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**Robotic Systems Joint Project Office
Unmanned Ground Systems Roadmap**

ADDENDUM

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Introduction

The Robotic Systems Joint Project Office (RS JPO) Unmanned Ground Systems (UGS) Roadmap is designed to provide insight into the current and future state of Army and Marine Corps UGS procurement. Its purpose is to provide information to our senior leadership and industry partners about RS JPO efforts in the near and long term. The intent of this addendum is to summarize recent developments in policies, requirements documents, interoperability, and the Science & Technology (S&T) base that have impacts on the current and future state of UGS. There have been a number of significant developments relating to UGS since the publication of the 2009 RS JPO UGS Roadmap.

Army Policy Memo for UGS Acquisition

The battlefields of the 21st century have proven the worth and the need for robots in armed conflict, thereby shaping the process of acquisition and deployment of UGS. The RS JPO has supported this mission by leading the development, systems engineering, integration, acquisition, testing, fielding, sustainment and improvement of UGS for the Warfighter, ensuring that safe, effective and supportable capabilities are provided while meeting cost, schedule, and performance objectives. In recent years, the threat of Improvised Explosive Devices (IEDs) in combat has been a major impetus for investments in robots capable of Explosive Ordnance Disposal (EOD), route clearance, and similar capabilities. As robotic systems proliferated and were rapidly fielded by various organizations, it was recognized by senior leadership that acquisition of ground robots in the Army should be managed by a single organization. In order to consolidate the acquisition of Army UGS, the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT)) issued on 24 November 2009 the “U.S. Army Policy for the Acquisition of Unmanned Ground Systems and Integration of Mission Capability Packages,” directing the RS JPO to be the focal point for all future US Army UGS acquisition.

Under this policy, ASA(ALT) directs RS JPO to be the centralized UGS project manager with the responsibility for the acquisition life cycle, including budgetary and Program Objective Memorandum (POM) execution. The memorandum defines the term UGS to include both robotic platforms and robotic appliqué kits. The policy further characterizes a robotic platform (regardless of size and mission) as being a ground mobility platform with sensors, computers, software (including modules for perception, navigation, learning), human-robot interaction, communication, power and a separate mission package depending on the unmanned systems mission role. Robotic appliqué kits are those that can be applied to manned combat or tactical platforms, converting them into unmanned configurations.

The memorandum directs the Army Program Executive Offices (PEOs) and Project Managers (PMs) to establish continuing relations with the RS JPO. Memoranda of Understanding (MOUs) are currently being developed between PEO Ground Combat Systems (GCS) and the other Army PEOs in order to establish the strategic relationships necessary to ensure long term UGS acquisition success. Upon the completion and approval of the PEO level MOUs, subsequent Memoranda of Agreement (MOAs) will also be developed between RS JPO and any PM with a significant stake in UGS acquisition.

Additional organizations partnering with RS JPO through MOUs and MOAs include Joint IED Defeat Organization (JIEDDO), the Rapid Equipping Force (REF), and Army laboratories within RDECOM. These MOUs will help to ensure early coordination for emerging requirements and future systems. To date MOUs have been established with PEO Aviation, JIEDDO, PEO Enterprise Information Systems, and PEO Intelligence, Electronic Warfare, and Sensors.

In summary, the ASA(ALT) memorandum is transforming the portfolio of unmanned ground systems in the Army, and will lead to a more integrated and consolidated procurement strategy and set of capabilities.

Unmanned Systems Initial Capabilities Document

As unmanned systems were being fielded in response to urgent requirements in theater, the U.S. Congress also directed in the 2007 National Defense Authorization Act that:

“The Secretary of Defense shall develop a policy, to be applicable throughout the department of defense, on research, development, test and evaluation, procurement, and operation of unmanned systems.

- An identification of mission and mission requirements, including mission requirements for the military departments and joint mission requirements, for which unmanned systems may replace manned systems.
- A preference for unmanned systems in acquisition programs for new systems, including a requirement under any such program for the development of a manned system for a certification that an unmanned system is incapable of meeting program requirements...”

