

UNMANNED SYSTEMS: OPERATIONAL CONSIDERATIONS FOR THE 21ST
CENTURY JOINT TASK FORCE COMMANDER AND STAFF

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Joint Planning Studies

by

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ABSTRACT

UNMANNED SYSTEMS: OPERATIONAL CONSIDERATIONS FOR THE 21ST CENTURY JOINT TASK FORCE COMMANDER AND STAFF, by MAJ Ronny A. Vargas, 95 pages.

The Fiscal Year (FY) 2001 National Defense Authorization Act (NDAA) signed into law a mandate directing the Department of Defense (DoD) to develop and procure Unmanned Systems through FY 2030. These unmanned air, ground, and sea systems are being designed to support Full Spectrum Operations (FSO) in a hybrid-threat environment. The impact for the 2020 Joint Task Force (JTF) is that it will operate with unmanned systems that will revolutionize the way it conducts its operations. Furthermore, the 2020 JTF will be required to leverage cutting-edge information technologies that will ensure a secure and collaborative command and control network in a security environment that is increasingly competitive due to the proliferation of advanced unmanned systems. The challenge then is to posture the 2020 JTF to integrate these revolutionary unmanned systems. The essential tasks are to ensure operational reach and establish operational access throughout operations which are increasingly ready to be accomplished with revolutionary unmanned systems in lieu of manned systems.

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ACRONYMS

AFRL	U.S. Air Force Research Laboratory
AI	Air Interdiction
ARCIC	Army Requirements Capabilities Integration Center
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CBP	Complex Battle Position
CBRNE	Chemical, Biological, Radiological, Nuclear, and High Yield Explosives
CCDR	Combatant Commander
DARPA	Defense Advanced Research Projects Agency
DIOCC	Defense Intelligence Operation Coordination Center
DCJ2	Deployable Joint Command and Control Systems
DoD	Department of Defense (also DOD)
EOD	Explosive Ordnance Disposal
FY	Fiscal Year
GCS	Ground Control Station
GFMAP	Global Force Management Allocation Plan
IR&D	Industry Independent Research and Development
ISR	Intelligence, Surveillance, and Reconnaissance
JCA	Joint Capability Area
JCIDS	Joint Capabilities Integration and Development System
JCSE	Joint Communications Support Element
JCTD	Joint Capabilities Technology Demonstration
JDT	Joint Deployable Team

JECC	Joint Enabling Capabilities Command
JFC	Joint Force Commander
JFCC-ISR	Joint Functional Component Command for Intelligence, Surveillance and Reconnaissance
JIAC	Joint Interagency Coordination Group
JIIM	Joint, Interagency, Intergovernmental, and Multi-national
JROC	Joint Requirements Oversight Council
JSCP	Joint Strategic Capabilities Plan
JTF	Joint Task Force
JUTL	Joint Universal Task List
JWE	Joint War Fighting Experiments
MUM	Manned-Unmanned Teaming
NDAA	National Defense Authorization Act
NIE	Network Integration Evaluation
ONR	Office of Naval Research
OSD	Office of the Secretary Defense
QDR	Quadrennial Defense Review
UAS	Unmanned Aircraft System
UAV	Unmanned Aircraft Vehicle
UCAS	Unmanned Combat Air System
UGS	Unattended Ground Sensor
UGV	Unmanned Ground Vehicle
UMS	Unmanned Systems
USV	Unmanned Surface Vehicle
UUV	Unmanned Underwater Vehicle

RJP	Ready JEC Package
RSJPO	Robotic System Joint Program Office
R&D	Research and Development
WMD	Weapons of Mass Destruction
WMD-E	Weapons of Mass Destruction - Elimination

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CHAPTER 1

INTRODUCTION

We must recognize that we are living in a machine age and in interest of national defense ‘cut its cloth’ accordingly . . . in the commercial world, the machine has largely replaced manpower; we to the fullest degree must use machines in place of manpower in order to occupy and hold without terrific losses.¹

— *Cavalry Journal*, January 1930

The Fiscal Year (FY) 2001 National Defense Authorization Act (NDAA) signed into law a mandate directing the Department of Defense (DoD) to develop and procure Unmanned Systems through FY 2030.² These unmanned air, ground, and sea systems are being designed to support Full Spectrum Operations (FSO) in a hybrid-threat environment. The impact for the 2020 Joint Task Force (JTF) is that it will operate with unmanned systems that will revolutionize the way it conducts its operations. Furthermore, the 2020 JTF will be required to leverage cutting-edge information technologies that will ensure a secure and collaborative command and control network in a security environment that is increasingly competitive due to the proliferation of advanced unmanned systems.³ The challenge then is to posture the 2020 JTF to integrate these revolutionary unmanned systems. The essential tasks are to ensure operational

¹“Mechanized Force Recommended,” based on recommendations by the 1930 War Department Mechanized Development Board. *Cavalry Journal* 39 no. 1 (January 1930): 112. Ft. Leavenworth CARL Library, Microfiche section; 2361 Armor, v. 37-43. January 1928-December 1934 reel.

²National Defense Authorization Act for Fiscal Year 2001, Public Law 106-398, Section 220, U.S. Statutes at Large 114 (2001).

³Chairman, Joint Chiefs of Staff, *Chairman’s Strategic Direction to the Joint Force* (Washington, DC: Government Printing Office, 6 February 2012), 6.

reach and establish operational access throughout operations which are increasingly ready to be accomplished with revolutionary unmanned systems in lieu of manned systems.

