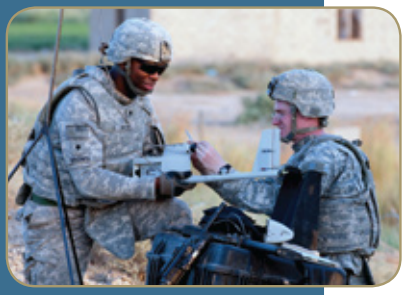


Torchbearer
National Security Report

U.S. Army Unmanned Aircraft Systems: Changing Modern Warfare

An AUSA Torchbearer Issue
July 2010




15 July 2010

"If you are far from the enemy, make him believe you are near," wrote Sun Tzu some 2,500 years ago in *The Art of War*. Today, unmanned aircraft systems, or UAS, allow the U.S. Army to be simultaneously near and far and to roll back the fog of war and distance in which our enemies hide. The complexity and diversity of modern battlefields require better intelligence, faster identification and more precise effects than at any point in history. UAS are rapidly delivering that capability to commanders and leaders in far-flung, dangerous and critically important missions around the globe.

The Army finds itself in the challenging position of having to win current conflicts while remaining prepared for future ones. Fortunately, Army UAS provides multi-echelon, multipurpose intelligence and combat capability, straddling the warfighting spectrum from low to high. Since the first pilot dropped a grenade from a biplane, militaries around the world have sought a more dynamic and responsive link between information and effects. The Army UAS program leads the way with control technology, payloads and cutting-edge platforms. The lag between the Soldier on the ground and supporting fires is shrinking on a daily basis, and the quality and quantity of relevant information available to decisionmakers is increasing as UAS take their place on the battlefield beside traditional operating systems.

This latest installment of AUSA's signature Torchbearer series focuses on the capability and employment of Army UAS in modern conflict. We examine the development, capability, integration and future research efforts that define the extraordinary success of the Army UAS program and highlight areas in which critical support is still needed to continue the evolution of the UAS. We hope that you will find this report a useful base of knowledge for Army UAS as well as a link to the broader context of Army aviation, and that you will continue to look to AUSA for thoughtful, credible analysis of contemporary national security issues.

GORDON R. SULLIVAN
General, USA Retired
President, AUSA

Contents

Executive Summary

As we've seen firsthand through eight years of war, intelligence, surveillance and reconnaissance assets are absolutely critical enablers for the warfighter.

Admiral Michael G. Mullen,
Chairman, Joint Chiefs of Staff*

The current conflicts in Afghanistan and Iraq highlight the complexity, speed and nuance of modern combat overlaid by a constant demand for accurate, timely information. The unmanned aircraft systems (UAS) fielded by the U.S. military are quickly evolving and expanding to fill the information and operational voids created by dynamic and diverse military battlefields. Reflecting the hard-won lessons of combat, the 2010 Quadrennial Defense Review (QDR) reinforced the expansion of the UAS program both implicitly and explicitly with a commitment to excelling in current conflicts and a call for expansion of UAS intelligence, surveillance and reconnaissance (ISR). In this, the U.S. Army leads from the front by integrating UAS capability at the tactical and operational levels, providing unparalleled capability down to its smallest units.

Supporting the technology is a doctrine that embraces the participation, availability and flexibility of the UAS. By formalizing UAS as part of the Aviation Branch, the Army has integrated them into the planning, execution and after-action processes of all echelons. The linchpin to this integration has been making UAS organic to brigade combat teams, rather than attachments or add-on forces. This trust and support of the UAS pilots and operators in a vertical integration grants coherent, tightly orchestrated, synchronized control that can still respond to dynamic re-taskings and mission changes. Vertical integration also provides relevant and timely feedback on procedures and operations, reinforcing the combined-arms team mentality and increasing efficiency.

Ground control and data dissemination are the foundation of the Army UAS mission and fleet; the link between potential and reality, between sensor and shooter. Key to this link are the One System Ground Control Station (OSGCS) and One System Remote Viewing Terminal (OSVRT). The two systems link the operator, the airframe and the ground commander together in a seamless manner through a near-universal interface. The OSGCS variants can control almost all types of UAS the Army fields while the OSVRT receives and displays the corresponding real-time data, telemetry and imagery through a man-portable station. The multi-platform interfaces, supported by a robust enlisted Soldier backbone, allow the rapid dissemination of information and intelligence with a minimum of hardware overhead and organizational lag.

The Army UAS program platform hardware began with humble roots from the 1970s through the Gulf War but has grown over the past two decades to incorporate a family of distinct airframes:

- **MQ-1C Extended Range/Multi-Purpose (ERMP)**, soon to be called Grey Eagle, is the largest and most capable of the Army's UAS, carrying payloads that provide electro-optical/infrared video, target designation, communications relay, synthetic aperture radar/ground moving target indicator, signals intelligence and precision munitions; and 30 mission hours of endurance (24 hours on station at a range of 300 kilometers). ERMP primarily supports divisions.

* Quoted in Amber Corrin, "Future warfare gets funding nod, but little prioritization," Defensesystems.com, 4 March 2010, http://www.defensesystems.com/Articles/2010/03/08/HOMEPAGE-Inside-DOD-intelligence-surveillance-reconnissance.aspx.

- **MQ-5B Hunter** is an enduring UAS airframe that carries payloads providing electro-optical/infrared video, target designation, communications relay and Viper Strike munitions, with approximately 20 hours' endurance. Hunter generally supports corps and divisions.
- **RQ-7B Shadow** is a brigade-dedicated ISR platform with optical/infrared imaging, infrared illumination and laser target designation and six to eight hours' endurance.
- **RQ-11 Raven** is the primary small UAS used to support battalion and below operations. Soldiers hand launch and locally recover. The Army is further examining the concept of a Family of Small UAS that provide the small unit greater flexibility in providing situational awareness.

The Army UAS fleet has expanded rapidly around these airframes. From a bare handful supporting Operations Enduring Freedom and Iraqi Freedom in 2003, today there are around 337 systems and 1,013 aircraft in both theaters. Moreover, the Army owns 61 percent of the total military UAS fleet. The Army has flown more than one million hours, 88 percent of which were executed in combat. The decisive evolution from strictly a surveillance tool into a multi-role combat multiplier along with the substantial corresponding program expansion highlights the pivotal role of the UAS in current and potential future conflicts. The Army is in the process of integrating UAS into combat aviation brigades by replacing OH-58D Kiowa reconnaissance helicopters with Shadow UAS to maximize combat potential and build a full-spectrum team.