This direction led the Army Training & Doctrine Command (TRADOC) to identify the need for an Initial Capabilities Document (ICD) for Unmanned Systems. An ICD is an overarching requirements document that defines a required set of capabilities, to be further defined within a subordinate Capabilities Development Document (CDD), or a Capabilities Production Document (CPD). Having an ICD in place forms a basis for further requirements decomposition, as well as for creating a POM funding line for the requirements.

In November 2009, TRADOC assembled a team of Combat Developers from the functional areas and drafted the Unmanned Systems ICD. This draft ICD leveraged existing robotics strategies and validated robotic Joint Urgent Operational Needs Statements (JUONs) and Operational Needs Statements (ONs) to define the capabilities and operational performance criteria required. The Office of the Secretary of Defense (OSD) 2009-2034 Integrated Unmanned Systems Roadmap offered supporting analysis for the draft ICD, and the timeline for the envisioned capabilities within the draft ICD is aligned to be through the 2034 timeline. The draft ICD supports the Congressional directive by identifying required capabilities across the Warfighting Functions.

Similar to the ASA(ALT) policy described previously, the draft ICD defines an Unmanned System as “consisting of a powered physical system, with no human operator aboard the principal platform, which acts in the physical world to accomplish assigned tasks. It may be mobile or stationary.” While the draft ICD was primarily developed to provide a requirements basis for the UGS community, it also includes unmanned aircraft systems (UAS), unmanned maritime systems (UMS), and unattended munitions and sensors. Additionally, robotic appliqué kits fall within the scope of the draft ICD.

The intent of the Unmanned Systems draft ICD is to provide a solid basis from which CDDs and CPDs for unmanned capabilities can be supported, to facilitate initiating Programs of Record (PoRs) when necessary. This may also serve as a method for converting currently fielded rapid acquisition equipment into more sustainable long-term programs, or to create new sustainable acquisition programs for new capabilities.

The ICD supports Unmanned Systems through the Joint Capability Areas (JCAs) in the areas of joint battlespace awareness, force application, protection, command and control, force support, net-centric, building partnerships, and focused logistics.

The overarching capability gaps that the draft ICD intends to address are:

- 1) **Intelligence:** The current force lacks the ability to conduct persistent multi-discipline intelligence collection, near-real-time reallocation, and dynamic re-tasking of assets. The leap-ahead technology to full autonomous capability will allow for intelligence fusion and will reduce cognitive workloads. This gap is an issue of both sufficiency (insufficient number of intelligence collection assets) and a lack of capability (limited sensing and endurance of assets).
- 2) **Fires:** The force lacks sufficient capability to deliver lethal and non-lethal fires, field-scalable munitions, and advanced technologies (electromagnetic (EM), high power microwave (HPM) and high power lasers (HPL)), where manned systems are limited, restricted, denied entry, or unavailable.
- 3) **Protection:** The force lacks the sufficient capability to provide adequate standoff distance to protect the force from threats in the Operational Environment (OE). Force health protection capability gaps include the inability to safely diagnose, recover, and transport casualties with enroute care from areas where manned systems are denied entry or unavailable.
- 4) **Command and Control:** The force lacks sufficient capability to enable a robust network to fully support information and knowledge connectivity throughout the extended OE. Unmanned Systems will also provide network extension capabilities to enable a robust network to fully support information and knowledge connectivity. This lack of capability impacts collaboration and dissemination of relevant information for the Common Operational Picture (COP), creating communications enterprise overload. The capability to access, update and collaborate on consistent geospatial and environmental data across the OE does not exist. These gaps result in voice and text situation reports requiring manual entry or the re-entry of information to support the COP. Classification policies between nations, the absence of technological competency, consistency, and standards between disparate applications, further complicated by language and cultural differences, are examples of the challenges facing Commanders in the execution of Unified Action.
- 5) **Movement and Maneuver:** The force lacks the sufficient capability to reduce the dismounted Soldier load, reduce cognitive workloads, provide extended weapons effects against the enemy, provide standoff from the threat, and provide assured mobility throughout the OE. Current Unmanned Systems do not support manned/unmanned teaming and lack sufficient power for continuous operations, operational ranges, endurance, and speed. Current Unmanned Systems lack the levels of autonomy to coordinate and collaborate between systems to enable multiple unmanned system force application. Current Unmanned Systems require one or more dedicated operators per Unmanned System. Current Unmanned Systems lack the required platforms, payloads, and sensors to accomplish the Joint Force Capabilities (JFCs) current and projected future missions described in Operational Needs Statements (ONS).
- 6) **Sustainment:** The Force lacks sufficient autonomous ground, air, and maritime logistics and distribution capability to provide responsive, assured supply and services to highly