Background

The FY2001 NDAA, in conjunction with the FY2007 NDAA, provides DoD with guidance on unmanned systems. The key points that the documents emphasize are, (1) identifying a preference for unmanned systems in acquisitions of new systems, (2) addressing joint development and procurement of unmanned systems and components, and (3) transitioning Service unique unmanned systems to joint systems as appropriate.⁴

The 2006 Quadrennial Defense Review (QDR) further identified four national security challenges for the 21st century. These challenges will require future joint platforms with (1) greater reach (independent reach), (2) greater persistence (ability to loiter over the target area), (3) improved stealth (ability to survive in contested airspace), and (4) improved networking (ability to operate within a joint multidimensional network).⁵ In order to address these challenges the Department of Defense (DoD) invests heavily within Research and Development (R&D) Directorates. The lead R&D directorate for the Department of Defense is the Defense Advanced Research Projects Agency (DARPA), which focuses on creating multi-disciplinary innovative technologies

⁴Department of Defense, *FY 2009-2034 Unmanned Systems Integrated Roadmap* (Washington, DC: Government Printing Office, 2009), 4.

⁵These four challenges are: defending the homeland in depth; fighting the long war against radical extremists and defeating terrorist networks; preventing state and non-state actors from acquiring or using weapons of mass destruction; and hedging against the rise of a power or powers capable of competing with the United States militarily, <http://www.csbaonline.org/publications/2008/06/carrier-based-unmanned-combat-air-system/> (accessed 26 November 2011).

to support the operational commander. Other R&D stakeholders are the Office of Naval Research (ONR) that focuses on producing revolutionary capabilities for the U.S. Navy (USN) and the U.S. Marine Corps (USMC); the U.S. Air Force Research Laboratory (AFRL) is responsible for the Air Force's Science and Technology Program; the USMC War Fighting Laboratory, Office of Science and Technology (OS&T) serves as the Office of the Secretary Defense (OSD) office of record for the Joint Capabilities Technology Demonstration (JCTD) program and Joint Testing and Evaluation (JT&E).

The unmanned systems developed by these R&D directorates not only address the challenges highlighted in the 2006 QDR, they also focus on three critical additional areas: first, reducing risks to the Service members while operating across the operational domains; second, replacing prolonged and mundane workloads performed by Service members; and third, enabling unprecedented operational capabilities throughout the air, ground and sea operational domains. In other words, the future operational capabilities from these revolutionary unmanned systems will support full spectrum superiority, which consists of persistent intelligence, surveillance, and reconnaissance (ISR) requirements, full-dimensional security, precise enemy engagement from extended standoff ranges, and unmanned sustainment operations/support with minimal forces on the ground. Due to the revolutionary speed and capabilities becoming available to employ UMSs across the operational domains (air, ground, and sea), the capability of seizing, retaining, and exploiting the initiative will dramatically facilitate the 2020 JTF throughout its operations.

The surest way to achieve decisive results is to seize, retain, and exploit the initiative. Seizing the initiative dictates the nature, scope, and tempo of an operation . . . commanders use initiative to impose their will on an enemy or

adversary or to control a situation. Seizing, retaining, and exploiting the initiative are all essential to maintain the freedom of action necessary to achieve success and exploit vulnerabilities.⁶

Primary and Secondary Research Questions

The following research questions will assist in focusing the research to be conducted: The primary research question is will the 2020 JTF be postured to utilize mandated unmanned systems? The secondary research questions will be (1) what future training will be required for the JTF to employ UMSs? and (2) how will the incorporation of robust UMS capability impact the organization of a JTF in 2020?

Assumptions

There are three assumptions that are considered in developing the framework of this thesis. First, that DoD continues to regard the benefits from employing UMSs demonstrated in OIF/OEF for future operations. Second, that DoD continues to regard UMSs as a vital platform in providing persistent ISR and strike capabilities to the JTF in lieu of manned aerial systems. Finally, that the U.S. Congress, domestic industry, and Academia continue to support DoD's vision on UMS Research and Development (R&D).

Definition of Key Terms

The following definitions are based on *the Autonomy Levels for Unmanned Systems (ALFUS)* Framework developed by the National Institute of Standards and Technology (NIST).⁷ The document was produced by the Federal Agencies Ad Hoc

⁶Department of the Army, Field Manual (FM) 3-0, *Operations* (Washington, DC: Government Printing Office, 2008), Appendix A, A-1.

⁷Federal Agencies Ad Hoc Autonomy Levels for Unmanned Systems Working Group Participants, *Autonomy Levels for Unmanned Systems (ALFUS) Framework*,

Autonomy Levels for Unmanned Systems Working Group. The working group consisted of unmanned systems professionals from government agencies and their supporting contractors on a voluntary basis. The intent is to develop a lexicon for unmanned systems (definitions not based on the ALFUS framework will be cited with the corresponding source).

Anti-access. Refers to those long –range capabilities and actions to prevent an opposing force from entering an operational area. Also known as A2 (Joint Operational Access Concept, version 1.0, 17 January 2012, Executive Summary, i).

Area-denial. Refers to those short-range actions and capabilities designed to limit freedom of action within the operational area. Also known as AD (Joint Operational Access Concept, version 1.0, 17 January 2012, Executive Summary, i).

Autonomous. Operation of an unmanned system (UMS) wherein the UMS receives its mission from the human and accomplishes that mission with or without further human-robot interaction (HRI). The level of HRI, along with other factors such as mission complexity, and environmental difficulty, determine the level of autonomy for the UMS.

Autonomous Collaboration. The ability of a UMS to collaborate with one or more manned vehicles or UMS without the need for an external controlling element.

