for the Route Reconnaissance and Clearance Robot and all future Marine Corps efforts. This will ensure the RS JPO can advocate and plan for integrating Marine Corps systems in its portfolio.

3.3 Technical Management Strategy Developments

RS JPO continues to strive toward using sound Systems Engineering practices in planning for and executing the technical and engineering requirements of its current and emerging programs. Three key parts of this strategy are: Requirements and Capabilities Analysis; Technology Alignment to RS JPO programs; and Interoperability of components within a system.

3.3.1 Requirements and Capabilities Analysis

Background

As the Materiel Developer for the Joint Unmanned Ground Systems (UGS) community, the RS JPO supports and executes requirements from both US Army TRADOC and the US Marine Corps Combat Development Command (MCCDC). To efficiently provide accurate and timely capability needs, the U.S. Army Training and Doctrine Command (TRADOC) led UGS Campaign Plan is being updated to provide an overarching and unifying strategy for the Army UGS.

The most significant impact of the UGS Campaign Plan will be its effect on U.S. Army Concepts by providing both a vision and a cohesive strategy that integrates UGS programs into the current and future force. Currently only the M160 and the XM-1216 assets have been fielded as programs of record and integrated into Army force structure. As the Army's document to communicate the cohesive strategy to senior-level leadership on how future programs of record will be

implemented, the UGS Campaign Plan lays the groundwork for the following current and emerging requirements documents. These requirements are the basis for the RS JPO's Requirements and Capabilities Analysis as emerging programs of record:

- SUGV Increment II Capabilities Production Document CPD
- Man Transportable Robotic System Increment II CPD
- Route Clearance Interrogation System (RCIS) Type I/II CPD
- Tactical Robotic Controller (TRC) Capabilities Development Document CDD
- Autonomous Mobility Appliqué System (AMAS) CDD
- Squad Multi- purpose Equipment Transport (SMET) CDD
- Micro Unmanned Ground Vehicle (MUGV) CPD
- Engineering Squad Robot (ESR) CDD (US Marine Corps only)
- Route Reconnaissance and Clearance (R2C) Robot CPD (US Marine Corps only)

These emerging programs show where the DoD is making progress towards incorporating unmanned ground systems into our force structure, however, in the current resource constrained environment, military leadership at all levels across the services is requiring the acquisition workforce to do more without more. As a result, the near term focus is continued support and sustainment of contingency systems as part of a near term bridging strategy prior to the fielding of today's emerging UGS programs. As such, the Requirements and Capabilities Analysis work within the RS JPO will provide the basis for decreased redundancy and increased commonality and efficiency in future acquisition activities.

Execution

As part of a deliberate, multi-phased process, the RS JPO plans to initiate an effort to 1) baseline the current technical capabilities fielded through the Rapid Acquisition process to meet the demands of the current fight and 2) perform analysis of emerging requirements to identify commonality among requirements, specifications, and test methods, to ultimately meet the goal of gaining efficiencies across the requirements and systems engineering spectrum. As part of this analysis, the RS JPO intends to work with the User to prioritize the requirements and capabilities based on the materiel solutions approved as part of the bridging strategy as well as capabilities emerging from the combat developers. The current platform requirements will form the basis for requirements formulation for the future PoRs. The TRADOC schools are responsible for requirements generation process which results into documentation for materiel solutions for implementation by the future PoRs.

Technology Enablers

The results from the requirements and capabilities analysis will also help develop and align UGV Technology Enablers to guide technology development and maturation paths. As the unmanned systems bridging strategy in the "Directed Requirements" memorandum and the risk reduction definition of the near and mid-term PoRs are explored, the RS JPO will update these UGV Technology Enablers to continue to drive the Government Labs and industry partners. The OEMs will use these enablers to drive their technology investments to shape performance specification, manufacturing processes, and even standards to do more with less in this budget constrained environment. The RS JPO expects that this analysis and its outputs will be further developed to inform the 2013 RS JPO UGS Roadmap.

3.3.2 Technology Alignment

Background

The RS JPO continues to make strides towards leveraging RDT&E resources to reduce technical and performance risks for emerging programs, especially in times of ever decreasing budgets. The efforts are not only important to help define the state of industry; it is required in order to achieve successful Milestone B entry into the acquisition lifecycle.

The RS JPO works closely with its technology developers and provides them guidance to ensure technology efforts are aligned to RS JPO program requirements. This is done through leveraging and integration of matured capabilities throughout the acquisition life cycle of the individual current and emerging platforms. One form of the guidance from RS JPO to the S&T base is the UGV Technology Enablers provided in this roadmap; the RS JPO expects this to be fully updated to align with the current state of emerging programs by the 2013 RS JPO UGS Roadmap. These technology enablers are formulated from the requirements and capabilities analysis efforts within RS JPO. These efforts foster the development of advanced technologies and concepts to demonstrate capabilities that address not only the unmanned ground systems needs but also other manned systems needs to be more flexible and efficient at mission execution – capabilities demonstrated in air/sea domains can often be leveraged for the ground domain as program risk mitigation.

Technology Risk Reduction

RS JPO is informed through a number of pre-Milestone B risk reduction avenues through the technology developers including Small Business Innovative Research, Technology enabled Capability Demonstrations, Joint Concept Technology Demonstrator, Technology Maturation Initiative, Army Manufacturing Technology (ManTech), and RS JPO managed pre-acquisition risk reduction efforts through nationally known public and private organizations (*i.e. National Center for Manufacturing Sciences, Robotic Technology Consortium, Joint Ground Robotic Enterprise*). The intent is to drive the innovative technological solutions and manufacturing methods through collaboration, innovation, and demonstration. These efforts focus on development of candidate material solutions to shape performance specifications, government-authored standards, and manufacturing processes. The results are technology demonstrations that show a clear transition path to a program of record, which can be used to justify entry into the acquisition lifecycle at the appropriate milestone and phase: the Materiel Solution Analysis, Technology Development, and Engineering and Manufacturing Development phases of the RS JPO programs. Several examples of these efforts that RS JPO has directly sponsored or influenced to ensure alignment to its programs are as follows:

Accomplishments

- **Autonomous Mobility Appliqué System (AMAS):** As a risk reduction effort for the planned AMAS PoR, the RS JPO supported formulation and endorsement of the Autonomous Mobility Appliqué System Mission Payloads Technology Maturity Initiative that delivers additional level of autonomy (LOA3), and will develop a mission payload kit to allow plug-n-play integration of mission specific payloads to the platform-independent base Autonomous Mobility Appliqué System autonomy kit.