A variety of ongoing research efforts, developed through battlefield feedback, will improve Army UAS capability. Manned-unmanned teaming (MUMT) delivers UAS video directly to AH-64 Apache attack helicopters, reducing the sensor-to-shooter lag and enabling faster, more accurate engagements. Work is currently being done to bring MUMT capabilities to other helicopter types. Improvements to the ground control architecture will allow more airframe types to be controlled by one universal control station and allow real-time users to control the UAS sensor payload and customize the "picture" to meet their mission and planning needs.

The Army is also working with the Federal Aviation Administration to allow UAS flights in domestic airspace; the rapid expansion of the UAS program has exceeded existing federal airspace availability. To ensure the safety of domestic aircraft and UAS, the Army is developing a ground-based sense-and-avoid (GBSAA) capability that will allow a UAS to fly in commercial space until another aircraft is detected, at which point it will either return to restricted airspace or land. Furthermore, Performance-Based Logistics provides streamlined, common-core hardware and software to the UAS fleet, reducing maintenance costs and increasing operational readiness through scaled stocking and resupply functions. All told, these advancements in capability and sustainability are vital to the continued evolution of the Army UAS program.

To continue the deployment and development of such a potent tool into the future requires a robust and broad funding package that engages all aspects of the UAS program. Congress and the Department of Defense must not only sustain the current arsenal with adequate funding for ground control suites and current platforms, but also invest in the future. Small, universal control units for the warfighter, domestic airspace expansion, training facilities and interoperability/capability upgrades to existing airframes are required to keep the UAS program operating at full potential; adequate research and development funding must be allocated to allow it to reach technological maturity. In accordance with the 2010 QDR, more UAS capability will ensure that warfighters have access to the tools and combat multipliers they need to win in the complex fight. The investment into current and future UAS capability will ensure the Army remains at the cutting edge of the modern information-centric battlefield.

U.S. Army Unmanned Aircraft Systems: Changing Modern Warfare

The integration of [unmanned aerial vehicles] into the combat forces is paramount.

then Lieutenant General J. D. Thurman,
Deputy Chief of Staff/G-3[1]

Introduction

The complex operations that seem to define today's conflicts place a premium on flexibility and adaptability. Operations span the entire spectrum of conflict, and warfare in the Information Age requires not only unprecedented levels of information but delivery of that information to decisionmakers when they need it. In response, the U.S. Army has made dramatic changes in the way it fights. The integration of unmanned aircraft systems (UAS) has been a critical part of that change.

The Army UAS fleet has grown tremendously in recent years. In March 2003, the Army deployed three UAS, with 13 aircraft, in support of Operation Iraqi Freedom (OIF). Seven years later, some 337 systems and 1,013 aircraft are in the field in Iraq and Afghanistan. Today, the Army owns 61 percent of the total military UAS fleet. The Army has flown more than one million hours, 88 percent of which were executed in combat. Army UAS—"the eyes of the Army"—have proved to be invaluable in combat at the tactical and operational levels of war. The Army is in the process of integrating UAS into combat aviation brigades by combining RQ-7 Shadows and OH-58D Kiowa reconnaissance helicopters in the armed reconnaissance squadron to maximize combat potential and build a full-spectrum team.

The 2010 Quadrennial Defense Review (QDR)—the Department of Defense's (DoD's) every-four-year assessment of the U.S. national defense plans, programs and policies—placed particular emphasis on providing the men and women in the U.S. armed forces with the tools they need to prevail in today's wars. Drawing on lessons learned in combat, the review highlighted enhancements to several capabilities that have been "in high demand and have proven to be key enablers of tactical and operational success."[2] Among the recommendations was a commitment to "[e]xpand manned and unmanned aircraft systems (UAS) for intelligence, surveillance, and reconnaissance (ISR)."[3] The Army is aggressively implementing the QDR guidance.

The Army uses UAS at the operational and tactical levels of war, bringing benefits to units at all echelons. The roles and missions for which UAS are used have evolved in response to the needs

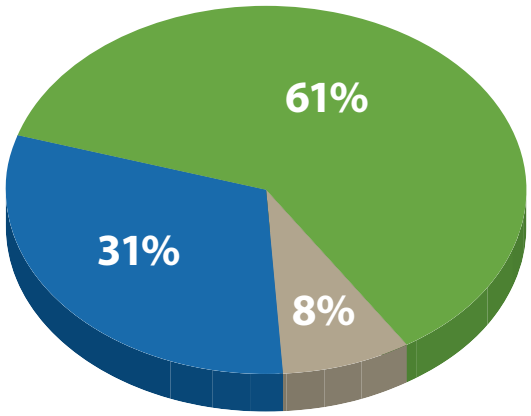
[1] Quoted in Bettina H. Chavanne, "U.S. Army Continues Heavy Focus on UAS," *Aviation Week*, 7 January 2010, http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=aerospacedaily&id=news/asd/2010/01/07/06.xml

[2] Department of Defense, *Quadrennial Defense Review Report*, February 2010, p. 21, http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf.

[3] *Ibid.,* p. 22.




Unmanned Aircraft Systems*



*Does not include small unmanned aircraft systems

Source: Headquarters, U.S. Army Aviation and Missile Command

and experiences of warfighters. As technology has advanced, UAS have become an important part of Army aviation's transformation and modernization to meet current and future full-spectrum requirements. Combat aviation brigades (CABs), the key aviation warfighting units, have as their core assets several types of rotary-wing aircraft: UH-60 Black Hawk (utility); CH-47 Chinook (cargo); AH-64 Apache (attack); and OH-58D Kiowa Warrior (reconnaissance). Also included is a suite of UAS already organic to all Army brigade combat teams (BCTs). UAS consist of dual components—unmanned aerial vehicles and ground control stations (with support equipment) that provide tactical commanders near-real time, accurate reconnaissance, surveillance and target acquisition (RSTA) data. This mission includes weapons, communications relay, specialty payloads and linkage to manned aircraft.

Unmanned aircraft are radically altering many facets of warfare, improving situational awareness, extending command and control and speeding decision cycles. Modern battlefield commanders need to be able to respond faster than their increasingly nimble adversaries. Increasingly, UAS are allowing U.S. commanders to turn inside their opponents' decision cycles and gain the advantage. UAS technology has evolved rapidly; no longer are they seen as little more than high-tech "toys." Rather, they now seem to be part of a momentous change in the way the Army operates, perhaps representing a revolution in military affairs.

The Evolution of Army Unmanned Aircraft Systems

The Army's development of UAS actually began in the 1970s with the Aquila program, which was followed by the larger Hunter UAS in the 1990s. The Hunter system was and continues to be fielded at corps level. In 2002, the Army's BCTs received the Shadow system—the nation's first UAS to pass an initial operational test and evaluation—with lower echelons obtaining the Raven. By 2004, the Army had a complete family of UAS capable of supporting formations from corps to platoon level.