Classifications. The “R” is the DoD designation for reconnaissance aircraft. The “M” is the DOD designation for multi-role, and “Q” means unmanned aircraft system. The number “1, 2, 3 . . .” refers to the aircraft series of remotely piloted aircraft systems.

Volume I: Terminology Version 1.1, edited by Hui-Min Huang, National Institute of Standards and Technology, September 2004, www.nist.gov/el/isd/ks/upload/NISTSP_1011_ver_1-1.pdf. (accessed 20 September 2011).

Additionally, a change in designation from “RQ-1” to “MQ-1” signifies the addition of armament, i.e. the AGM-114 Hellfire missiles (Author interpretation).

Fully Autonomous. A mode of operation of an UMS wherein the UMS is expected to accomplish its mission, within a defined scope, without human intervention.

Human Assisted. The type of HRI that that refers to situations during which human interactions are needed at the level of detail of task plans, i.e., during the execution of a task.

Human Delegated. The type of HRI that refers to situations during which human interactions are mainly at the task level.

Human Robot Interaction/Interface (HRI). The activity by which human operators engage with UMSs to achieve the mission goals. The Operator is the role assumed by the person performing remote control or teleoperation. The Supervisor monitors one or more robots with respect to progress on the mission, can task the robot(s) at the mission level, monitors mission progress, provides mission level directions, coordinates missions, and can assign an operator to assist a robot if needed. A commander would be an example of a person who performs the supervisor-only role.

Human Supervised. The type of HRI that refers to situations during which humans play the monitoring role and human interactions are mainly at the mission level.

ISR. (Intelligence, Surveillance, and Reconnaissance) An activity that synchronizes and integrates the planning and operation of sensors, assets, and processing,

exploitation, and dissemination systems in direct support of current and future operations. This is an integrated intelligence and operations function.⁸

Joint Capability Areas (JCAs). Collections of like DoD capabilities functionally grouped to support capability analysis, strategy development, investment decision making, capability portfolio management, and capabilities-based force development and operational planning (J7- Joint Concepts to Capabilities Division (JCCD) JCA 2010 Refinement approved 8 April 2011, <http://www.dtic.mil/futurejointwarfare/jca.htm>).

Methods of Control. The interface, either software or hardware, such as a joystick, waypoint selection via a map interface, natural language, hand signals, etc., that operators use to control a UMS.

Operational Access. The ability to project military forces into an operational area with sufficient freedom of action to accomplish the mission (Joint Operational Access Concept, version 1.0, 17 January 2012, Executive Summary, i).

Operational Reach. The distance and duration across which a unit can successfully employ military capabilities. The limit of a unit's operational reach is its culmination point (ADRP 3-0, 22 September 2011, 4-5).

Remote Control. A mode of operation of a UMS wherein the human operator, without benefit of video or other sensory feedback, directly controls the actuators of the UMS on a continuous basis, from off the vehicle and via a tethered or radio linked control device using visual line-of sight cues, in this mode, the UMS takes no initiative and relies on continuous or nearly continuous input from the user.

⁸Chairman, Joint Chiefs of Staff, Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: Government Printing Office, as amended through 15 November 2011), 171.

Robot/Robotic. An electro-mechanical system that can react to sensory input and carry out predetermined missions. A robot is typically equipped with one or more tools or certain capabilities, including knowledge so that it can perform desired functions and/or react to different situations that it may encounter.

Semi-Autonomous. A mode of operation of a UMS wherein the human operator and/or the UMS plan(s) and conduct(s) a mission and require various levels of HRI.

Sensor. Equipment that detects, measures, and/or records physical phenomena, and indicates objects and activities by means of energy or particles emitted, reflected, or modified by the objects and activities.

Sensor Fusion. A process in which data, generated by multiple sensory sources, is correlated to create information and knowledge. Sensor information, when fused, may yield immediately actionable combat information and/or intelligence. The capabilities are of four essential types: *Detection, Classification, Recognition, and Identification.*

Sensory Processing. Computing processes that operate either on direct sensor signals or on low-level sensory signatures to detect, measure, and classify entities and events and derive useful information, at proper resolutions and at levels of abstractions, about the world. Sensory processes can be organized hierarchically with proper relative spatial and temporal resolutions and organized horizontally with assigned but coordinated focuses.

Teaming. A method of operation where a system uses the combined sensing, information exchange, decision-making, and acting capabilities of humans and robots function together to carry out missions within the planned scope. In the situations of manned–unmanned teaming, air-to-ground teaming means that the manned system is in

the air with UMS on the ground. Similarly, there could be air-to-air, ground-to-ground, and ground-to-air types of teaming.

Teleoperation. A mode of operation of a UMS wherein the human operator, using video feedback and/or other sensory feedback, either directly controls the actuators or assigns incremental goals, waypoints in mobility situations, on a continuous basis, from off the vehicle and via a tethered or radio linked control device . In this mode, the UMS may take limited initiative in reaching the assigned incremental goals.

Telepresence. The capability of a UMS to provide the human operator with some amount of sensory feedback similar to that which the operator would receive if he were in the vehicle.

Tether. A physical communications cable or medium that provides connectivity between an unmanned system and its controlling element that restricts the range of operation to the length of the physical medium.

Unmanned System (UMS). An electro-mechanical system, with no human operator aboard, that is able to exert its power to perform designed missions. May be mobile or stationary. Includes categories of unmanned ground vehicles (UGV), unmanned aerial vehicles (UAV), unmanned underwater vehicles (UUV), unmanned surface vehicles (USV), unattended munitions (UM), and unattended ground sensors (UGS). Missiles, rockets, and their sub munitions, and artillery are not considered unmanned systems.