- **Man Transportable Robotic System (MTRS) Increment II:** As a risk reduction effort for the planned MTRS Increment II PoR, the RS JPO supported formulation and endorsement of the Technology Maturity Initiative that delivers an Interoperability Profile compliant computational kit, to supplement and/or replace existing computational box. Also, this effort will enhance existing functionalities such as driver optics, Operator Control Unit, manipulator arm, end effectors, radio, and other payloads, to bridge the

capability gaps between current contingency systems and long-term sustainment programs of record.

- **Engineer Squad Robot (ESR) and Tactical Robotic Controller (TRC):** A risk reduction effort for the ESR and TRC requirements has been initiated through the *National Center for Manufacturing Sciences*, to evaluate application of the IOPs to unmanned systems. The goal is to further validate the IOP Version 0, as well as drive competition and efficiencies among vendors, increase materiel availability, and reduce costs to the Government. Several vendors will be selected and will be required to apply the IOP standards to their sub-components; compliance with other robot manufacturers systems and payloads will be verified by integrating various manufacturers' components together and physical simulation testing achieved through the TARDEC interoperability System Integration Lab (SIL). In addition, the TRC will also be tested to assist in refining the human factors and software requirements as well as formulate the strategy for managing the various components of the hardware and software.

- As a risk reduction effort for future PoRs, the RS JPO supported formulation and endorsement of the Extended Mission Capability for Unmanned Ground Vehicles with Fuel Cell Hybrid Systems to develop automated processes, quality control procedures, accelerated test methods, and a physical prototype for evaluation on a SUGV to support future PoRs.

3.3.3 Interoperability

Background

The RS JPO continues to develop, mature, and institutionalize the utilization of Interoperability Profiles (IOPs) as part of technology risk reduction efforts as well as the program of records. The Interoperability effort is a low risk but high return approach as it greatly impacts the acquisition process in terms of cost, schedule, and performance. IOP standards will allow the RS JPO to reduce both the response time of rapid response initiatives as well as development and integration costs of system enhancements over the system lifecycle. These open standards allow RS JPO to plan and manage obsolescence issues by ensuring a greater range of Commercial-Off-The-Shelf (COTS) system availability at reduced cost. Third party vendors will be enabled to compete for future capabilities, whereas competition among third party vendors has been limited or non-existent using current acquisition approaches. These standards enable platform intelligence, flexibility, and adaptability, which ultimately enable the Warfighter to complete their mission successfully. Within the Interoperability domain, several developments have occurred since the 2011 roadmap that are valuable to the RS JPO stakeholders:

Accomplishments

- **IOP V0 published December 2011:** Based on recent coordination with industry leaders, the Joint Executive Board governing the review of the UGV Interoperability Profile voted unanimously on 21 December, 2011, to approve publishing the IOP Version 0, specifying product-level baseline capabilities for modular hardware and software interfaces. These interface requirements will promote industry competition and enable better buying power for the taxpayer, by increasing the number of potential vendors of system payloads, radios, and controllers. These will also promote responsiveness to Warfighter needs by reducing obsolescence risks and enabling faster integration of system upgrades, based on maturing technology and emerging requirements.

- **TARDEC Interoperability Lab:** The US Army Tank-Automotive Research, Development & Engineering Center (TARDEC) has unveiled the UGV Interoperability Lab, which was developed in direct support of UGV IOP verification & validation. The

Interoperability Lab has implemented all interoperability capabilities within the scope of IOP V0, and will expand in scope as the IOPs continue to evolve. The lab includes an IOP Conformance Verification Tool, virtual IOP compliant payloads, and an IOP radio lab. This will support developmental testing processes for RS JPO programs, and will give the RS JPO the ability to assess the interoperability compliance of various systems and components on the market.

- **IOP V1 Capability Plan developed:** The RS JPO has developed the IOP V1 Capability Plan, which was used to scope and bound the activity of the voluntary government/ industry UGV Interoperability Working IPT (WIPT) for the development of IOP V1. IOP V1 will expand upon the scope of IOP V0, by adding interface requirements for expanded capabilities. Some of these new capabilities for V1 include a basic interface with UAV video feed on UGV controllers, appliqué kit interfaces, additional payload types, basic radio mesh network requirements, and enhanced health management capabilities.

- **Instantiation of IOP on Programs:** Concurrently with the development of IOP V1, various programs are instantiating IOP V0 to specifically address the capabilities of their program or system. These program-specific instantiations will enable the actual implementation of modularity & interoperability into the RS JPOs portfolio of systems. All future RS JPO systems will be IOP compliant, and some fielded systems may be upgraded, dependent upon resource availability and a positive business case. Additionally, a number of tech-base programs are requiring their programs to develop IOP-compliant technologies. This will provide industry with experience in developing to the interfaces, and will also increase the likelihood of successful technology transition into PM-managed programs. The RS JPO will continue to evolve its implementation of the IOPs and communicate this to stakeholders via the 2013 RS JPO UGS Roadmap.

3.4 Test & Evaluation Strategy Developments

Background

As studies such as the recent RAND Arroyo report concluded, challenges to fielding robotic and autonomous systems to the Warfighter include gaining cultural acceptance of autonomous systems within both military culture and leadership, including Tactics, Techniques, and Procedures (TTPs), as well as within society in general. By continuing to align our strategies to leverage sound Test & Evaluation principles and accepted safety practices across the DoD, the RS JPO is both ensuring its systems are safe, effective and capable. In addition, this further bolsters the larger Test & Evaluation (T&E) and Warfighter community's abilities to evaluate and integrate these systems into their own plans and strategies.

In order to achieve this, the RS JPO continues to evolve its T&E strategies to address the need to verify and validate increasingly complex robotic capabilities including varying levels of control ranging from tele-operation to autonomy. It is recognized that multiple facets of verification are needed, to include an increased emphasis on modeling and simulation up front in the verification process as well as supporting the larger test community on standardizing the test procedures for these emerging capabilities.

Execution

Since 2011, the RS JPO has engaged with several organizations to further its ability to influence how its products are tested. Among them, Joint Improvised Explosive Device Defeat Organization (JIEDDO) has been a key partner in assisting with Counter Radio-Controlled

Improvised Explosive Devices (RCIED) Electronic Warfare (CREW) radio modeling and simulation to ensure that our systems can maintain mission effectiveness regardless of other soldier/marine equipment in use. RS JPO has also facilitated efforts with the Army Test & Evaluation Command (ATEC) to provide them visibility on emerging autonomous requirements and capabilities, with the ultimate goal of standardizing autonomous test procedures and capabilities across the DoD. In addition, the RS JPO continues to partner with TARDEC on the initiation of the Interoperability Lab, which will be the "proving ground" for government and industry partners looking to achieve IOP compliance for development and engineering efforts.