UAS were originally conceived of as an intelligence-gathering and fire-direction asset, and programmatic responsibility for them rested with the Army's Intelligence Center of Excellence (CoE) at Fort Huachuca, Arizona. By 2003, due to the greatly expanded presence of UAS and the need to better integrate them into aviation processes, the Army transferred responsibility to the Aviation CoE at Fort

Rucker, Alabama. This change has better integrated UAS into the Army's aviation and operational doctrine—a participation which had expanded far outside the specialized niche the systems once occupied.

The Army has also developed and was the first to implement a variety of technical innovations for UAS over the past two decades. In the late 1990s, automatic takeoff and landing technology greatly reduced the risk of crashes. The Army's "One System" program, begun in 2001, has produced common control systems for Army UAS. Integration of UAS data feeds and, increasingly, control stations into helicopter cockpits has facilitated manned-unmanned teaming (MUMT). The Army has also integrated simulation software into all UAS for training purposes, realizing cost savings through hardware commonalities and performance-based logistics. Army UAS has an extensive history complemented by dynamic research and a robust development program.

The Army UAS Family

One clear lesson learned through years of UAS operations is that warfighters need a standard and interoperable control system, common to all unmanned airframes. The Army's senior leadership has recognized that the control system is the heart of UAS architecture and has directed a customized approach for its employment. Currently, the Army's ground control stations range in size from a five-ton truck to a handheld computer with an antenna. The Army developed the One System Ground Control Station (OSGCS), which is mounted on a High Mobility Multipurpose Wheeled Vehicle (HMMWV) and can control both the Shadow and the Hunter. The OSGCS has two identical workstations, is NATO Standardization Agreement (STANAG)-compliant and weapons-control capable, and allows interoperable and common control, including common associated data link antennas and ground support equipment. The Army is currently in final development of the Universal Ground Control Station (UGCS) as a successor to OSGCS; UGCS will have

both HMMWV and five-ton truck variants and will allow control of Shadow, Hunter and the MQ-1C Extended Range Multi-Purpose (ERMP), soon to be called Grey Eagle. The Army uses the handheld Small UAS Ground Control Station (GCS) to control smaller UAS.

The Army has already fielded 2,453 One System Remote Video Terminals (OSRVTs), primarily to Soldiers in support of OIF and Operation Enduring Freedom (OEF). The lightweight, laptop-sized OSRVT is used by unit commanders (in many cases not possessing UAS) to receive full-motion video and metadata (positioning information, etc.) from UAS and manned aircraft, and in the future it will allow payload control. A man-portable system with a reception range of 10–50 kilometers (depending on the antenna), it provides enhanced situational awareness with near-real time video and telemetry data from most manned and unmanned platforms,




The U.S. Army Family of Unmanned Aircraft Systems

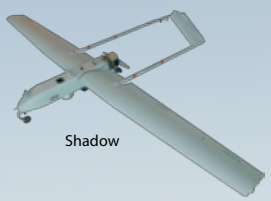
Extended Range Multi-Purpose (ERMP) and Hunter
Day or night, provides corps and below units dedicated far over-the-horizon support for reconnaissance, synthetic aperture radar/ground moving target indicator, target acquisition, communications relay, signals intelligence/attack and target engagement based upon commander's priorities.

Shadow
Day or night, provides brigade and below commanders with dedicated over-the-horizon tactical-level reconnaissance, target acquisition and communications relay based on commander's priorities.

Small UAS (Raven, gasoline Micro Air Vehicle [gMAV])
Day or night, provides small units with organic capability to perform over the hill/in the city reconnaissance and target acquisition. gMAV provides hover and stare capability for complex environments (cities, etc.).


Extended-Range Multi-Purpose Unmanned Aerial Vehicle


Hunter


Shadow


Raven


gasoline Micro Air Vehicle

Air

Ground

One System Ground Control Station
Controls or will soon control all aircraft and payloads (with the Universal Ground Control System) within the Army family. Features a modular and flexible design hardware and software architecture.

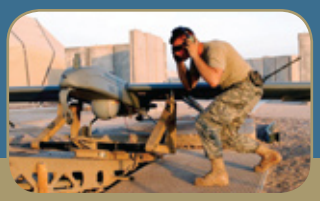
Ground Control Station (GCS) + One System Remote Video Terminal
Laptop-based, provides small units reconnaissance and target acquisition capability. GCS controls SUAS family.


One System Ground Control Station


Ground Control Station


Ground Control Station and One System Remote Video Terminal

Source: Headquarters, U.S. Army Aviation and Missile Command

including Raven, Shadow, Hunter, ERMP, Predator, Warrior Alpha, gasoline Micro Air Vehicle (gMAV), other DoD UAS and even manned platforms such as the Apache helicopter. The OSRVT not only displays UAS information, it can show payload targeting data and location icons on maps. It is a joint solution to enhance multi-service UAS effectiveness and provide a common battlefield picture to users. The system consists of a receiver, modem and antennas, cables, software and an optional extended-range antenna.

The Army currently fields five distinct unmanned aircraft. Although similar in outward appearance to the Predator air vehicle and sharing 15 percent of common components, the ERMP air vehicle's internal components are significantly more advanced and include critical function redundancy. ERMP was designed to provide division commanders and below with dedicated RSTA, attack, command and control, communications relay, signals intelligence and electronic warfare capability. The Army's largest and most capable UAS, the ERMP, addresses ever-increasing demands for range, altitude, endurance and payload flexibility, allowing dynamic mission changes while in flight.

In 2005, the Army decided to field the ERMP with 128-Soldier companies assigned to each of the 10 active Army divisions. The system consists of 12 aircraft with electro-optical/infrared/laser designator (EO/IR/LD), synthetic aperture radar with ground moving target indicator (SAR/GMTI), communications relay and precision weapons (includes up to four Hellfire missiles) as payloads. Ground equipment includes five OSGCSs and associated ground support equipment, to include one Satellite Communication Ground Data Terminal enabling over-the-horizon aircraft control via satellite link. The ERMP features a heavy-fuel engine, 30 mission hours of endurance (24 hours on station at a range of 300 kilometers), Tactical Common Data Link technology (a congressionally mandated encryption link), network connectivity, teaming with manned platforms and redundant flight controls and avionics. Like the rest of the Army's medium and large UAS fleet, ERMP has automatic takeoff and landing

capability and the flexibility to operate with or without satellite communications data links.

Prototypes from the ERMP program (dubbed "Warrior Alpha" and "ERMP Block 0") have been fielded to deployed units as Quick Reaction Capabilities (QRCs) to meet the needs of Soldiers in combat. The first ERMP QRC deployed in April 2009 and is currently being used in operations in Iraq. This early fielding has also provided valuable testing and feedback for the development program. The full-capability ERMP has been approved for low-rate initial production and will field its first unit equipped in Fiscal Year (FY) 2011.