Limitations

The thesis framework is the following; first, it will not be a detailed unmanned system capability brief; the intent is to focus on the impact of these various systems on

the ability of the 2020 JTF to conduct operations. Second, an analysis of a revolution of military affair (RMA) is outside the scope this paper. Finally, the topics and research will remain unclassified and will not relate information, capabilities, or missions that have been classified otherwise.

Significance

The continued development of unmanned systems will revolutionize the operational capabilities of the 2020 JTF. First, it will continue to impact the entire doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) analysis process. Most important for this thesis are organization and training. Second, a full spectrum superiority concept as outlined in Joint Publication (JP) 3-03, *Joint Interdiction*, can be achieved through the employment of unmanned systems throughout the entire joint area of operation in lieu of manned systems (see figure 1).

The cumulative effect of dominance in the air, land, maritime, and space domains and information environment (which includes cyberspace) permits the conduct of joint operations without effective opposition or prohibitive interference.⁹

The significance of continuous UMS development for all leaders was aptly reflected in a statement by the US Forces Command (FORSCOM) commander, General (GEN) David M. Rodriguez, that “in my first 20 years in the Army we probably got about

⁹Chairman, Joint Chiefs of Staff. Joint Publication (JP) 3-03, *Joint Interdiction* (Washington, DC: Government Printing Office, 14 October 2011), I-10.

20 to 30 new systems . . . in the 15 months [in Afghanistan], when I was a division commander, I got 172 new ones.”¹⁰

Third, with the accelerated development and proliferation of unmanned systems, our allies and foreign militaries are procuring or developing their own unmanned systems programs. This proliferation of UMSs will impact the risk for the 2020 JTF throughout its operations, thereby creating an emphasis on counter-UMS mitigation considerations.

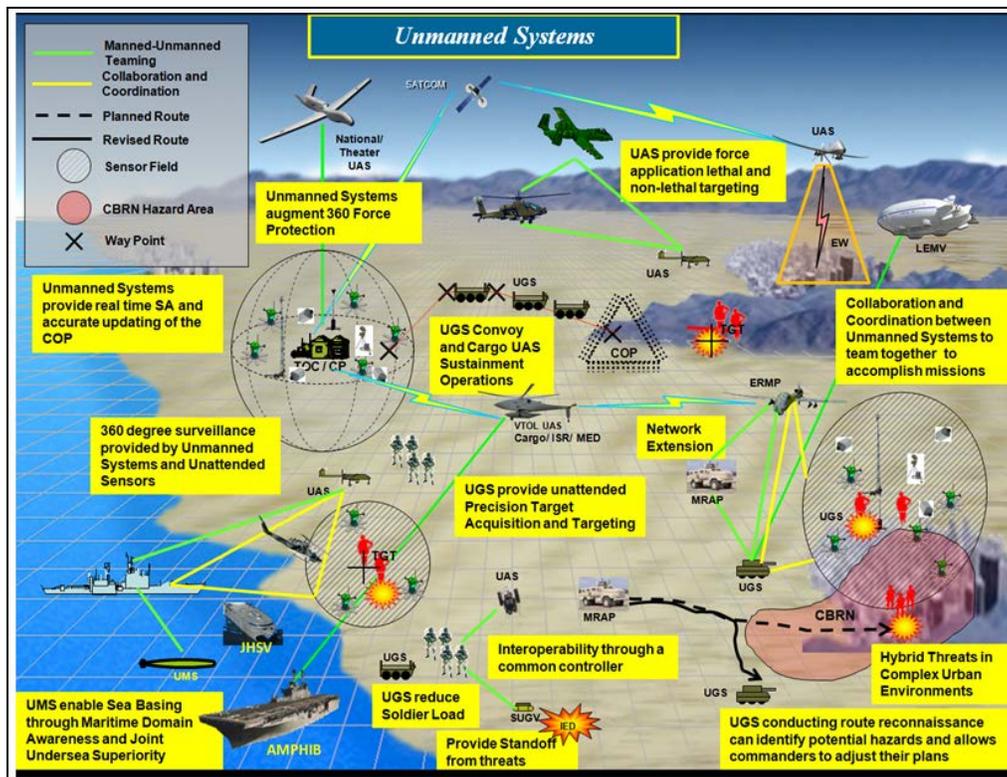


Figure 1. Example of a UMS Full Spectrum Dominance Concept (Unclassified)

Source: Maneuver, Aviation and Soldier Division, “Initial Capabilities Report for Unmanned Systems (Air, Ground, and Maritime),” prepared for a Material Development Decision, draft version 2.2 (Fort Monroe, VA: 2010), Appendix A.

¹⁰Associated Press, “New FORSCOM boss: Soldiers to be spread thin,” *Army Times*, 26 September 2011, 25.

CHAPTER 2

LITERATURE REVIEW

The purpose of this thesis is to answer the primary research question: Will the 2020 JTF be postured to utilize mandated unmanned systems? The following literature review will assist in this research by focusing on the major concepts of unmanned systems in order to establish a common understanding of their capabilities and employment considerations.

The breakdown for this chapter is as follows: (1) reviews the base documents and the NDAA's that establish the mandate for DoD unmanned systems acquisition and development; (2) identifies the Service's UMS roadmaps and major programs; (3) highlights Joint DoD publications that establish the doctrinal framework for establishing a JTF; (4) investigates academic publications that provide justification for the incorporation of UMS throughout military operations; and (5) provides an overview of UMS proliferation both adversary and friendly.