It is expected that future updates of the RS JPO Unmanned Ground Systems Roadmap will expand on knowledge gained from the efforts mentioned above, to further inform the UGS community on this key part of delivering capability to the Warfighter.

3.5 Logistics & Sustainment Strategy Developments

Background

Fielding of today's fleet of unmanned ground systems has presented a key challenge in how to manage and sustain them within the military inventory. The operational urgency of need and uniqueness of these platforms required a non-standard approach in integrating these technologies into the force. This understandable and needed deviation created, as a byproduct, a parallel management system that bypassed many established sustainment processes and procedures. As a result of both the drawdown in theatre and the aforementioned Directed Requirement, RS JPO is developing a responsible drawdown strategy that includes long term sustainment and future disposition of robotic systems.

Execution

The RS JPO's unique approach to integrating unmanned ground systems into the current force is through direct support to the Warfighter including Joint Robotic Repair and Fielding (JRRF) activity in the Continental US (CONUS) and Joint Robotic Repair Detachments (JRRDs) outside the continental U.S. (OCONUS). Within the RS JPO, the Logistics Division has developed and refined the Joint Robotic Repair and Fielding (JRRF) mission. The JRRF is designed to provide CONUS and OCONUS support for fielded robotic platforms to include training, sustainment, assessment, repair and accountability. Continuous improvement efforts within the JRRF include enhanced inventory control and asset visibility; integrating Radio-Frequency Identification Devices; Condition Based Maintenance; and standardizing processes for Commercial Off-The-Shelf and Non-Standard Equipment repair and sustainment.

Facilities

Additionally, the JRRF has the capability of deploying Mobile Training Teams to support CONUS units preparing to deploy. Over 6,000 Army and Marine Corps personnel have been trained on UGVs at various locations by JRRF trainers. The JRRF is located at Selfridge Air National Guard Base in Michigan and manages all of our Joint Robotics Repair Detachments (JRRD) worldwide. The RS JPO works closely with the original equipment manufacturers to ensure that our trainers and technicians have the most current repair and procedure information available. The JRRDs are subsets of the JRRF that provided on-site CONUS and OCONUS training, sustainment, repair and support for robots from all branches of service and multiple Coalition partners. The following table lists various repair and training facilities across the globe.

Existing Joint Robotic Repair Detachments (JRRDs)	Existing RSJPO Joint Robotic Repair & Training Teams (JRRTTs)	New RSJPO/FORSCOM Home Station Training (HST) initiative Joint Robotic Repair & Training Teams (JRRTTs)
JRRD-Afghanistan	Ft. Irwin (NTC)*	Ft. Drum
JRRD-Kuwait	Ft. Polk (CTC)*	Ft. Bragg
	Ft. A.P. Hill	Ft. Stewart
	Ft. Leonard Wood	Ft. Benning
	Tyndal Air Base	Ft. Campbell
	29 Palms	Ft. Knox (supported by JRRTT Ft Campbell)
	Hohenfels, Germany	Ft. Irwin (NTC)*
		Ft. Polk (CTC)*
		Ft. Riley
		Ft. Hood
		Ft. Carson
		Ft. Bliss
		Joint Base Lewis McChord (JBLM)
		Camp Shelby

*Ft Irwin and Ft Polk were existing JRRTTs, but since they are FORSCOM installations they are now connected to the HST initiative.

As highlighted in the above table, the RS JPO is expanding its training facilities to support the FORSCOM Training Initiative in which Army leadership has tasked RS JPO to increase its presence throughout the CONUS home station training facilities that includes robotic training lanes and repair capabilities. These activities further reinforce the institutionalization of UGS within the Army and support the transitions of systems from Contingency/Rapid Acquisition to Program of Record – using the Directed Requirement as the basis for the bridging strategy.

Accomplishments

Key developments in this area include:

- RS JPO is posturing itself to incorporate unmanned systems (both COTS and PoR) into the standard Army Logistic Information Systems.
- Emerging contracts for new capabilities will be structured so that organizations can acquire the minimum logistics information relative to sustainment costs.
- Consideration is being given to a joint effort with TRADOC to establish a structure such as the RS JPO Robotics University that would provide trained operators on multiple platforms within one course. This course would fill the gap between FORSCOM and TRADOC, thus allowing FORSCOM to tap into a course that would provide them trained operators to use robotic systems at their Home Station Training Lanes. This would align with the Army Force Generation (ARFORGEN) schedule and reduce the logistical footprint required to maintain MTT teams and equipment.
- The Chief of Current and Future Warfighting Capabilities, USA signed a memorandum approving Pre-Deployment Training Equipment (PDTE) quantities required by the Operational Needs Statement (ONS) for United States Army Pacific (USARPAC) Counter Improvised Explosive Devise (CIED) Training Equipment. The equipment

validated the responsibility for maintenance, sustainment and property accountability to be led by PM RS JPO.

- In order to be successful in managing evolving robotic technologies, RS JPO is preparing to develop systems employing modular, interoperable technologies and Government-led Interoperability Profiles (IOPs).

3.6 Process Management Strategy Developments

Multiple external requirements, stakeholders, and technologies are driving the RS JPO to formalize and institutionalize its business, technical, and program management processes. The intent is to standardize how the RS JPO does business and align with both the PEO GCS and industry best practices, as well as gain efficiencies through repeatable process and execution of the DoD acquisition system. The effort within RS JPO has been initiated under the name Process Excellence Program (PEP).

PEP is on track to establish a Business Management System for the RS JPO. This program employs the concepts of ANSI/ISO/ASQ Q9000:2008 Quality Management Systems – Requirements and Capability Maturity Model Integration for Acquisition (CMMI-ACQ). Leadership Off-Sites were conducted that provided management with training and this allowed management to establish an Overarching Process. The Overarching Process defines how the organization employs the strategies directed from higher level organizations ("Big Army", ASA (ALT), and PEO GCS) and implements these strategies at a working level. The Overarching Process sets the structure for a quality systems manual and defines how the organization will measure effectiveness. Further PEP developments and their impacts on external stakeholders will be included in the 2013 UGS Roadmap.

4.0 Conclusion

There has been a clear shift in how the Government and DoD are expected to do business – involving every aspect of product lifecycle management, from business planning, technology alignment and management, test & evaluation, and fielding and sustainment. The recent developments described in this document are paving the way toward a more consolidated, sustainable, interoperable and capable portfolio of UGS within the Army and Marine Corps. As the RS JPO crafts an update of the Unmanned Ground Systems Roadmap in 4QFY13, these developments will contribute to the foundation being laid to provide senior leadership and the Warfighter a clear and integrated vision of the future of Unmanned Ground Systems in the Department of Defense.