The MQ-5B Hunter provides state-of-the-art RSTA, communications relay, signals intelligence and weapons delivery. With approximately 20 hours of endurance and a range of 200 kilometers, it has a maximum altitude of 18,000 feet. Hunter companies (consisting of five aircraft, three ground control systems and supporting ground equipment) support corps and divisions. The MQ-5B Hunter is distinguished by its two heavy-fuel engines and its "wet" (fuel-carrying) extended center wing with weapons-capable hard points. Its automatic takeoff and landing system is currently being fielded.

The Hunter carries multiple payloads to provide a variety of capabilities on the battlefield, including standard EO/IR/LD sensors, Viper Strike munitions, signals intelligence and communications relay. The Hunter system will be an important part of the Army




UAS family for another decade, after which it will be replaced by the ERMP.

The RQ-7B Shadow provides maneuver commanders a near-real time, highly accurate, sustainable capability for over-the-horizon RSTA. Shadow units are organized by platoon, each consisting of four airframes, two OSGCSs and associated ground support equipment. An airframe can remain on-station for periods greater than six hours at altitudes above 14,000 feet and can carry a variety of payloads such as an electro-optical/infrared (EO/IR) with IR illuminator and laser designator. In 2010, the Shadow is being upgraded with a larger wing, which allows eight hours of endurance and greater payload capability. Shadow was the first U.S. military unmanned aircraft to use an automatic takeoff and landing system.

The U.S. Marine Corps has partnered with the Army for the purchase of Shadow systems, support equipment and Performance-Based Logistics services. This partnership provides efficiencies for cost, commonality and joint operations. As of June 2010, 80 systems (320 aircraft) have been fielded to the Army and nine systems (36 aircraft) to the Marine Corps.

Army Small UAS (SUAS), the RQ-11B Raven systems, provide units at brigade and below—down to platoon and even squad level—with reconnaissance, target acquisition and force protection. A Raven UAS typically contains three airframes with control and support equipment. Raven airframes have an endurance of 90 minutes and can carry either electro-optical or infrared payloads. They are hand-launched and can be flown by any Soldier after a ten-day training course.

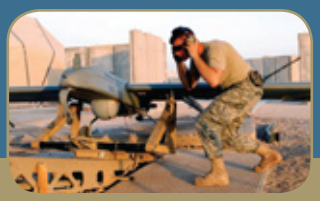
The Army has fielded 1,318 Raven systems (3,954 aircraft) with 291 systems (873 aircraft) currently supporting Soldiers in Iraq and Afghanistan. In addition to being fielded by the Army, the Raven is also being used by the U.S. Special Operations Command, the Marine Corps and the Air Force.

The Army is also experimenting with the gMAV. The 18-pound aircraft offers "hover and stare" capability and 47-minute endurance, allowing it to stay in one place for an extended period of time. Launched from any flat surface, gMAV has an interchangeable electro-optical and infrared payload. Currently, 15 systems (29 aircraft) are in use in OIF by the 2d Infantry Division.

Procurement and use of UAS within the Army has grown dramatically over the past two decades, and that growth continues. Current plans call for approximately doubling the size of the Army's UAS fleet over the next five years. These UAS provide widespread, direct and dedicated support to all Army echelons as they fight.

Army UAS Integration with All Echelons

Some military organizations centralize their unmanned systems in a general support pool. This control scheme relies on planners far from the battlefield to ration assets and make prioritization decisions to the lowest levels—often at the cost of responsive and flexible UAS support in multiple simultaneous combat operations. This can impede ad hoc teaming of manned and unmanned aircraft as the battle unfolds and disrupt unity of command between a commander and his aerial support. Applying battlefield lessons learned, the Army and Marine Corps have organized UAS with their supporting maneuver commands, ensuring effective support and timely re-tasking within each sector.

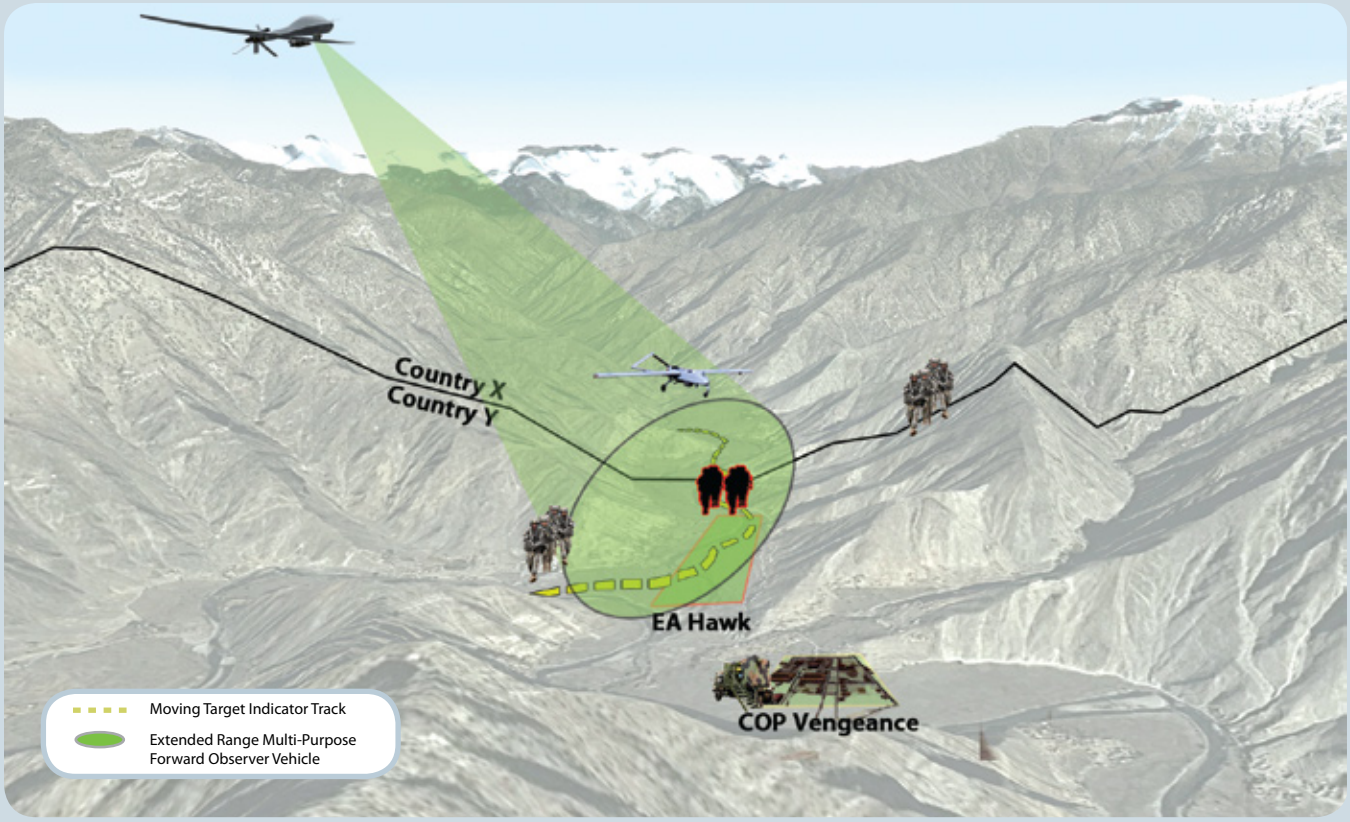
A centralized methodology also separates UAS from the rest of the combined-arms force with which it should be training and operating. In the Army, UAS organic to maneuver units have become an integral part of operations. UAS missions are tightly orchestrated with planned maneuvers at each echelon, and they involve extensive pre-mission planning and synchronization among ground maneuver, UAS units and other Army aviation and joint assets. Army UAS aircrews participate in mission planning, rehearsals, execution and after-action reviews. This tight integration allows for clear and direct control and dynamic re-tasking to support the commander's main effort, providing actionable intelligence and decreasing the time between sensing and shooting.

