Evolving U.S. Department of Defense (DoD) Unmanned Systems Research, Development, Test, Acquisition & Evaluation (RDTA&E)

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ABSTRACT

As research, development, test, acquisition and evaluation (RDTA&E) of unmanned systems experiences increased attention by the Department of Defense (DoD), elements within the acquisition community are responding by mapping out changes to management systems, including fundamental policy shifts, to support the expanding role of robots on the battlefield. Unmanned systems – air, land, and sea – are increasing in complexity and capability such that their use is becoming pervasive in mission areas such as explosives ordnance disposal and aerial surveillance. This paper reviews the state of unmanned systems RDTA&E within the context of Defense Acquisition, highlighting existing and emerging public policy, relevant acquisition reform, the resulting organizational adaptations, and the success with which one enterprise has brought together the sometimes competing values found within the major elements of the larger acquisition system.

Keywords: Unmanned system, robot, acquisition, public policy, JGRE, DAPA, DoDI 5000.02

1. AN EMPHASIS ON UNMANNED SYSTEMS

Unmanned systems RDTA&E is undergoing a groundswell as the DoD embraces the value of fighting from a distance, with robots being used to keep warfighters out of harm's way while increasing individual and team capabilities through extended sensing and remote manipulation. Both tactics, techniques, and procedures (TTPs) and concepts of operation (CONOPS) are changing to incorporate the use of robots as part of the service member's overall technology toolkit. Over the last 25 years, unmanned systems have moved from basic and applied research laboratory experiments to congressionally mandated technology thrust areas that are receiving increasing budget allocations. As we move into the 21st Century, the nation's focus on acquiring and fielding unmanned systems has never been more intense and its commitment never more clear.[1] In response to the increased operational tempo of robotic acquisitions, the DoD has developed an unmanned systems roadmap that emphasizes coordination amongst the various elements of the defense acquisition system:

> As the Department of Defense (DoD) develops and employs an increasingly sophisticated force of unmanned systems over the next 25 years (2007 to 2032), technologists, acquisition officials, and operational planners require a clear, coordinated plan for the evolution and transition of unmanned systems technology.[2]

Funding for unmanned systems programs is planned to increase from $2.8B in FY08 to approximately $4.0B in FY10.[2] The majority of spending is within the Unmanned Aircraft Systems (UAS) arena as the services expand the use of robots for reconnaissance, surveillance, and target acquisition missions; in FY10, 93% of the total planned unmanned systems budget will be assigned to UAS systems. While there are still few formal acquisition programs of record (the U.S. Army's Future Combat Systems being the most prominent), the number of systems being fielded is increasing quickly. Early Operation Enduring Freedom Rapid Equipping Force fielding of small Unmanned Ground Vehicle (UGV) systems paved the way for considerable investments in robots for explosives ordnance inspection and disposal used extensively in Operation Iraqi Freedom, where the number of systems now stands in the thousands.[3]

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An analysis of standing National and Service strategy documents reveals significant interest in the future development and planned use of unmanned systems. Figure 1 shows the frequency of unmanned systems references in seven key strategic documents. Of the Service strategic plans, the *Army Modernization Strategy 2008* [4] leads in unmanned systems references at 39, while the *U.S. Marine Corps S&T Strategic Plan* [5] trails at seven. Within the Service roadmap documents, the *Naval Transformation Roadmap of 2003* [6] leads in unmanned systems references at 46, while the *Army Transformation Roadmap of 2004* [7] trails at 21. There are 18 references to unmanned systems within the *Quadrennial Defense Review(QDR) Report of 2006* [8] (the QDR of 2001 contained only seven references to unmanned systems). While the reference count is only a cursory indicator of interest in unmanned systems, it represents widespread acceptance at high levels within the Government that unmanned systems are here to stay and that their use is becoming common place in our National defense.