Author's Note

The following *Appendix A: RS JPO Systems/Programs Portfolio* is an updated portfolio of RS JPO's fielded systems and active programs, based on the events and developments listed in the addendum. This version of the appendix included in the 2012 Addendum supersedes the Appendix of the same title in the 2011 RS JPO UGS Roadmap.

Appendix A: RS JPO Systems/Programs Portfolio

A1 Anti-Personnel Mine Clearing System, Remote Control (M160)

OCU

M160 Platform

Mission: Area Clearance and Route Clearance missions
User Service: U.S. Army
Manufacturer: DOK-ING D.O.O., Demining and Manufacturing, Zagreb, Croatia

Program Description:
The Anti-Personnel Mine Clearing System, Remote Control (M160) is a component system in the Area Clearance FoS that responds to the U.S. Army Area Clearance Family of Systems CPD, approved by HQDA Revision 1, 11 March 2010. The Area Clearance FoS provides the capability for current and future Joint and Army Forces to clear the full range of anti-personnel (AP) mines quickly and safely to support operational deployments. The FoS will be employed at Division and Corps levels and generally task-organized with the Engineer Brigade or Combat Support Brigade. The M160 is a legacy, contingency system which transitioned to a post-Milestone B, ACAT III Non-developmental Item program.

The M160 is an improved version of the COTS DOK-ING MV-4A. Integration of performance improvements to the MV-4A mechanical, electronics and control and communications subsystems increased reliability and durability resulting in the production of the DOK-ING MV-4B model.

An authorized nomenclature and model record number for the Anti-Personnel Mine Clearing System; Remote Control MV-4B was released by the Standardization Branch on 04 March 2010. The new model number, M160 has replaced the OEM model number (MV-4B).

The M160 tracked combat engineer vehicle is designed for teleoperation by Soldiers from either mounted or dismounted positions to neutralize AP mines by destroying or detonating them with its rotating flail head. It has been proven to be reliable and very effective in clearing AP mines and explosives in OND and OEF. The vehicle will continue to be improved through the modernization plan to provide stand-off protection to soldiers as areas are cleared of AP mines.

Program Events and Associated Timelines:

- Log Demo: Completed in September 2010
- Initial Operational Test and Evaluation (IOT&E) Event: 28 November 2010 – 10 December 2010
- Program of Record Safety Confirmation received – 23 February 2011
- MDA Program Certification (MS C): 3rd Qtr FY11
- Type Classification Standard: 2nd Qtr FY12
- Full Materiel Release (FMR)/ Full rate Production (FRP): 1st Qtr FY13
- RECAP - Army Acquisition Objective (AAO) total of 41: 1st Qtr FY15 -3rd Qtr FY17
- First Unit Equipped: 1st Qtr FY16
- Initial Operational Capability (IOC): 1st Qtr FY17
- Full Operational Capability: 1st Qtr FY18
- Fielding: 64 systems are currently fielded in OEF in support of a validated ONS Requirement for 92 Systems

A2 PackBot Family of Systems

OCU

EOD

FasTac

PackBot 510 chassis

Mission: Provide the Warfighter standoff for missions involving explosive or hazardous materiels, reconnaissance, and other Combat Engineer missions
User Service: U.S. Army and U.S. Marine Corps
Manufacturer: iRobot Corporation, Bedford, MA

Program Description:
The PackBot is a small, teleoperated, tracked robotic platform. The family of vehicles was designed to inspect and clear suspicious objects during IED and EOD missions. The robot provides a safe standoff distance for the Soldier performing an explosive residue detection, interrogation and removal of suspicious objects. The system includes a remote controlled articulated arm with a gripper and a pan/tilt/zoom color surveillance camera with ultra low-light capabilities. The robot operates at speeds up to 5.8 miles per hour, enabling fast, tactical maneuvers.

The first fielded PackBot robots were the PackBot 500 and the PackBot FIDO, both with a 3-link arm with gripper for manipulating and carrying objects and a proprietary suitcase controller (Portable Command Console [PCC]) for the OCU. The arm extends 80", and can lift 10 pounds at full extension and 30 pounds close to the chassis. The head, shoulder and gripper independently rotate a continuous 360 degrees with an auto-focus, 312X zoom color camera that enables the robot to identify, lift, carry, and manipulate small objects. The fully integrated FIDO sensor is used for explosive detection.

A smaller, lighter version of the PackBot was later fielded for route reconnaissance missions. The PackBot FasTac has two smaller arms (SAM, CAM), flippers without tracks, and a smaller, lighter weight, ruggedized PC for the OCU. The FasTac uses a modern version of the original PackBot 500 chassis (the PackBot 510) with a higher frequency embedded radio. The CAM has three degrees of freedom with the same highly capable color zoom camera seen on the 3-link arm, and can extend 29" to view heights up to 41". The SAM has four degrees of freedom with continuous wrist rotation and 185 degrees shoulder pitch. It extends 42" and can lift five pounds at full extension. A software upgrade on the PackBot 510 platform to Aware 2.0 enables plug-and-play interoperability of all 500 and 510 series payload on the FasTac chassis.

System Characteristics:

	PackBot 500 (3-link arm, PCC)	PackBot 510 (CAM & SAM OCU)
Size	27" L x 20" W x 16" H	27" L x 20" W x 12" H
Weight (robot)	68 lbs	53 lbs
Weight (OCU)	41 lbs	13 lbs
Lift Capacity	10 lbs full extension; 30 lbs close	5 lbs full extension; 15 lbs close
Endurance	3 to 4 hrs	3 to 4 hrs
Max Speed	Up to 5.8 mph	Up to 5.8 mph

Payloads (options):
- Fiber optic spooler
- FIDO explosive detector
- Water bottle charge disrupters
- Enhanced awareness package (compatible with FasTac arms only)
- Thermal camera
- Comm select radio (PackBot 500 series only)
- BB2590 battery cradle upgrade (PackBot 500 series only)

Capabilities:
- Carry/place explosive charges
- Detect explosives such as RDX, TNT, PETN
- 312X zoom (26X optical, 12X digital)
- Both white and NIR LED arrays for illuminating in all ambient light conditions
- Camera mounted on a slip ring, and can rotate continuously 360 degrees
- Modular chassis capable of accommodating a number of different payloads
- Ability to traverse rough outdoor terrains as well as operate in urban environments
- Trackless flippers can be upgraded to tracked flippers

Program Events and Associated Timelines:
RS JPO maintains a fleet of PackBot systems in support of OEF and OND operational and CONUS/OCONUS training requirements identified through an ONS or JUONS.