The Army places great trust in the quality, intelligence and initiative of its enlisted personnel—particularly UAS operators. In the 1990s, the Army recognized that, with proper training (and technology such as automatic takeoff and landing systems), its enlisted Soldiers were fully capable of managing the complex, often intensive, responsibilities of unmanned aircraft planning, control and analysis. This confidence has not been misplaced. More than 2,100 Army operators and 140 enlisted operators from the Marines, Navy and U.S. Special Operations Command have been trained by the Army UAS Training Battalion at Fort Huachuca. Today, approximately 820 enlisted operators worldwide are planning and executing combat missions with large and medium airframes. Enlisted Soldiers (such as infantry and military police) also plan and execute missions with more than 3,000 small UAS airframes.

Employment of Army UAS

The Army has integrated UAS into many mission-types. In their original role, UAS are highly flexible intelligence-gathering assets, able to carry a wide variety of payloads for different missions. They can be redirected quickly, transmit data to multiple users and are quiet and unobtrusive compared to manned aircraft. Technical improvements are adding to UAS ability to process data onboard



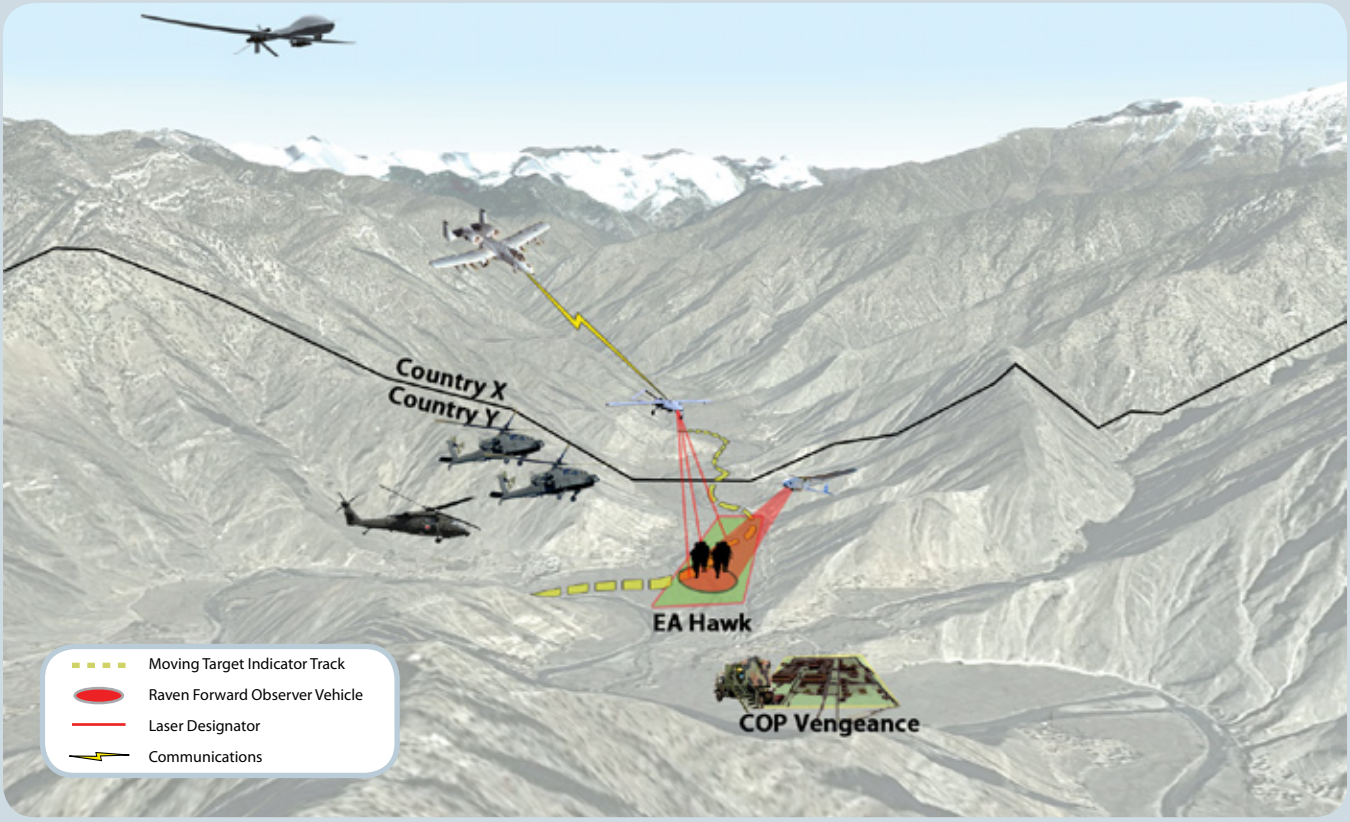


In the figure above, the 10th Division's 1st Brigade Combat Team (1BCT) is defending an area along an international border region to interdict enemy forces coming into their area of operations and to secure key terrain. While conducting a three-day surveillance operation along the border, a 10th Division ERMP detects possible enemy infiltration across the border from ground moving target indicator (GMTI) sensors on the airframe. Data analysis indicates heavier movement in larger-than-normal groups. The ERMP data is communicated to BCT and division tactical operations centers. The BCT's Alpha Company, 1st Battalion, 1st BCT conducts routine patrols within the valley and establishes low-level voice intercept operations to monitor movements. A human intelligence (HUMINT) team reports an increase in enemy movement and a potential attack on Combat Outpost (COP) Vengeance. Company A establishes an observation post and engagement area to provide early warning for the COP and potentially engage the enemy as they traverse the mountain pass. 1BCT allocates a Shadow UAS, a quick reaction force (QRF, comprising two AH-64 Apache attack helicopters, two CH-47 Chinook transport helicopters and one UH-60 Black Hawk medical evacuation helicopter) and an M119 artillery battery—to support actions at the COP.

and provide greater value to Soldiers. But UAS do far more than gather intelligence.