Why is DoD investing in Unmanned Systems?

The Fiscal Year (FY) 2001 National Defense Authorization Act (NDAA) mandated DOD to develop and procure unmanned Systems thru FY2030. It mandated two requirements that (1) by 2010, one-third of the aircraft in the operational deep strike force aircraft fleet are unmanned and that (2) by 2015, one-third of the operational ground combat vehicles are unmanned. It further instructed DoD to provide a description and assessment of the acquisition strategy for unmanned advanced capability combat aircraft and ground combat vehicles planned. This report will include a detailed estimate

of all research and development, procurement, operation, support, ownership, and other costs required to carry out such strategy through the year 2030.¹¹

The impact to the 2020 Joint Task Force is that it will operate in a foreseeable hybrid-threat environment with unmanned systems that will revolutionize the way it executes its missions. The complexity of this hybrid-threat environment will require the Joint Force Commander (JFC) and his staffs to collect, analyze, and disseminate information thru an integrated battle command systems network integrated with unmanned systems.¹² The DoD *Unmanned Systems Integrated Roadmap: FY2011-2036* provides a centralized source for DOD's vision for unmanned systems.

The DOD vision for unmanned systems is the seamless integration of diverse unmanned capabilities that provide flexible options for Joint War fighters while exploiting the inherent advantages of unmanned technologies, including persistence, size, speed, maneuverability, and reduced risk to human life. DoD envisions unmanned systems seamlessly operating with manned systems while gradually reducing the degree of human control and decision-making.¹³

Joint Capabilities Areas (JCA)

The Department of Defense (DoD) established JCAs as the preferred method to manage UMS capabilities. Each JCA represents a collection of related missions and tasks

¹¹National Defense Authorization Act for Fiscal Year 2001, Public Law 106-398, Section 220, U.S. Statutes at Large 114 (2001).

¹²Maneuver, Aviation and Soldier Division, "Initial Capabilities Report for Unmanned Systems (Air, Ground, and Maritime)," prepared for a Material Development Decision, draft version 2.2, (Fort Monroe, VA: 2010), 2.

¹³Department of Defense, *Unmanned Systems Integrated Roadmap, FY2011-2036* (Washington, DC: Government Printing Office, October 2010), 3.

that are typically conducted to bring about the desired effects associated with that capability.¹⁴ Table 1 highlights the density of UMSs to their respective JCA's.

Table 1. UMS by JCA and Domain

Unmanned Systems by JCA and Domain Numbers of Named Systems					
Battlespace Awareness	84	Corporate Management & Support	1	Logistics	28
▪ Air	30	▪ Air	0	▪ Air	6
▪ Ground	38	▪ Ground	1	▪ Ground	22
▪ Maritime	16	▪ Maritime	0	▪ Maritime	0
Building Partnerships	32	Force Application	42	Net-Centric	18
▪ Air	6	▪ Air	22	▪ Air	8
▪ Ground	18	▪ Ground	10	▪ Ground	10
▪ Maritime	8	▪ Maritime	10	▪ Maritime	0
Command & Control	20	Force Support	20	Protection	66
▪ Air	8	▪ Air	2	▪ Air	11
▪ Ground	12	▪ Ground	18	▪ Ground	42
▪ Maritime	0	▪ Maritime	0	▪ Maritime	13

Source: Department of Defense, *FY2009–2034: Unmanned Systems Integrated Roadmap* (Washington, DC: Government Printing Office, 2009), 8.

Battle space Awareness (BA) is focused primarily on ISR which utilizes the Tasking, Production, Exploitation, and Dissemination (TPED) process to translate the sensor data into a common picture. Current platforms that support BA are the Predator, Reaper, and RQ-4 Global Hawk. The immediate requirement for BA ISR platforms is to operate with full autonomy extending their persistence capabilities from days to weeks across all of the domains.¹⁵

Force Application (FA) is focused on maneuver and engagement. Current UAV platforms that support force application are the Predator, Reaper, and MQ-1C Gray Eagle. The immediate end state for UGVs is to support and execute dismounted offensive

¹⁴Ibid., 16.

¹⁵Ibid.

operations, armed reconnaissance and assault operations. In maritime operations, unmanned surface vehicles (USVs) and unmanned underwater vehicles (UUVs) will support mine countermeasures (MCM), anti-submarine warfare (ASW), maritime domain awareness (MDA) and maritime security (MS).¹⁶

Protection platforms will assist in force protection (FORCEPRO), to include assuming tasks that are determined to be “dirty, dull, and dangerous.” The immediate end state is for fully autonomous platforms to assume responsibility for FOB security, obstacle construction/breach, sophisticated explosive ordnance disposal, and casualty extraction and evacuation.¹⁷

Logistics is suitable for the employment of UMSs to deploy, distribute, and resupply units.¹⁸ In March 2010 the A160T Hummingbird unmanned helicopter successfully completed a cargo delivery demonstration under a U.S. Marine Corps War Fighting Laboratory contract. The demonstration proved the Hummingbird’s ability to resupply frontline troops operating in restrictive terrain. The A160T Hummingbird exceeded all of the demonstration requirements, being able to deliver at least 2,500 pounds of cargo from one simulated FOB to another located 75 nautical miles away under the required six hours.¹⁹ Furthermore, a detachment from Marine Unmanned Aerial Vehicle Squadron 1 from Twenty-Nine Palms, California, completed the first combat of a

¹⁶Ibid., 17.

¹⁷Ibid., 17.

¹⁸Ibid., 17.