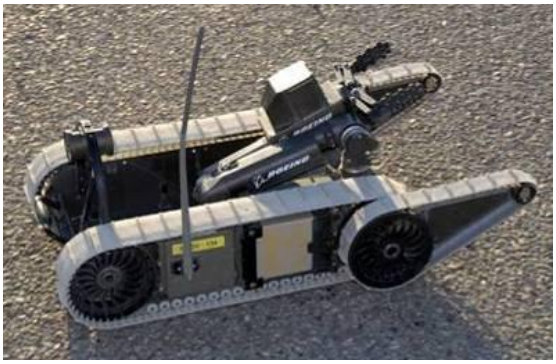
For the PackBot FIDO, no new requirements exist, and the PackBot 500 chassis is no longer available from the manufacturer. Current PackBot FIDO and EOD robots will be upgraded to the PackBot 510 chassis with Aware 2.0 software for ongoing sustainment. Future requirements can be met by utilizing the 510 chassis with plug-and-play modularity of the Aware 2.0 software. Payloads from existing PackBots are modular with the upgraded chassis, and can be used along with any new payloads developed to meet mission needs.

A Safety Confirmation was received in March 2008 for the FasTac system. All FasTac robots will be upgraded to the Aware 2.0 software in 2011.

Sustainment Plan:
The PackBot was designated by the Capabilities Development for Rapid Transition process as sustain for wartime and will continue to be sustained until overseas contingency operations cease.

The current sustainment for the PackBot FoS is provided by CONUS and OCONUS JRRDs. The JRRDs either replace the entire inoperable robot or replace the broken component and ship it back to the manufacturer for repair.

A3 Mini-EOD

	
OCU	**Mini-EOD**

Mission: Identify and neutralize IEDs
User Service: U.S. Army, U.S. Marine Corps, U.S. Navy, U.S. Air Force
Manufacturer: The Boeing Company (Prime) with iRobot Corporation (Sub)

Program Description:
The Mini-EOD system supports a JUONS to assist in EOD operations requiring a smaller robot. The Mini-EOD identifies and neutralizes roadside bombs, car bombs, and other IEDs and is specially designed for locating, identifying and disarming explosive and incendiary devices, and collecting forensic evidence.

The Mini-EOD is a small, lightweight, Modular Lightweight Load-carrying Equipment (MOLLE) pack transportable vehicle operated from a wearable OCU. The Mini-EOD uses a chassis with four cameras allowing a forward/rear facing Wide-Field-of-View (WFOV), gripper, and body chassis view while utilizing BB2557 batteries. The Mini-EOD uses a manipulator arm. Together, the vehicle and OCU weigh less than 35 lbs, and can be stowed in a military rucksack or MOLLE pack.

System Characteristics:
Size ..... 24" L x 18" W x 11" H
Weight (robot) ..... 30 lbs
Weight (OCU) ..... 4.4 lbs
Endurance ..... 90 min
Max Speed ..... 5.8 mph

Payloads:
- Manipulator arm
- Arch camera
- Front and rear cameras
- Lights

Capabilities:
- 360° pivotal arm that can lift ten pounds with a reach of two feet beyond the body of the robot
- Capable of moving over most types of terrain
- Night and low-light capable
- Identify and neutralize roadside bombs, car bombs and other IEDs
- Capable of collecting forensic evidence
- Rucksack/MOLLE pack portable
- Wearable OCU
- Capable of 5.8 mph with 5 lb payload

Program Events and Associated Timelines:
More than 320 Mini-EOD systems are being sustained CONUS/OCONUS.

Sustainment Plan:
Mini-EOD systems are currently being fielded in support of contingency operations and are supported only through OCO funding. As a result, no long term sustainment strategy has been developed.

Current sustainment for the Mini-EOD is provided by CONUS and OCONUS JRRDs. The JRRDs either replace the entire inoperable robot or replace the broken component and ship it back to the manufacturer for repair.

A4 TALON Family of Systems

	
OCU	**TALON IIIB and TALON IV (Base Configuration)**

Mission: Engineer Support/Reconnaissance and Surveillance missions
User Service: U.S. Army
Manufacturer: QinetiQ North America, Waltham, MA

Program Description:
The TALON IIIB and IV platforms provide commanders the ability to detect, identify, and neutralize suspected explosive hazards using a tele-operated system. The platforms utilize an articulated arm and gripper, multiple illuminated cameras, a pan/tilt surveillance camera, long range radios, and a ruggedized OCU to execute missions. Additional capabilities available for the TALON IV Engineer include three infrared (IR) cameras, a 300:1 color zoom with wide-angle camera, and a JAUS-compliant design that allows for modular plug-and-play upgrades.

System Characteristics:

	TALON IIIB	TALON IV
Size	34" L x 22.5" W x 11" H	34" L x 22.5" W x 11" H
Weight (robot)	160 lbs	168 lbs
Weight (OCU)	45 lbs	44 lbs
Lift Capacity	10 lbs full extension; 30 lbs close	5 lbs full extension; 15 lbs close
Endurance	3 hrs	4.5 hrs
Max Speed	5.2 mph	5.2 mph

Payloads (Standard [S] and Optional [O]):
- 2-stage manipulator arm w/ wrist gripper (S)
- Extendable pan/tilt/zoom video camera (S)
- Analog video (S)
- COFDM video (O)
- FIDO sensor (O)
- CATNAP remote power on/off system (O)
- Battery tray for BB2590 Li-Ion batteries (O)
- Quick disconnect universal mounting bracket (O) [TALON IV only]
- Hazardous material sensor suite (O) [TALON IV only]
- 2-channel explosive firing circuit (O) [TALON IV only]
- WARVVS camera (O) [TALON IV only]

Capabilities:
- Explosive ordnance disposal using the attached gripper
- Extended detection ranges using the heat contrast detection cameras, night navigation system, and visual cameras
- Fiber optic tether in the event of unusable RF links

Program Events and Associated Timelines:
RS JPO maintains a fleet of TALON IIIB and IV systems in support of OEF and OND operational and CONUS/OCONUS training requirements identified through an Operational Needs Statement or Joint Urgent Operational Needs Statement.

Sustainment Plan:
TALON systems are currently being fielded in support of contingency operations and supported only through OCO funding. As a result no long term sustainment strategy has been developed. There is a desire in RS JPO to move towards a uniform fleet to reduce sustainment footprint and configuration management issues.