The surveillance and reconnaissance provided by UAS also greatly improve the ability of Soldiers and units to maneuver on the battlefield. Having "eyes in the sky" allows maneuver formations to keep track of enemy movements and more easily coordinate with neighboring units. This reduces the risks of unexpected contact with the enemy or friendly fire. To achieve these advantages, integration with maneuver forces is vital and a variety of platforms is necessary to appropriately match capabilities with the needs of maneuver formations.

UAS are invaluable in supporting force protection and fires. They can loiter over fixed bases or operating areas for hours at a time or follow convoys



In the figure above, an Air Force A-10 close air support patrol and QRF AH-64 Apache gunships position themselves to provide support if needed. The Company A observation post launches a Raven UAS and observes a large organized force moving through their engagement area (EA Hawk) in the mountain pass toward the COP. The enemy engages the observation post and Company A breaks contact and returns to COP Vengeance. The QRF AH-64s and the UH-60 medical evacuation (MEDEVAC) helicopter launch to support the observation post's MEDEVAC and exfiltration needs. The Shadow assumes responsibility for observing the engagement area and acquiring targets for the A-10 close air support as well as artillery fires.

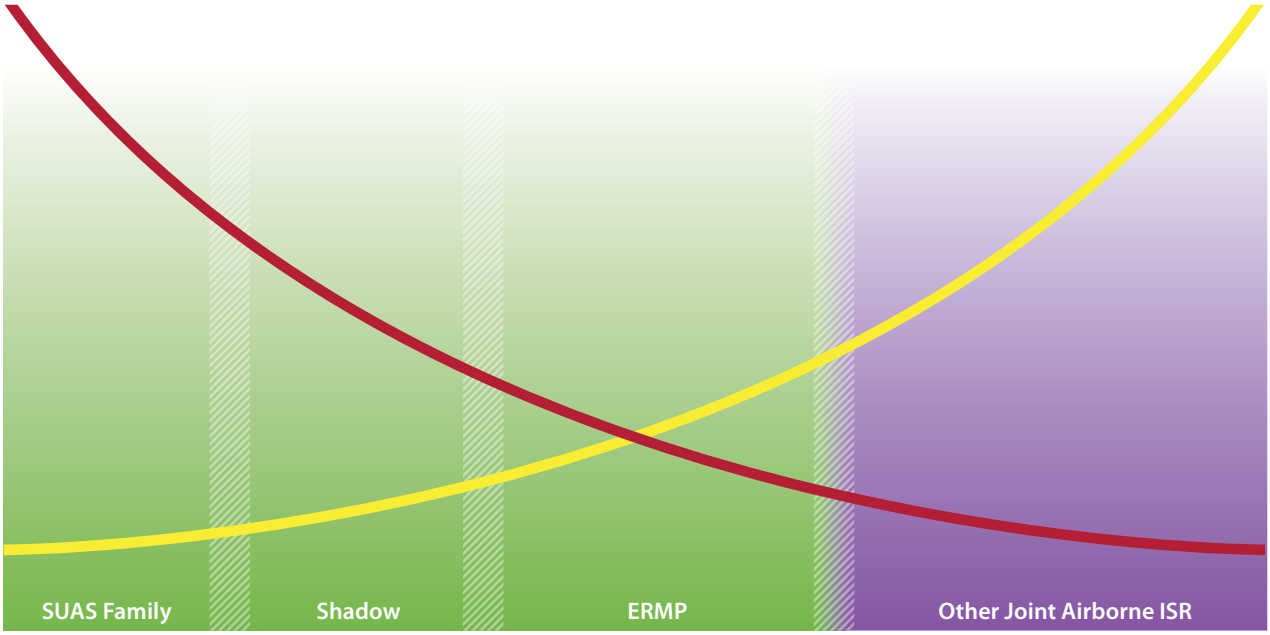
Source: Headquarters, U.S. Army Aviation and Missile Command

for long distances, providing uninterrupted surveillance. They can scout ahead, providing information on terrain and identifying hazards. UAS provide target recognition, tracking and laser-designating, significantly shortening the sensor-to-shooter response time. With a weapons payload, they can deliver effects directly, including non-lethal fires such as electronic warfare. And because they are unmanned, UAS can be used for high-risk missions without exposing Soldiers to hostile fire.

Other uses are emerging from technology development efforts. UAS data connectivity allows the Army to extend its reach across the battlefield. According to General Martin E. Dempsey, Commanding General, U.S. Army Training and Doctrine Command,




Risk vs. Time to Plan by Echelon



Source: Headquarters, U.S. Army Aviation and Missile Command

> [T]o operate effectively under conditions of uncertainty and complexity in an era of persistent conflict, leaders must understand the situation in depth, adapt the actions of their formations to seize and retain the initiative, and be capable of rapid operations over extended distances.[4]

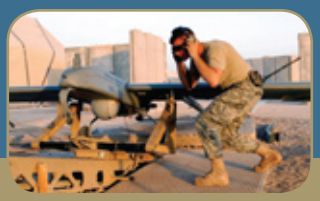
The expansion of ISR capabilities provided by UAS enables the collection of more information than ever before and its dissemination to more users faster than previously imagined. While UAS are not able to lift the "fog of war," they make peering through it far easier. This increased information and the improved speed and flexibility that UAS offer in accomplishing Army missions are changing the way the Army fights and even the way warfighters conceive of their missions. Properly integrated into Army formations, highly capable UAS have the potential to revolutionize ground warfare.

The Future of Army UAS

The Army has been at the forefront of UAS employment and technical advances in the past. Examples include:

- implementation of technologies supporting automatic takeoff and landing;

[4] U.S. Army UAS Center of Excellence, *'Eyes of the Army': U.S. Army Unmanned Aircraft Systems Roadmap 2010–2035*, April 2010, Foreword, p. i, http://www.rucker.army.mil/usaace/uas/US%20Army%20UAS%20RoadMap%202010%202035.pdf.

- adoption of control system architectures common between Army aircraft and those of the other services;
- refinement of manned aircraft and UAS teaming;
- development of a family of small UAS;
- development of a high-fidelity simulator capability for individual UAS and for the total UAS family;
- development of ground-based sense and avoid technologies to increase access to national air space; and
- sustainment and commonality efficiencies.