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dispersed units across the extended OE. The Force lacks the capability to provide health services or mortuary affairs services where manned systems are denied entry or unavailable.

Additionally, the draft ICD recommends:

- The development of interoperable unmanned systems in the air, ground, and maritime domains, to include modularity within capability ranges and commonality at the platform and controller levels.
- Requirements for new or upgraded manned vehicles to include open systems connectivity for future autonomous appliqué systems.
- A common standardized remote tele-operations control system for Unmanned Systems currently in use
- Standardized operating software, integrating network, and communications architecture across all unmanned systems.
- A continuous organizational assessment of the mix of manned and Unmanned Systems to ensure a synchronized and increased capability is introduced over time
- An interoperable set of Unmanned Systems and their modular payloads, that will cover the JCAs to mitigate the identified gaps
- The continued evaluation of Unmanned Systems currently fielded in support of approved Joint Urgent Operational Needs Statements (JUONSS) and ONSs, for potential conversion into PoRs through the Capabilities Development for Rapid Transition (CDRT) process
- The establishment of a TRADOC Capabilities Manager Unmanned Ground Systems (TCM UGS) under the Maneuver Center of Excellence

The Draft ICD is currently (as of July 2010) under review at the 3-Star level in the Army Requirements Oversight Council (AROC). It is anticipated that AROC 4-Star approval will be forthcoming and based on the Marine Corps' interest, it is anticipated that the document will eventually be approved at the Joint Requirements Oversight Council (JROC) level. Upon approval, the document will form the basis for the future of sustainable, interoperable Unmanned Systems in the ground, air, and maritime domains.

RS JPO Interoperability Effort

Interoperability is integral to the success of missions using unmanned systems, and represents a long term objective of the RS JPO and its stakeholders. The urgent needs in theater and corresponding rapid acquisition approach during recent years have resulted in a current fleet of robotic systems that generally do not interoperate with each other or with external systems. Within the last 18 months, the RS JPO initiated a strategic and revitalized effort to address these challenges and develop the necessary elements for achieving interoperability.

The RS JPO Interoperability Integrated Product Team (IPT) has been formed with representation from a variety of agencies who possess the critical expertise required to define an integrated and optimized path toward interoperability. The IPT's objective is to define interoperability standards for integration across UGS, while leveraging the interoperability efforts of the Unmanned Aerial System (UAS) community and the Navy Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV) to the greatest extent possible. The scope for this effort includes defining the following:

- Open Architecture & Interfaces
- Common Control Standards
- Communications ("Common" Data Link)

feedback. Upon completion of the Industry Forum, several government/industry Working level IPTs (WIPTs) were initiated in order to strengthen the long term collaboration and synchronization of ideas. The IOP development effort will be refined with the RS JPO's government and industry stakeholders, and will undergo Modeling & Simulation (M&S) Validation for a Version 1 IOP publication date of FY12. The IOP will subsequently undergo an annual update, based on continued refinement and validation over time.