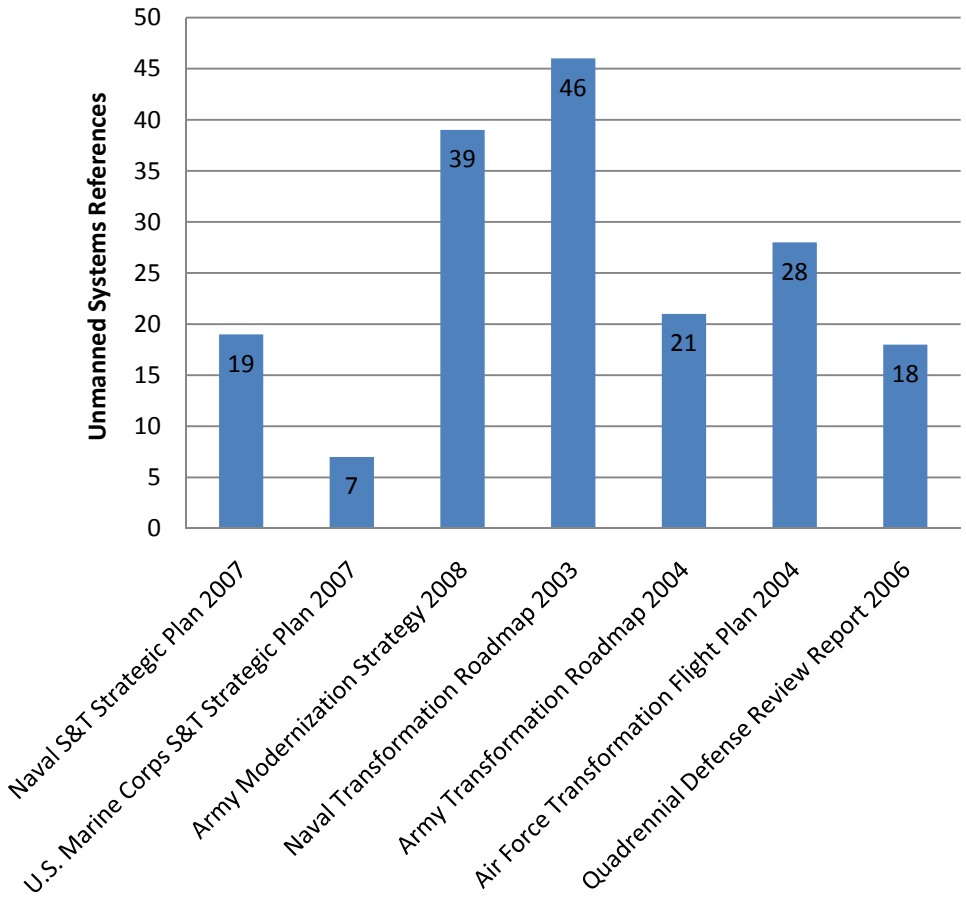

Figure 1. Count of unmanned systems references in key National and Service strategy documents.

2. SUPPORTING PUBLIC POLICY

In support of the growing emphasis on unmanned systems solutions, Congress has passed public law that mandates increased use of robotics by the DoD and that seeks to improve robotics systems acquisition management. Action by Congress is partially a consequence of emerging capabilities offered by advances in technology, and partially the result of a growing concern for coordination and management of on-going unmanned systems programs. Since the late 1980s, policy has been prescribed to focus technology efforts in unmanned systems and to consolidate DoD-related funding

under one agency.[9] Three of the most important pieces of legislation that influence unmanned systems investments today are summarized below:

Public Law 106-398 Section 220 [10] (2001) establishes goals for the fielding of unmanned systems such that:

(1) By 2010, one-third of the aircraft in the operational deep strike force aircraft fleet are unmanned; and
(2) By 2015, one-third of the operational ground combat vehicles are unmanned.