Army technical advancements will continue to improve UAS capabilities. Ongoing and future technology enhancements include:

- signature reduction;
- supervisory control of multiple systems;
- advanced vertical takeoff and landing capabilities;
- collision avoidance;
- survivability improvements;
- weaponization;
- autonomy;
- advanced manned/unmanned teaming;
- small heavy-fuel engines; and
- communications relay and extension.

Additionally, sustainment/cargo UAS will emerge as a capability to deliver sustainment support to Soldiers in hard-to-reach locations or where use of manned aircraft is not feasible. All of these advancements are in concert with the Army's overall enhancements to network centricity.

Common control system and architecture. Along with airframes and their payloads, control station capabilities determine unit structure, training and doctrine. Quickly and seamlessly transferring control of aircraft and distributing sensor information—regardless of the airframe being used—is critical to the maneuver force at all echelons. As early as 2001, the Army embarked on the "One System" program to ensure control systems of all Army UAS airframes were interoperable. The goal was to avoid having each different UAS controlled by a unique, proprietary system. This effort required changes in acquisition strategy, industrial relationships, hardware and software architecture and the development of a set of common integration profiles and standards, defined and enforced across all Army UAS. The result has been a set of interoperable and common control systems being fielded to the Army, Marine Corps and U.S. Special Operations Command. Multiple types of unmanned aircraft are controlled from the Army's OSGCS, while video and data are delivered to command posts, vehicles, helicopter cockpits and even individual Soldiers (via the OSRVT) with seamless efficiency.

The OSGCS is being improved and upgraded to the Universal Ground Control Station (UGCS), which will be able to control additional airframes the OSGCS currently cannot. The UGCS is also part of the BCT modernization program. SUAS Ground Control Stations, interoperable with One System and Universal GCS architecture, will be upgraded to control unmanned ground vehicles, allowing small-unit commanders to carry a single "unmanned controller" rather than several different controllers.

OSRVT is being upgraded from Level 2 interoperability (receipt and display of imagery and data directly from the aircraft without filtering or processing) to Level 3, which includes Level 2 and also allows control of the payload but not control of the aircraft. This added bidirectional connectivity means real-time users of UAS data (small units, helicopters, Abrams tanks, etc.) can be given control of their supporting sensor payloads and customize the "picture" to their planning and execution needs. A single Army UAS control architecture allows rapid integration of new capabilities and will be needed for future UAS capabilities, such as advanced information analysis/dissemination and autonomy.




Manned-unmanned operations. Battlefield experience has shown that teaming of manned and unmanned aircraft enhances combat power in ways far exceeding the additive value of either airborne system individually. The most inefficient "sensor-to-shooter" lag time was between manned and unmanned aircraft. Sensor information was transmitted from a UAS to a sensor operator, through a command post processor, then to a helicopter, crossing multiple, sometimes incompatible, systems. To solve this problem, the Army developed a new version of the OSRVT, the Manned-Unmanned Teaming-Level 2 (MUMT-2), which delivers video from UAS directly into the cockpits of AH-64 Apache helicopters. Development work is being done to extend this capability to other helicopters and to increase the level of control being delivered.

Small UAS. Starting with the Raven in 2003, the Army has developed a variety of small UAS, all using One System software. Having a variety of small, medium and large airframes allows units to choose the right size aircraft for the mission—larger for longer endurance and range, smaller with vertical lift for urban areas—all controlled by the same handheld device. Having one common controller will also reduce the load that Soldiers have to carry. The concept is currently being demonstrated by the 101st Airborne Division (Air Assault) as a proof of principle. For this demonstration the 101st has been augmented with Puma (larger), Raven (medium) and Wasp (smallest) airframes.

The Army is also developing a larger, longer-endurance version of the gMAV, currently known as the Class I. It has a single, integrated gimbal consisting of an electro-optical camera, infrared camera, laser range finder and laser designator. The Class I Block 0 is in development and testing as part of the spin-out of new technologies from the BCT modernization program.

Access to domestic airspace. As the UAS fleet has grown, the military's needs for airspace for development, training and deployment have grown; the restricted airspace available above federal lands is no longer sufficient. In conjunction with the Federal Aviation Administration (FAA), the Army is taking steps to allow UAS limited use of domestic airspace alongside manned aircraft. To ensure safety, the Army is developing a ground-based sense-and-avoid (GBSAA) capability that will allow an unmanned aircraft to fly in a monitored volume of airspace until another aircraft penetrates the airspace. Using sensors (currently ground radar) to feed information to automated systems and the unmanned aircraft operators, GBSAA will move unmanned aircraft to a safe state (either returning to restricted airspace or landing) when a manned aircraft is detected. GBSAA is being developed for all services, and plans call for fielding an initial capability within the next year. The Army plans to develop the technology further, eventually placing it on the aircraft to improve total ground- and air-system effectiveness. Sense-and-avoid technology should someday allow UAS safe, near-unfettered access to domestic airspace.

Sustainment savings. The Army has also found innovative solutions in the crucial area of UAS support. Roughly two-thirds of the procurement and sustainment cost of a UAS pays for ground-based equipment; the actual airframe and payload account for only one-third. Especially for medium and large UAS, the Army has made great progress in fielding hardware and software that is common across platforms, realizing economies of scale and decreasing the logistical burdens of training, stocking and resupplying. Using the Shadow system as the test

case, Army UAS has also proved the concept of Performance Based Logistics (PBL).[5] Continual refinement has led to a dramatic reduction in the cost to support UAS. Successful PBL implementation in the Shadow program has reduced annual maintenance costs from 10 percent to just 4.5 percent of procurement cost in recent years. The Army has extended the concept to small UAS and ERMP systems. The PBL strategy has consistently produced readiness rates of over 90 percent while supporting an operational tempo (flight hours) of up to three times the originally planned system requirement.

Rapid upgrade integration. The Army is continuing to demonstrate its rapid integration capability for new systems components, payloads and techniques for immediate battlefield use. To accelerate this capability, the Army opened the new Rapid Integration and Acceptance Center at Dugway Proving Ground in Utah. This center has the airspace, expertise and aircraft not only for the Army but also for all services, academia and industry to demonstrate and improve capabilities.

What Is Needed

The Army has a plan—*'Eyes of the Army': U.S. Army Unmanned Aircraft Systems Roadmap 2010–2035*—to focus UAS growth, thereby increasing utility and effectiveness for the warfighter.[6] This roadmap provides an overview of planned growth to 2035 using DoD's guiding principles.

Despite their deep integration into, and widespread effects on, Army operations, UAS are still a very young technology. Research and development is continuing at a furious pace, constantly incorporating lessons learned on the battlefield; the rate of technological advancement is much faster than with more mature technologies. Although many consider UAS to be much cheaper than manned aviation systems, the Army needs a steady flow of research, development, test and evaluation (RDT&E) funding to best support the warfighter's UAS needs. ERMP, Shadow and Small UAS all require sufficient RDT&E dollars each year to develop technological maturity.