In order to sustain the current fleet of TALON systems in theater today, the current sustainment is provided by CONUS and OCONUS JRRDs. The JRRDs either replace the entire inoperable robot or replace the broken component. A plan is in place to provide RS JPO the ability to ship broken components back to the manufacturer to have them repaired.

A5 MARCbot

	
MARCbot IV + OCU	**MARCbot IV-N + OCU**

Mission: MARCbot serves as a wheeled reconnaissance robot designed to provide the Warfighter with a remote, look only capability.
User Service: U.S. Army and U.S. Marine Corps
Manufacturer: Applied Geo Technologies, Inc., Choctaw, MS

Program Description:
The MARCbot IV-N is a low-cost IED investigation capability used by U.S. Army and U.S. Marine Corps personnel to provide standoff investigation of suspected IED emplacements. MARCbot IV-N uses an articulating arm to maneuver a camera into position to confirm or deny a suspected IED. The robot is not equipped with a manipulator arm or gripper for manipulating or lifting objects. The ability to confirm IEDs reduces the number of IED false alarm calls and allows the patrol or convoy to proceed with minimal exposure to hostile environments. The MARCbot IV-N is an upgrade to the previously fielded MARCbot IV. All fielded MARCbots will be upgraded to the MARCbot IV-N configuration. Modifications include a digital radio at a higher frequency and improved OCU that consists of a ruggedized PC with game-style hand held controller. The U.S. Government has purchased a Technical Data Package (TDP) with Government purpose rights for the MARCbot IV-N.

System Characteristics:
Size ..... 24" L x 19" W x 13.5" H
Weight (Robot)..... 35 lbs
Weight (OCU) ..... 9.5 lbs
Endurance..... 4 hrs
Max. speed..... 5 mph

Payloads:
- Retractable pan and tilt color camera with near-infra red LED lighting for low light imaging

Capabilities:
- Remote observation distance greater than 100 meters
- Low-light camera and LED arrays for night time mission capability
- Pan/tilt camera can be raised to 3 feet and extended to 1.2 feet to inspect container and other obstacles

Program Events and Associated Timelines:
MARCbot IV-N received a Safety Confirmation (SC) on 26 August 2008. The contractor delivered an additional 496 MARCbot IV-Ns to supplement the already existing 850 MARCbot IVs. These additional units will be used to support OND, OEF, Foreign Military Sales, and training and spares. All current MARCbot IVs will be upgraded to the MARCbot IV-N configuration with the installation of the Line Replaceable Unit (LRU) radio/OCU upgrade kit.

Sustainment Plan:
Systems fielded under JOUNS. The MARCbot is currently designated as a wartime sustained system and will continue to be sustained until OCO ceases.

A6 XM1216 Small Unmanned Ground Vehicle (SUGV)

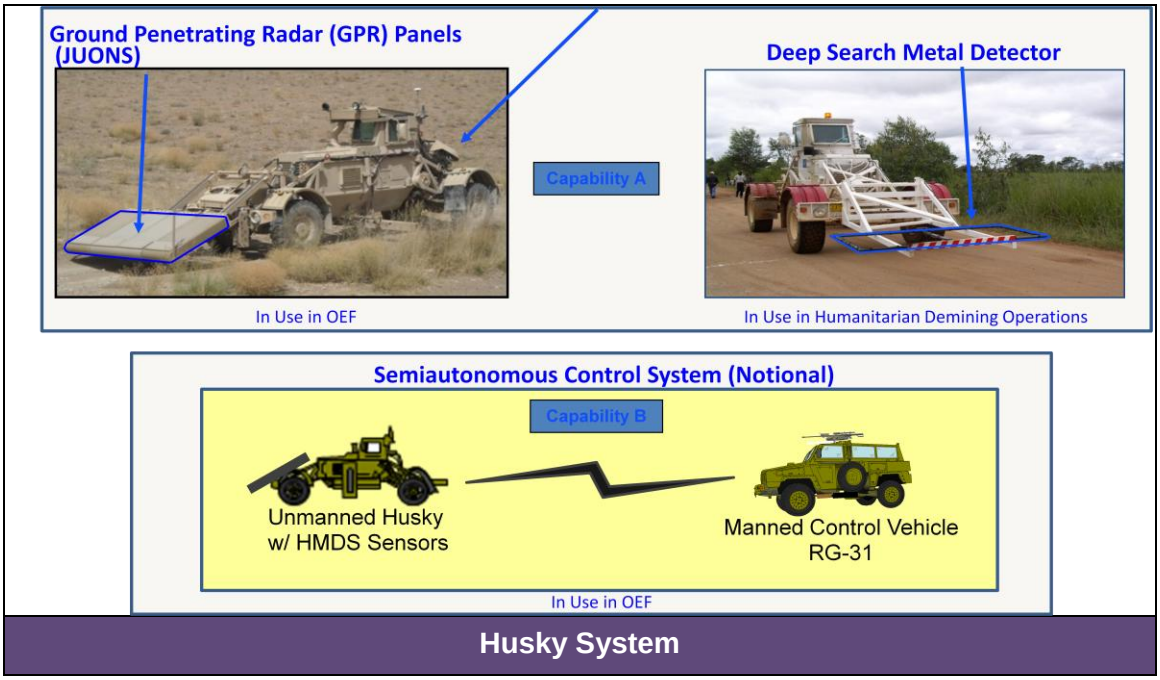
SUGV

Mission: Situational Awareness and ISR for the dismounted Soldier
User Service: U.S. Army
Manufacturer: iRobot Corporation, Bedford, MA

Program Description:
The SUGV is a light weight, Soldier-portable, UGV capable of conducting military operations in urban terrain, tunnels, sewers and caves. The SUGV provides SA/SU and ISR to dismounted Soldiers enabling the performance of manpower intensive or high-risk functions without exposing Soldiers directly to the hazard. The SUGV modular design allows multiple payloads to be integrated in a plug-and-play fashion. The SUGV is capable of carrying up to four pounds of payload weight.

Program Events and Associated Timelines:
- 1st Brigade fielding, 3rd QTR FY11, 3rd Brigade/1st Armored Division
- 2nd Brigade fielding, 4th QTR FY12, 4th Brigade/101st Armored Division (Air Assault)
- 3rd Brigade fielding, TBD

A7 Husky Mounted Detection System



Husky System

Mission: Route Clearance
User Service: Army
Manufacturer: N/A (contracts not awarded)

Program Description:
The HMDS program consists of two distinct capabilities. Capability A is an upgraded GPR and Deep Search Metal Detector. Capability B is a Semi-Autonomous control capability of the Husky vehicle and Capability A. The Husky Semi-Autonomous Control Capability will enable an operator to semi-autonomously control all functions of a Husky in an unmanned mode from inside the Mine Protected Clearance Vehicle at standoff; and will remove the operator from the proximity of the effects of explosive hazards. The operator will be able to deactivate the Semi-Autonomous Control Capability and operate the Husky in the manned mode.