¹⁹“A160T Hummingbird unmanned helicopter proves resupply capability for U.S. Marines,” <http://www.armybase.us/2010/03/a160t-hummingbird-unmanned-helicopter-proves-resupply-capability-for-u-s-marines/> (accessed 28 December 2011).

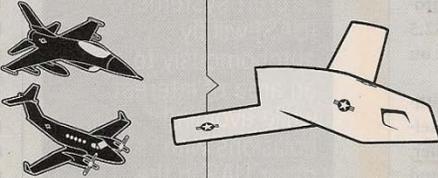
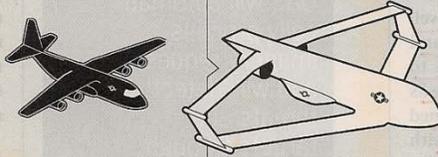
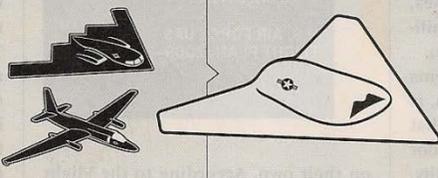
K-MAX helicopter to deliver 3,500 pounds of food and supplies from Camp Dwyer, Afghanistan, to Combat Outpost Payne in Helmand province.²⁰ This platform and capability are in accordance with the Army's Logistics Innovation Agency's desire to develop unmanned cargo aircraft within the next 7-10 years, with an emphasis placed on the autonomy in its development.²¹

U.S. Air Force

At the outset of the Global War on Terrorism (GWOT), the UAS became the weapon of choice. The U.S. Air Force's *Unmanned Aircraft Systems Flight Plan 2009-2047* envisions a networked family of UASs. These next generation UASs will operate autonomously and provide an exponentially improved degree of operational capabilities which will be managed by the designated Joint Force Air Component Commander (JFACC), a role traditionally carried out by the USAF. These systems will consist of a common airframe and will perform varied tasks traditionally executed by manned platforms, such as attacking enemy air defenses, operating as an airborne warning and control aircraft (AWACs), and long-range bombers. Ultimately, the end state will be to reduce the logistical footprint and requirements of fixed wing formations (see figure 2).

²⁰James K. Sanborn, "UAV delivers cargo in first warzone run," *Marine Corps Times*, 31 December 2011, <http://www.marinecorpstimes.com/news/2011/12/marine-uav-delivers-cargo-in-first-warzone-run-123111/> (accessed 1 January 2012).

²¹Michael Hoffman, "Army seeks industry help in developing unmanned cargo aircraft," *Army Times*, 19 December 2011, 30.

PRESENT		FUTURE
<p>F-16 FIGHTING FALCON This oft-upgraded multirole warplane has proved itself in dogfights and air strikes since 1979.</p> <p>MC-12W LIBERTY In 2009 this plane began flying battlefield surveillance missions.</p>		<p>MULTIMISSION UAV Medium-size UAVs will swap onboard gear and weapons to intercept communications, bomb ground targets or fight enemy aircraft. This year the Pentagon will select a design for a 2015 replacement of the MQ-9 Reaper.</p>
<p>KC-135 STRATOTANKER This 136-foot airplane can offload 6500 pounds of jet fuel per minute but fills only one airplane tank at a time. The average age of the Air Force's fleet of tankers, flying since 1957, is now more than 40 years.</p>		<p>JOINED-WING AERIAL REFUELING UAV A box-wing UAV could fuel many airplanes at the same time and loiter, perhaps for a week, until needed. The Pentagon is spending more than \$40 billion on manned refuelers, but unmanned tankers could be built to service UAVs.</p>
<p>B-2 SPIRIT Since 1989, this stealth bomber's mission has been to attack well-guarded ground targets.</p> <p>U-2 DRAGON LADY This unarmed, high-altitude recon airplane, in service since 1957, can fly 12-hour missions.</p>		<p>LONG-RANGE SURVEILLANCE BOMBER This stealth UAV could monitor a target for days—and then destroy it at the time of a commander's choosing. The Air Force hopes to restart its bomber program this year; the new aircraft will likely be able to fly with or without a pilot.</p>

AIRCRAFT NOT TO SCALE

Figure 2. Non-DoD Manned and Unmanned UAV concept comparison

Source: Popular Mechanics, “Air Strike 2025, The Radical Plan to Reinvent the Air Force,” March 2010, 59.

The U.S. Air Force’s (USAF) vision for medium sized UASs (MQ-M) by 2020 is designed on a common platform and will contain an enhanced autonomous networked system. The MQ-M will evolve from the current medium-sized unmanned aircraft, Predator and Reaper, and it includes three phases of development, MQ-Ma, MQ-Mb, and MQ-Mc. In the first phase, the MQ-Ma’s will be designed as a networked all weather platform supporting electronic warfare (EW), Close Air Support (CAS), Strike, and multi-intelligence (multi-INT) ISR missions. Additionally, the MQ-Ma allows for the flexibility to be controlled from mobile ground control stations. In the second phase, the MQ-Mb will merge capabilities from the MQ-9 Reaper and MQ-Ma in order to provide a

wider spectrum of capabilities, which include Suppression of Enemy Air Defenses (SEAD) , Air Interdiction (AI), Special Operations (SOF) ISR, and the ability to conduct unmanned air refuel (see figure 3).²²



Figure 3. MQ-1 Predator in-flight refuel exercises circa 2007

Source: Popular Mechanics “Air Strike 2025, The Radical Plan to Reinvent the Air Force,” March 2010, 59.