The RS JPO interoperability initiative will enable a number of capabilities described within the Draft Unmanned Systems ICD, and will form the technical basis for sustained interoperability between and among both unmanned and manned systems over time.

Joint Ground Robotics Enterprise

The Joint Ground Robotics Enterprise (JGRE) is an organization under the Land Warfare & Munitions (LW&M) directorate within the OSD office of Acquisition, Logistics & Technology that manages the S&T developments required for future UGS capabilities. The membership of the JGRE includes representatives from the Combat Development, Materiel Development, and S&T branches of each service. The JGRE serves as a central funding point for the strategic development of future UGS technologies.

To ensure that a well informed decision making process exists for funding the optimal balance of technology efforts, LW&M established a three tier vetting structure consisting of the Technology Advisory Board (TAB), the O-6 Council and the Senior Steering Group (SSG).

Technology Advisory Board (TAB)

The TAB is comprised of scientists, engineers and managers from the robotics community at large and includes multiple representatives from each Service as well as Industry. The primary missions of the TAB is to assess and map ground robotics technology to Warfighter capability needs and provide recommendations on funding priorities to the O-6 Council.

O-6 Council

The O-6 Council members are military officers and government O-6 civilian equivalents, representing all four Services and the Joint Staff. The Council meets as required to represent their respective Service, assist in generating the DoD strategy for advancing ground robotics, prioritize technology enablers, provide guidance to the TAB, and provide recommendations to the SSG.

Senior Steering Group (SSG)

The JGRE Senior Steering Group is chaired by the Deputy Director, LW&M and is comprised of flag level military officers or equivalent civilians as designated by each of the four Services and the Joint Staff. The SSG body recommends funding priorities to the Chair, as well as allocations within the program elements. The SSG Chair has final approval of the portfolio of investments funded annually, as well as the process and composition of the JGRE. Participation of the SSG members signifies the commitment on the part of the Services to the successful accomplishment of the DoD mission pertaining to ground robotics.

The process for JGRE funding consideration begins with the O-6 Council members identifying the individual Service's ground robotic priorities. These inputs are provided in the form of a User Focus List. A consolidated User Focus List of desired unmanned ground capabilities is developed by the combined O-6 Council and is grouped into 3 Tiers, with capabilities in Tier 1 being the most pressing. From this tiered list, individual Service labs and Industry are asked to submit topics for funding consideration that may enable one of the desired capabilities or offset a stated

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deficiency. The submitted topics are then evaluated for technical maturity, feasibility and risk by the TAB members. The JGRE Director develops the JGRE Technology Portfolio from the highest scoring topics. This portfolio is presented to the O-6 Council for review and approval. The O-6 Council can accept the portfolio as presented or request that the JGRE Director make changes. If the JGRE Director and O-6 Council cannot reach an agreement, then it is elevated to the SSG. The final portfolio is presented to the SSG for approval.

The JGRE FY2011 User Focus List consists of the following broad areas, which serve as a basis for prioritizing S&T investments across the services:

- | | | |
|--------|---|--|
| Tier 1 | { | <ol style="list-style-type: none"> 1. Detect/Locate Explosives 2. Remove/Dispose of Explosives 3. Terrain Reconnaissance 4. Transport Warfighter Equipment – Warfighter’s Pack |
| Tier 2 | { | <ol style="list-style-type: none"> 5. Perimeter Security – Outside the Wire 6. Logistics – Vehicle Convoy Assistance 7. Vehicle/Personnel Recovery 8. Battlefield Personnel Recovery |
| Tier 3 | { | <ol style="list-style-type: none"> 9. Handheld/Throwable Reconnaissance 10. Firefighting 11. Logistics – Construction and Repair 12. Logistics – Cargo Handling |

As this joint User Focus List was being developed, the RS JPO worked with its Army and Marine Corps Combat Developer customers in order to identify their priorities in the area of S&T investments. The identified priorities included:

- Longer mission capability
- Greater Line-of-Sight (LOS) and Non-Line-of-Sight (NLOS) communication range
- Autonomous capabilities to lighten the Warfighter load while keeping pace with mounted and dismounted forces
- Modular payloads with “plug and play” architectures
- Autonomous mobility in various terrains at speeds equivalent to manned vehicles using advanced perception
- Capabilities for executing covert and clandestine infiltration
- Interoperability and collaboration with manned and unmanned systems
- Increased mobility and agility
- Autonomous tactical behaviors
- UGS that support counterinsurgency and psychological operations
- Enhanced reliability and availability
- Increased Soldier Robot Control (SRC) ratio with enhanced soldier/machine interfaces and distributed situational awareness
- Weaponized UGS
- Improved Modeling & Simulation (M&S) environments to support UGS testing and validation
- Automatic target identification capabilities
- Capabilities to supplement the medical forces

S&T programs supporting these desired capabilities will be performed by organizations such as the DoD S&T labs and the Robotics Technology Consortium (RTC). The RTC is a consortium consisting of over 200 organizations from industry and academia, and can be awarded funds from the DoD through an Other Transaction Agreement (OTA) contractual arrangement.

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The RS JPO monitors S&T developments within these areas to enable a smooth technology transition into mature systems when appropriate Technology Readiness Levels are reached.

Conclusion

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 3QFY11, 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 UGS.

Any questions or concerns regarding this publication can be directed to robotics.jpo@us.army.mil.

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Acronym List

.....A

AROC.....Army Requirements Oversight Council
 ASA(ALT).....Assistant Secretary of the Army for Acquisition, Logistics and Technology

.....C

CDDCapabilities Development Document
 CDRTCapabilities Development for Rapid Transition
 COPCommon Operational Picture
 CPDCapability Production Document

.....D

DoD.....Department of Defense

.....E

EM.....Electromagnetic
 EODExplosive Ordnance Disposal

.....G

GCSGround Combat Systems

.....H

HPLHigh Power Laser
 HPMHigh Power Microwave

.....I

ICDInitial Capabilities Document
 IEDImprovised Explosive Device
 IOPInteroperability Profile
 IPTIntegrated Product Team

.....J

JAUS.....Joint Architecture for Unmanned Systems
 JCAJoint Capability Area
 JFCJoint Force Capabilities
 JGREJoint Ground Robotics Enterprise
 JIEDDO.....Joint IED Defeat Organization
 JROCJoint Requirements Oversight Council
 JUONS.....Joint Urgent Operational Needs Statements

.....L

LOS.....Line of Sight
 LW&MLand Warfare & Munitions

.....M

M&SModeling and Simulation
 MOA.....Memoranda of Agreements
 MOU.....Memoranda of Understanding

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.....**N**

NAVEODTECHDIV ...Navy Explosive Ordnance Disposal Technology Division
 NLOSNon Line of Sight

.....**O**

OCUOperator Control Unit
 OE.....Operational Environment
 ONSOperational Needs Statements
 OSDOffice of the Secretary of Defense
 OTA.....Other Transaction Agreement

.....**P**

PEOProgram Executive Office
 PM.....Project or Program Manager
 POM.....Program Objective Memorandum
 PoRProgram of Record

.....**R**

RDECOMResearch, Development and Engineering Command
 REFRapid Equipping Force
 RFIRequest for Information
 RS JPORobotic Systems Joint Project Office
 RTC.....Robotics Technology Consortium

.....**S**

S&TScience and Technology
 SAESociety of Automotive Engineers
 SRCSoldier Robot Control
 SSGSenior Steering Group

.....**T**

TABTechnology Advisory Board
 TCMTRADOC Capabilities Manager
 TRADOCTraining and Doctrine Command

.....**U**

UAS.....Unmanned Aircraft Systems
 UGSUnmanned Ground Systems
 UMSUnmanned Maritime Systems

.....**W**

WIPTWorking level IPT