System Characteristics: N/A

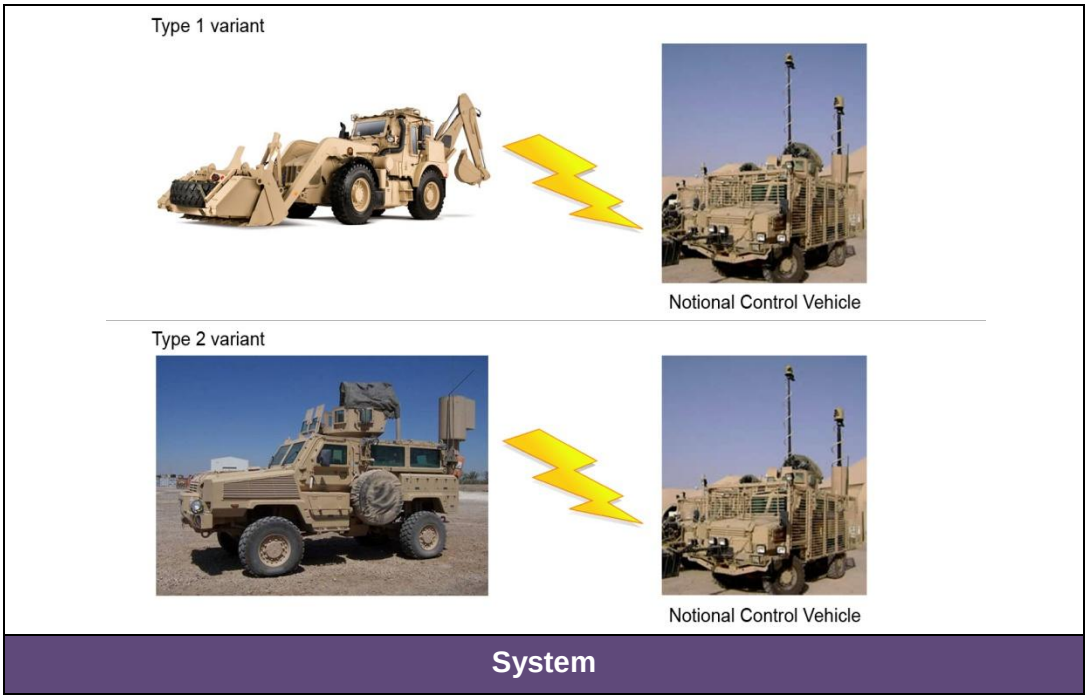
Payloads (options): N/A

Capabilities: Provide operator standoff while semi-autonomously controlling the Husky mobility platform, Ground Penetrating Radar and Deep Metal Detection payloads.

Program Events and Associated Timelines (Capability B):
Market Survey: Fall 2012
Draft RFP: Summer 21013
RFP Release: Winter 2014
EMD contract award: Summer 2014
LRIP: FY16
FUE: FY17

Sustainment Plan: The plan is to have organic sustainment of both Capabilities by FY17.

A8 Route Clearance Interrogation System (RCIS)



Mission: Route Clearance and Interrogation
User Service: U.S. Army
Manufacturer: Contracts not awarded

Program Description: The Route Clearance and Interrogation System (RCIS) provides a System of Systems solution to mitigate gaps identified in the Explosives Hazards Defeat Initial Capabilities Document (ICD) and the Mobility Through Urban and Complex Terrain ICD, incorporating operational lessons learned. RCIS provides Soldiers standoff while conducting detection (interrogate and classify), neutralization, proofing, preventing, reducing hazards while on the move, and force protection during route clearance missions. RCIS counters the full spectrum of worldwide explosive hazards including surface-laid, buried and concealed landmines, improvised explosive devices (IEDs), explosively formed penetrators, unexploded explosive ordnance, battlefield munitions, booby traps and trigger mechanisms, and caches.

System Characteristics: Utilizes existing capabilities in the Route Clearance Company (RCC) and allows Soldiers to safely complete high-risk operations without exposing them to the blast effects of various explosive hazards. The RCIS Type I Variant will be placed on the High Mobility Engineer Excavator (HMEE)-Type I (LIN H53576). It will enable Soldiers to semi-autonomously control: interrogating and classifying (and excavating) deep buried explosive hazards.

The RCIS Type II Variant will be placed on the RG-31. The Type II will enable Soldiers to semi-autonomously control: detecting, neutralizing, and proofing explosive hazards and trigger mechanisms.

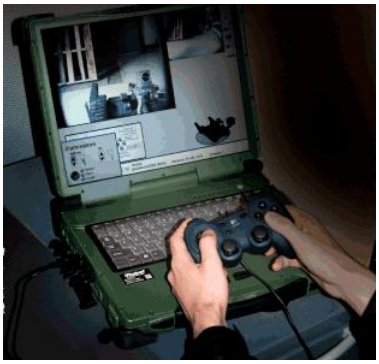
Payloads (options): N/A

Capabilities: Semi-autonomous control of the HMEE provides the RCC a robust platform designed for excavation operations, overcoming the limitations of interrogation arms to dig up buried hazards, without exposing operators. HMEE provides lifting and moving capability, interrogation and raking. Cameras allow classification of hazards. Semi-autonomous control of the RG-31 MRAP reduces hazards to Soldiers during detection, neutralization, prevent and proofing during clearance operations. RCIS allows for the interchanging of modular components, such as mine rollers and blowers to be used remotely. Modular payloads will provide safety warning and object sensing, 360 degree visual scanning, and cameras.

Program Events and Associated Timelines:
Program Approval: Fall 2012
Market Survey: Fall 2012
Draft RFP: Winter 2013
RFP Release: Summer 2013
EMD contract award: Fall 2013
LRIP: FY16
FUE: FY18

Sustainment Plan: The plan is to have organic sustainment of both Capabilities by FY18.