Continued investment in control systems and supporting architecture is especially important. Most of the cost of a given system is not for the airborne platform but for the ground-based portions that control and sustain the aircraft and collect and disseminate the data it collects. If these pieces of the system are made common and interoperable, they can be reused even as the aircraft are replaced, retired or attrited. Just as important is the continued development of analysis and dissemination tools that filter UAS data into usable formats and displays for commanders and units. One important aspect of this dissemination is the need to continue the proliferation of tools such as OSRVT and its follow-on, bidirectional OSRVT, to units.

Computer storage and analysis systems have also become an area of great need. UAS in Iraq and Afghanistan have gathered thousands of hours of digital video, and forensic techniques developed to combat improvised explosive devices have proved the value of storing that video for later access. However, computer systems are straining to hold these vast amounts of data and disseminate them to many potential users. And technology to allow quick, easy searching and analysis of digital video is still in its infancy.

Fielded Army ground control stations for Hunter, ERMP and Shadow systems include advanced UAS training software for training aircrew operators. As units return from deployment, there will be a growing demand for training facilities, simulators and access to airspace for training purposes. To meet this need, the Army will require some military construction, development and procurement funding for

[5] For a brief explanation of PBL and links to additional documentation, see http://en.wikipedia.org/wiki/Performance_Based_Logistics.

[6] U.S. Army UAS Center of Excellence, *'Eyes of the Army': U.S. Army Unmanned Aircraft Systems Roadmap 2010–2035*, April 2010, http://www.rucker.army.mil/usaace/uas/US%20Army%20UAS%20RoadMap%202010%202035.pdf.




improved simulators, along with selective policy changes by the FAA for access to national airspace.

Recent DoD and Joint Staff decisions have validated the Army's requirements for organic UAS and direct battlefield control at all echelons. It is critical that this understanding, and the relationships that fostered it, be maintained. Congressional support for Army UAS is also vital, and procurement funding must continue to flow. Army units need the capabilities UAS offer as quickly as possible, and systems previously fielded need the upgrades that have been developed.

What Must Be Done

The Army's UAS program is critical to current and future operations. The situational awareness and precision attack capabilities provided by Army UAS are among the most critical combat multipliers found on the battlefield. Unmanned aircraft systems are vitally important to the battlefield commander's ability to conduct decisive operations without placing Soldiers' lives at risk. Current operations in Iraq, Afghanistan and elsewhere continue to highlight the need for these invaluable assets. UAS capability and numbers need to continue to grow, providing Soldiers and commanders the best tools possible to guarantee their safety and success. Continued development and procurement of new unmanned aircraft are essential to meet the demand for the capabilities these systems provide.

To ensure the Army can continue to provide this critical capability and prepare for the future, Congress and DoD must:

- support the Army's need for organic UAS and their direct battlefield control from small units through the corps level;
- support the Army's efforts to work with the FAA to provide UAS with safe, routine access to domestic airspace for training and other purposes;
- fully fund the development of vertical take off and landing UAS;
- accelerate funding of interoperability programs such as Universal Ground Control Station and One System Remote Video Terminal and its bidirectional version, proliferating the Army's UAS control architecture;
- continue to fully fund the improvements to and fielding of the Extended Range Multipurpose System;
- fund limited upgrades and full sustainment for the Hunter system until it is fully replaced by ERMP systems;
- fully fund development upgrades to the Shadow program (both airframes and ground equipment) and provide procurement funding to accelerate the fielding of upgrades throughout the force;
- fully fund the Small UAS Family of Systems concept, providing small-unit leaders with a tailorable toolkit of airframes and the ability to control unmanned ground vehicles to best support the mission—whether on open plains, in mountains or in an urban environment.

Torchbearer Message

Warfare in the modern era is characterized by complexity and ambiguity. Military operations span the full spectrum of conflict and demand adaptability on the part of leaders and warfighters. Nearly a decade of operations in Iraq and Afghanistan has taught the U.S. Army many lessons, among them the need for fast, reliable collection and dissemination of information on the battlefield. Unmanned aircraft systems (UAS) provide exceptional value in meeting these needs.

Although still quite new, UAS technology is already revolutionizing the way the Army fights. Army UAS combine the capabilities of the persistent view of an area, precise target designation, instant assessment of attack results and rapid destruction of fleeting targets.

The Army has integrated UAS into many combat functions and all echelons of command. The increased capabilities UAS bring have dramatically increased the situational awareness and battlefield effectiveness of Army forces. UAS continue to evolve at a furious pace; the battlefield functions as a laboratory, feeding back into the rapid technology cycle that is constantly improving UAS capabilities and refining the doctrine that guides their use.

Although relatively low in cost compared to manned aviation systems, each UAS requires a constant flow of research, development, test and evaluation (RDT&E) dollars to continue developing new and better capabilities. Steady procurement funding is also essential to expand the Army's UAS fleet—so deployed units can be supplied with the hardware they need to succeed in today's conflicts—and to prepare for the future. The Army must maintain the critical balance between providing a superior UAS fleet to today's combatant commanders and preparing for tomorrow's conflicts.

The Extended Range Multipurpose (ERMP) system, Shadow and Small UAS each require the RDT&E dollars to fully mature their respective technologies and the procurement dollars to field the advancements. To this end, continued and accelerated funding for the ERMP and for critical upgrades to Shadow and the family of SUAS is crucial. Equally vital is further funding for ground control and data dissemination tools such as the One System Remote Video Terminal and the Universal Ground Control Station. And a whole host of planned technical advancements must also be funded. *'Eyes of the Army': U.S. Army Unmanned Aircraft Systems Roadmap 2010–2035* lays out a 25-year plan for the future of Army UAS, and this ambitious plan must be supported.

The Army also needs congressional support to ensure continued assignment of Army UAS to combat units. The Army's decision to allocate UAS to almost every echelon (corps through platoon) means leaders requiring support can quickly task or re-task assets to meet their needs. Other relationships must be assiduously maintained, such as growing cooperation with the Federal Aviation Administration to allow UAS safe access to domestic airspace.

In two decades, the Army's "eyes in the sky" have gone from "gee-whiz" gadgets to vital battlefield assets. They have proved their value in hard-fought combat and have paid back the investments made in them many times over. Leaders across the Department of Defense have acknowledged their value and called for increased investments in UAS. Those investments will save Soldiers' lives. They are owed no less.

There have been many technologies introduced during this eight-and-a-half years of war. However, I don't think any has made a greater impact than UAS [unmanned aircraft systems].

General Peter Chiarelli,
Vice Chief of Staff, Army*

* Quoted in Kelly Pate, "UAS Roadmap, full-spectrum CABs hot topics at Army Aviation convention," Army.mil News, 15 April 2010.

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