Public Law 109-163 Section 261[11] (2006) required a detailed report on the development and utilization of robotics and unmanned ground vehicle systems by the Department of Defense to include the following elements:

(1) A description of the utilization of robotics and unmanned ground vehicle systems in current military operations.
(2) A description of the manner in which the development of robotics and unmanned ground vehicle systems capabilities supports current major acquisition programs of the Department of Defense.
(3) A description, including budget estimates, of all Department programs and activities on robotics and unmanned ground vehicle systems for fiscal years 2004 through 2012, including the Joint Robotics Program and other programs and activities relating to research, development, test and evaluation, procurement, and operation and maintenance.
(4) A description of the long-term research and development strategy of the Department on technology for the development and integration of new robotics and unmanned ground vehicle systems capabilities in support of Department missions.
(5) A description of any planned demonstration or experimentation activities of the Department that will support the development and deployment of robotics and unmanned ground vehicle systems by the Department.
(6) A statement of the Department organizations currently participating in the development of new robotics or unmanned ground vehicle systems capabilities, including the specific missions of each such organization in such efforts.
(7) A description of the activities of the Department to collaborate with industry, academia, and other government and nongovernmental organizations in the development of new capabilities in robotics and unmanned ground vehicle systems.
(8) An assessment of the short-term and long-term ability of the industrial base of the United States to support the production of robotics and unmanned ground vehicle systems to meet Department requirements.
(9) An assessment of the progress being made to achieve the goal established by section 220(a)(2) of the Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 (as enacted into law by Public Law 106–398; 114 Stat. 1654A–38) that, by 2015, one-third of operational ground combat vehicles be unmanned.
(10) An assessment of international research, technology, and military capabilities in robotics and unmanned ground vehicle systems.
(11) A description of the role and placement of the Joint Robotics Program in the Department.
(12) A description of the mechanisms of the Department for coordinating pre-systems development and demonstration funding for robotics and unmanned ground vehicle systems.

Public Law 109-364 Section 941[1] (2007) establishes a formal policy for the RDTA&E of unmanned systems by the DoD to include:

(1) An identification of missions and mission requirements, including mission requirements for the military departments and joint mission requirements, for which unmanned systems may replace manned systems.

(2) 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.
(3) An assessment of the circumstances under which it would be appropriate to pursue joint development and procurement of unmanned systems and components of unmanned systems.
(4) The transition of unmanned systems unique to one military department to joint systems, when appropriate.
(5) An organizational structure for effective management, coordination, and budgeting for the development and procurement of unmanned systems, including an assessment of the feasibility and advisability of designating a single department or other element of the Department of Defense to act as executive agent for the Department on unmanned systems.
(6) The integration of unmanned and manned systems to enhance support of the missions identified in paragraph (1).

These policies are significant as they reflect a shift in favor of unmanned systems over manned systems. This represents a turning point in the history of robotics with respect to both acceptance of the technology as viable militarily, and in terms of the inferred integration of robotics with current and future military doctrine.

Such policy also sets the stage for increased funding, resulting in increased activity by acquisition agencies and their supporting industrial base – if not well managed and coordinated, the programs built around the expansion of unmanned systems will falter. Additionally, even programs that are well executed, if not successfully integrated with the larger military (acquisition) institution, will again be seen as failures.

3. ACCOMPANYING ACQUISITION REFORM

Evolving public law, bolstered by constant pressures to transform business practices within the DoD, has compelled the Acquisition System to adapt its underlying structures to meet the challenges of advanced technology development in areas such as robotics. Public Law 109-364 indicates that the underlying acquisition systems structure requires improvement in several fundamental functional areas including management, budget, and procurement. This same law emphasizes the need to examine requirements for the use of manned versus unmanned systems, and also for joint use of unmanned systems.

Complementary findings of the Defense Acquisition Performance Assessment (DAPA) Panel of 2006 indicate that the Acquisition System in general is a "disconnected and unstable"[12] institution with divergent organizational values that has driven apart the processes of requirements, acquisition, and budget. The DAPA Panel recommended far-reaching changes in six major elements of the larger acquisition system including organization, workforce, budget, requirements, acquisition, and supporting industry. And although the more drastic recommendations of the DAPA Panel were not adopted (for example, replacing the Joint Capabilities Integration and Development System [JCIDS] process, establishing a stable funding account, establishing four-star acquisition commands), the general message was clear: the DoD Acquisition System (still) needs reform as it tends to work against itself due to a lack of coordination and cooperation brought on by different and competing agendas.