The advanced autonomous MQ-Mb will utilize SWARM technology which will allow multiple MQ-Mb aircraft to cooperatively operate at the control of a single pilot.²³

²²United States Air Force, *United States Air Force Unmanned Aircraft Systems Flight Plan: 2009-2047* (Washington, DC: Government Printing Office, 18 May 2009), 39.

²³On 18 August 2011, Boeing announced the successful autonomous communications and operation of dissimilar unmanned aerial vehicles (UAV), which communicated using a Mobile Ad Hoc Network and swarm technology developed by Johns Hopkins University Applied Physics Laboratory. Swarm technology is similar to how insects communicate and perform tasks as an intelligent group. The UAVs worked together to search the test area through self-generating waypoints and terrain mapping, while simultaneously sending information to teams on the ground,

Finally, the MQ-Mc will possess the full spectrum of capabilities to assume manned system capabilities, such as Defensive Counter Air (DCA), Strategic Attack, Missile Defense and SEAD.

The U.S. Air Force vision for large-sized UASs (MQ-L) by 2020 will leverage autonomous capabilities and will also undergo three phases of development. In the first phase, the MQ-La will incorporate high resolution imaging Synthetic Aperture Radar (SAR) and Ground Moving Target Indicator (GMTI) capabilities, advanced signal intelligence (SIGINT) capabilities, and will operate in conjunction with the RQ-4 Global Hawk in multi-INT ISR missions. Furthermore, the USAF will design these platforms to replace manned battle management command and control (BMC2) platforms such as Joint Surveillance and Target Attack Radar System (JSTARs) and Airborne Warning and Control System (AWACS). Second phase, an all-weather MQ-Lb will be a multi-mission endurance aircraft providing ISR, EW, BMC2, and lift capabilities. In the third phase, the MQ-Lc will serve as the foundation for all missions requiring a large aircraft platform, such as air mobility, airlift, air refueling, EW, multi-INT ISR, Strategic Attack, Global Strike, CAS, and Air Interdiction operations.²⁴

In summary, the USAF UAS Road Map supports the 2020 JTF essential tasks of providing operational reach and establishing operational access throughout its operations. The ability to accomplish these tasks with the projected unmanned systems in lieu of manned systems is in accordance with responsibilities outlined in JP 3-33, *Joint Task*

<http://uavbusinessreview.com/2011/08/26/boeingswarmtechnology> (accessed on 15 November 2011).

²⁴United States Air Force, *United States Air Force Unmanned Aircraft Systems Flight Plan*, 39.

Force Headquarters (see figure 4). Additionally, the JFACC is further responsible for ensuring that all of the elements in the Theater Air-Ground System (TAGS) are in place prior to the commencing of joint operations.²⁵

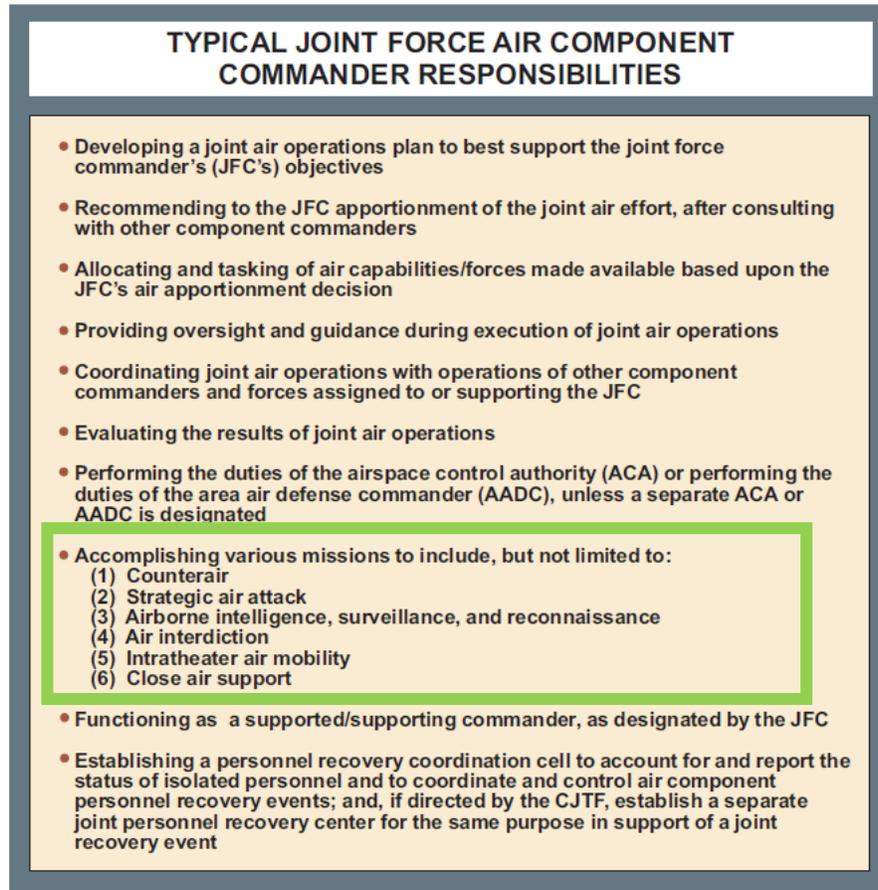


Figure 4. Typical JFACC Responsibilities

Source: Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-33, *Joint Task Force Headquarters* (Washington, DC: Government Printing Office, 6 February 2007), III-5.

²⁵When all elements of the USAF Theater Air Control System (TACS), Army Air-Ground System (AAGS), Marine Air Command and Control System (MACCS), and Navy Tactical Air Control system (NTACS) integrate, the entire system is labeled the Theater Air-Ground System (TAGS), JP 3-03, *Joint Interdiction*, 14 October 2011, IV-4.