A9 Route Reconnaissance and Clearance (R2C) Robot

	
OCU	**PackBot 510 chassis**

Mission: The R2C Robot system will enable a Marine to fulfill his mission including route reconnaissance; visual identification of explosive devices; the interrogation and reduction of suspected explosive devices in advance of a convoy; and the breaching of manmade obstacles through explosive emplacements.
User Service: U.S. Marine Corps
Manufacturer: iRobot Corporation, Bedford, MA

Program Description:
R2C Capabilities Production Document (CPD), Version 1.4 dated 29 June 2009, established the Marine Corps' need for a Route Reconnaissance and Clearance (R2C) robot system capable of providing standoff detection and reduction of explosive obstacles in order to protect Marines against mines, explosive obstacles, and small arms fire by taking them out of the engagement area. The R2C Robot has been designated an Abbreviated Acquisition Program (AAP) for the first five year increment of the 20 year lifecycle. This increment will utilize already procured government-owned PackBot 510s with FasTac Kit that are available due to the drawdown of forces in the Iraq Theater of operations. The base PackBot 510 with FasTac Kit systems that will be used for R2C Robot are previously purchased, Government-owned assets that will be re-purposed to meet the R2C Robot requirements. The systems' configuration will be modified to remove the FasTac Kit and replace it with a 3-link arm, 4.9 GHz Comm-select radio for use outside the United States, fiber-optic spooler, and tracked flippers. In addition to the 4.9 Comm-select, the secondary embedded radio will be changed to 2.4 GHz for use in the United States. Both the PackBot 510 systems and the parts to support the modification are procured from a FAR Part 12, Commercial, Indefinite Delivery, Indefinite Quantity (IDIQ) contract that is currently managed by the Army Contracting Center (ACC) (Warren MI). The technologies used are not new to the USMC, and are Commercial, Off the Shelf (COTS) /Non Developmental Items (NDI) components.

Program Events and Associated Timelines:
Materiel Decision Authority (MDA): February 2012
Performance Testing: May 2012
E3 Testing: April 2012
Limited User Evaluation: June 2012
WSERB: September 2012
Fielding Decision: February 2013
IOC (12 robots): March 2013
FOC: May 2013

A10 Ultra-Light Reconnaissance Robots (ULRR)

Armadillo (Macro USA)

Dragon Runner DR-10 (QinetiQ)

FirstLook (iRobot Corp.)

Recon Scout XT (Recon Robotics)

Mission:
Provide remote interrogation capability at the combat engineer and infantry squad level to clear structures and look for IEDs during dismounted operations.

User Service: U. S. Army and Marine Corps

Manufacturers:
iRobot Corporation, Bedford, MA
Macro USA, McClellan, CA
QinetiQ, Pittsburgh, PA
Recon Robotics, Edina, MN

Program Description:
This program is in response to JUONS 0461/0480 and the Marines UUNS 11098UA . A large scale user evaluation of 100 robots from each manufacturer is currently ongoing in Afghanistan. Feedback from the Forward Operation Assessment will be used to refine the requirements for a full and open competition to occur later this year for the Army Acquisition of assets to meet the requirements of the JUONS. JIEDDO is considering pulling ahead a portion of the Army purchase based upon feedback from the FOA. The Marines have pulled ahead the purchasing decision from data obtained from the Limited Objective Experiment conducted at Ft. Benning in February 2012 and Limited User Evaluation at Selfridge in April 2012, and are acquiring 222 QinetiQ DR-10 robots. In addition, ninety two Recon Scout XTs have been purchased and fielded to meet the Marine Corps UUNS 11098UA.

System Characteristics:

Armadillo (Macro USA)	Dragon Runner DR-10 (QinetiQ)
• Size: 11" W X 13" L X 5.3" H • Weight: 6.6 lbs • Ground Clearance: 1.32" • Maximum Speed: 3 km/hr • Climbing Performance: 45^{o} slope • Temperature: -20^{o}C to +55^{o}C	• Size: 13.5" W X 15" L X 5.8" H • Weight: 11 lbs (with battery, throwable sprockets, treads and external antennae) • Ground Clearance: 2" • Maximum Speed: 4 mph @ 45 degree slope
FirstLook (iRobot Corp.)	**Recon Scout XT (Recon Robotics)**
• Size: 9" W X 10" L X 4" H • Weight: 5 lbs • Maximum Speed: 3.4 mph • Turns in place	• Size: 7.3" W X 8" L X 4.5" H • Weight: 1.2 lbs • Maximum Speed: 1.5 ft/sec

Payloads (options):

Armadillo (Macro USA)	Dragon Runner DR-10 (QinetiQ)
• 6.6 lbs attached to Picatinny rail or inserts • RE2 2-Degree of Freedom (DOF) arm with gripper and 1 DOF camera mast provided	• Payload: 5 lb capacity • None currently available, but RSTA camera head and 3 DOF arm are under development
FirstLook (iRobot Corp.)	**Recon Scout XT (Recon Robotics)**
• Payload: Port facilitates future integration of specialized cameras, thermal images, and chem.-bio-radiation sensors up to half pound • None currently available	• None

Capabilities:

Armadillo (Macro USA)	Dragon Runner DR-10 (QinetiQ)
• Can withstand multiple 2.5 meter drops to concrete and 8 meter horizontal throws. • 360 degree Field of View • 4 day/night color cameras • NIR and visible LEDs all four sides • 250 m LOS / 200 m NLOS	• Can withstand 6 to 12 foot lateral throws • NIR/visible color camera with LEDs front and rear • 650 m LOS / 500 m NLOS • Automatically flips video image • Compass and GPS
FirstLook (iRobot Corp.)	**Recon Scout XT (Recon Robotics)**
• Can survive multiple 15 foot drop onto concrete and 20 ft throws • Waterproof to 3 feet • 360 degree Field of View • 4 day/night color cameras all four sides; LEDs front and rear • Can climb stairs up to 8" • Auto self-righting • Multiple public/military radio bandsSelf rights when flipped over	• Can withstand multiple 30 ft drops onto concrete and 120 ft horizontal throws. • 300 ft LOS / 100 ft NLOS • Water resistant to 1.75 in • B&W sensor with NIR LED illumination to 25 ft • Power up and deploy in less than 15 seconds

Program Events and Associated Timelines:
NIST Evaluation of Ultra Light Robot platforms: August 2011
Forward Operational Assessment: January – July 2012
Limited Objective Experiment (Ft. Benning): February 2012
Marine Corps Limited User Experiment (Selfridge ANG): April 2012
Request For Proposal: August 2012
Acquisition Decision: Q1 FY2013

Sustainment Plan:
Assets purchased for FOA will be used until system failure and replaced with systems as available. Contractor warranty will be used for the first 6 months (or 12 months) as provided by each manufacturer. Level 1 Maintenance will be done with Field Service Kits and consumable parts available in robot kits. Longer term sustainment plan to be developed as requirements are determined.