Accompanying charges for acquisition reform were calls by the DoD to operate enterprise-wide instead of with organizational-specific focus. This has lead to the establishment of "portfolios of joint capabilities"[8] that integrate horizontally rather than vertically as stove-piped programs.

In December of 2008, the DoD further redefined the acquisition process through revisions to DoD Instruction (DoDI) 5000.02, which included modifications to terminology, methodology, and systems engineering previously defined in the 2003 instantiation of the Defense Acquisition Management Framework.[13] One of the driving forces behind the acquisition framework change was the desire to put solutions into the hands of the users more quickly. Thus, the two processes of incremental development (end-state known) and spiral development (end-state unknown) as acquisition strategies have been replaced by a single evolutionary process that recognizes up front the need for future capability

improvements that can be delivered as mature, military useful increments (i.e., 80% solutions delivered faster with follow-on improvements as needed).

In terms of impact to unmanned systems RDTA&E, major differences between the 2003 and 2008 versions of DoDI 5000.02 also include changes to the Technology Development Phase, which now entails a mandatory requirement for competitive prototyping of the system or major system components from at least two sources (prior to or through Milestone B). The competitive prototyping requirement is intended to reduce technical risk, validate designs and cost estimates, evaluate manufacturing processes, and refine requirements. These issues have plagued unmanned systems development efforts for 25 years, which is a natural consequence of an emerging technical capability that is not widely understood in terms of its application or integration with existing doctrine (the EOD mission is the exception as it has brought unmanned systems to a state of maturity and acceptance never seen before within the DoD).

4. RESULTING ORGANIZATIONAL RESPONSE

In response to the rising prominence of unmanned systems along with changing public law and the forces of acquisition reform, leaders within the Office of the Under Secretary of Defense (OUSD) established what is now known as the Joint Ground Robotics Enterprise (JGRE). The JGRE was initiated in 1989 as the Joint Robotics Program (JRP) by direction of Congress in order to consolidate the numerous splintered robotics programs within the individual services. In 2006, the JRP was renamed the JGRE in accordance with the shift to enterprise-wide portfolio management as influenced by the Quadrennial Defense Review Report.[8] The JGRE now operates under OUSD, Acquisition, Technology and Logistics (AT&L), Portfolio Systems Acquisition (PSA), Land Warfare and Munitions (LW&M). The enterprise is charged with supporting robotic technologies to close gaps between warfighter requirements and existing capabilities, ensuring coordination between the Services, emphasizing interoperability and commonality among unmanned systems, and supporting the strategic goals of AT&L.[14]

As the lead OSD agency charged with coordinating unmanned systems RDTA&E across the services, in October of 2006, the JGRE addressed reporting requirements under Public Law 109-163 Section 261 by producing a 58 page document, *"Development and Utilization of Robotics and Unmanned Ground Vehicles,"* that covered all 12 elements specified by the legislature.[11] Then in December of 2007, the JGRE published a consolidated Unmanned Systems Roadmap for 2007-2032 that attempted to synchronize the various service-specific unmanned systems master plans and individual roadmaps for air, land, and sea. This interim report was focused on providing future prioritization and funding of systems and technologies. Its primary goal was to "guide military departments and defense agencies toward logically and systematically migrating applicable mission capabilities to this new class of military tools."[2] The 2007 roadmap is scheduled to be replaced by a follow-on document to be released in 2009 that will fully address the concerns of Public Law 109-364 Section 941. As of this writing, the updated 2009 unmanned system roadmap had not been published, but it is expected to be a significant revision to the 2007 document.

Over the last two years, the JGRE has formed a business strategy based upon an institutional perspective that operates around standard processes to identify, vet, and address capability gaps in (ground-based) unmanned systems. A Portfolio Manager coordinates the activities of a three-tier oversight structure consisting of a flag-level Senior Steering Group, an O-6 Council, and a Technology Advisory Board of subject matter experts.[14] By capitalizing upon the changing technological and political landscape, the JGRE has become a model for reform by emphasizing investments in technologies, systems, and capabilities derived from requirements that cut across the services and that flow down from senior executive and military leaders who have responsibility enterprise-wide.

Figure 2 shows the timeline associated with the establishment of the JGRE and the surrounding public policy emergence regulating and influencing unmanned systems RDTA&E. Note that 2006 was the year of the most recent Quadrennial Defense Review – it was a busy year for reform.

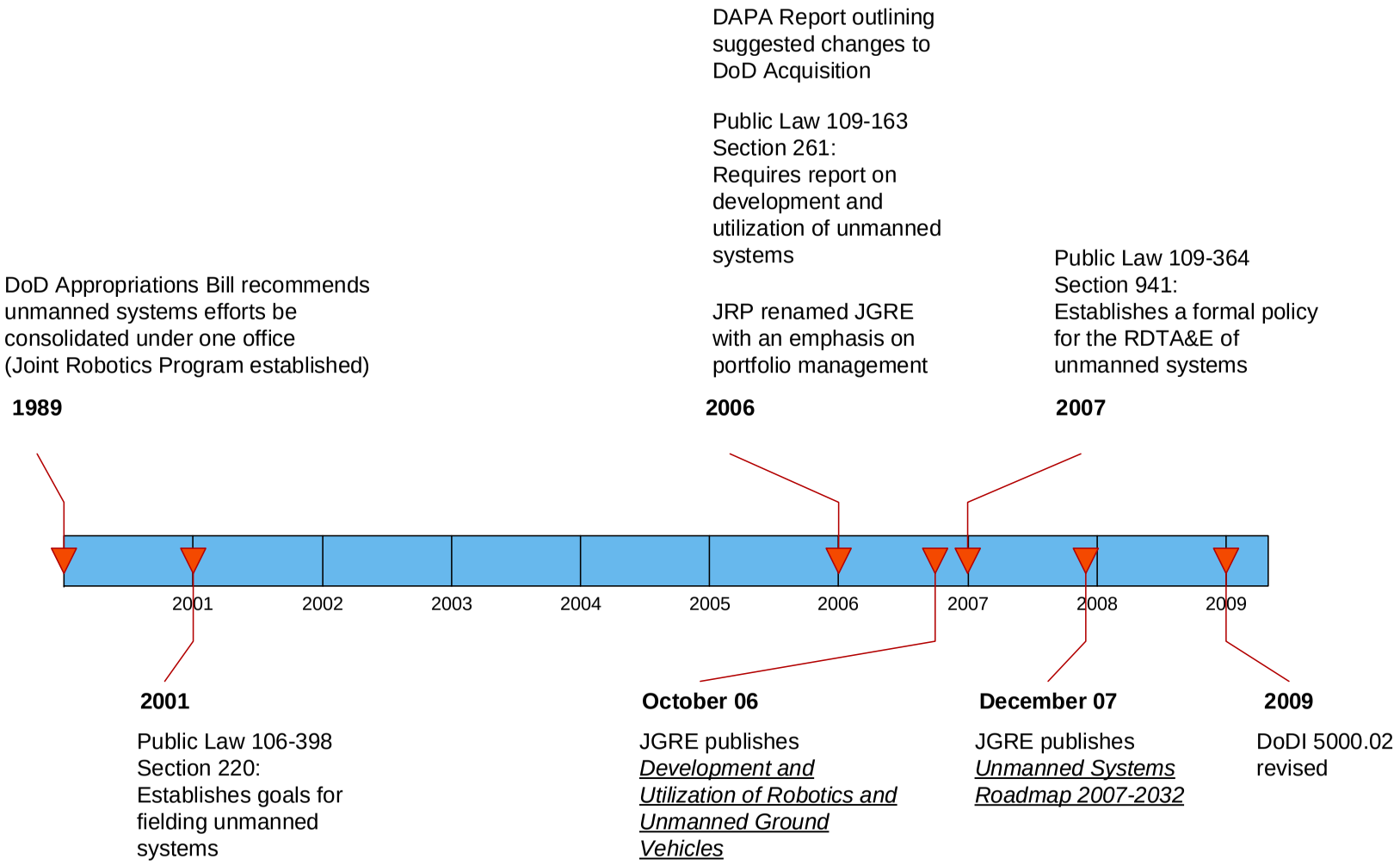

Figure 2: Timeline of relevant events influencing current RDTA&E of unmanned systems.

Organizationally, the enterprise that is the JGRE operates from top to bottom and across the larger acquisition system; agencies that typically are concerned with specific acquisition programs are part of the JGRE, and are supported both financially and technologically by investments from the JGRE. Oversight of JGRE-related programs is concerned not only about compliance and control, but also of results that meet needs.

The supporting **workforce** is comprised of industry partners, academic institutions, and Government laboratories that are highly motivated and energized to be working in the field of robotics. They are seen as team members who hold the subject matter expertise, from which technology solutions arise. JGRE membership is widely available, and the opportunity for input into the on-going processes is not only invited but also highly encouraged. The JGRE community meets at least annually to review project status, to perform technology assessments, and to showcase unmanned systems capabilities. Inclusion provides opportunities for job satisfaction that sometimes escapes other institutional approaches.

The JGRE **budget** is centrally managed and relatively minimal. Yet, as funding in robotics has been paltry over the last 25 years and roboticists understand the power of leveraging, a little goes a long way. Earmarks have supported much of the growth in the available discretionary spending over the last five years. Investments are made through a process that begins with identified capability needs that are vetted from the top down. The process includes input from all stakeholders, which minimizes the "instability that advocacy creates".[12] Competition for funding involves submission of yearly project plans that are linked to user needs or identified technology gaps, and that are vetted through the Technical Advisory Board (TAB). TAB recommendations are further reviewed by the O-6 Council, which then makes final recommendations to the JGRE Portfolio Manager (JGRE Chair) for funding.

Requirements generation is capability-based according to the JCIDS process. As an enterprise, the JGRE looks across the services and then down through the technology board to match capabilities with (potential) solutions. And then, where gaps are identified, the JGRE invests in technology base development to support both quick reaction and longer-term needs. Requirements are also viewed from the bottom up, with technologists providing the "push" where appropriate. Requirements generation, derivation, and capture are also dynamic and responsive – the enterprise is still small enough such that it can provide solutions very quickly to requirements coming from the field.

Acquisition, as represented by "little a"[12] programs, necessarily manage to cost, schedule, and performance. However, because of the larger breadth of concern of the JGRE as an enterprise and its ability to pull from its diverse constituency, acquisition (or more importantly, providing a meaningful capability in a timely manner) can be significantly accelerated. This flexible solutions-provider approach is not intended to side-step formal acquisition, but rather to infuse technology solutions that lead to formal efforts with near-term user evaluation. This evolutionary approach is consistent with revisions to the Defense Acquisition Management Framework stated in DoDI 5000.02 where 80% solutions are desired faster than 100% solutions that may never materialize.

Within the context of the JGRE, **industry** plays a significant role as a team member through a newly formed consortium that provides an opportunity for non-Government organizations to help plan DoD research efforts. This helps industry plan internal R&D investments to better support future DoD needs. Also key among the partners of the JGRE are academic institutions that serve as R&D centers and that also contribute to product development and project execution.

6. CONCLUSION

As investments in unmanned systems grow and robots become commonplace on the battlefield, the supporting RDTA&E of those same systems continues to evolve. Public policy, given developments over the past few years, can be expected to provide further provisions for the use of unmanned systems as both replacements for manned systems and as companions for men and women service members. We have already seen a significant shift in policy that prefers unmanned systems to their manned alternatives.

The Unmanned Systems Roadmap of 2007 and its follow-on document to be released in 2009 have brought together the organizational, technical, and managerial concerns of cross-service robotics RDTA&E. The roadmaps are powerful documents that serve to focus investment and prioritize requirements across application domains.

Reforms in the larger acquisition system have led to the establishment of enterprise-wide solutions to manage unmanned systems RDTA&E. The OUSD JGRE was built upon reforms that sought to consolidate coordination and funding of unmanned systems within the DoD. By adapting to the changing institutional landscape, the JGRE has managed to lessen the impact of diverging values described by the DAPA Panel of 2006.

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