U.S. Navy

The U.S. Navy (USN) is engaged in several major programs in support of UMS development and integration, such as the Littoral Combat Ship (LCS) as a command and control center for unmanned surface and undersea vehicles (USV/UUV), a vertical take-off unmanned air vehicle squadron (VTUAV), and the unmanned carrier-launched airborne surveillance and strike demonstration (UCLASS-D). The former Chief of Naval Operations (CNO) Admiral (Ret.) Gary Roughead stated that unmanned systems will be the future for the US Navy.²⁶ These unmanned systems are essential in supporting the Navy's global strategic presence mission, intelligence gathering, and extending the U.S. Navy's sea lines of communication (SLOCs). Furthermore, these unmanned systems will mitigate dangerous missions, such as conducting operations in the Arctic regions and mitigating anti-access/area-denial (A2/AD) threats.

In support of UMS integration, the U.S. Navy has designated the Littoral Combat Ship (LCS) to serve as a control center for both Unmanned Underwater Vehicles (UUV) and Unmanned Surface Vehicles (USV). The LCS is configured for various mission modules such as, anti-submarine warfare, mine countermeasures, anti-surface warfare, ISR, maritime intercept, and logistics. Several of these mission modules will be executed utilizing unmanned systems such as the Modular Unmanned Surface Craft Littoral, an ISR platform providing real time monitoring of vessels and personnel along waterways and shorelines.²⁷ An example of unmanned mine clearing operations, the U.S. Navy

²⁶Carlo Munoz, "CNO Bets on Underwater Drones for Future Fleet," *AolDefense.*, 19 August 2011, <http://defense.aol.com/> (accessed 10 November 2011).

²⁷P. W. Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century* (New York: Penguin Press, 2009), 225.

fielded the AN/WLD-1 RMS Remote Mine Hunting System, a three-foot-long robot that can detect mines underwater and carries a sensor payload that allows it to identify entities in the surrounding waters. In a mine-clearing operation in the port of Um Quasar, Iraq (2003), it cleared a square-mile area of mines within 16 hours; compared to the 21 days it would have taken USN divers to accomplish the same mission.²⁸

In support of the vertical take-off unmanned air vehicle squadron (VTUAV) concept, the USN has conducted trial runs of the MQ-8 Fire Scout, an unmanned helicopter which is expected to dramatically cut the Navy's kill chain (the time it takes to identify, track and eventually engage an enemy target). The MQ-8 Fire Scout can neutralize or destroy fleets of small, fast moving boats used by drug smugglers and pirates.²⁹ The U.S. Navy recently conducted MH-60R Sea Hawk trials with the MQ-8 Fire Scout in order to extend the command and control (C2) and range of the MQ-8 Fire Scout.³⁰ This capability will allow for the coverage of thousands of miles of ocean determined to support wide area security operations (see figure 5).

²⁸“Military Increasingly Looking to Robots to Clear Waterways of Dangerous Mines,” July 27, 2007, <http://www1.whdh.com/news/articles/national/MI56402/> (accessed 27 November 2011).

²⁹Carlo Munoz, “Navy Arms Its First Unmanned Vehicle, Fire Scout,” AolDefense, 9 November 2011, <http://defense.aol.com/> (accessed 20 November 2011).

³⁰Carlo Munoz, “Navy tries MH-60 Seahawks with unmanned helos,” AolDefense, 9 November 2011 <http://defense.aol.com/> (accessed 12 November 2011).

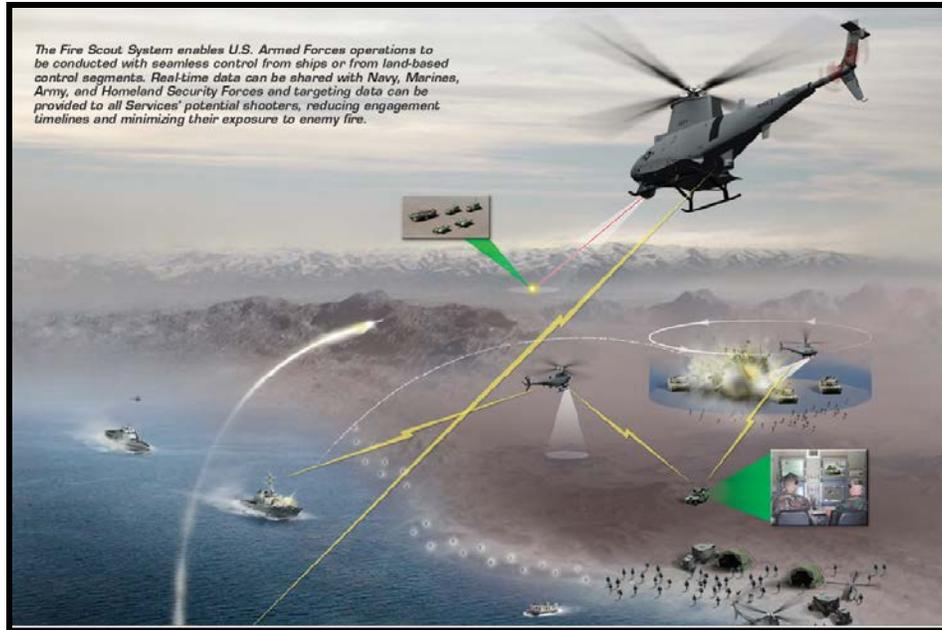


Figure 5. MQ-8 Fire Scout Unmanned Helicopter

Source: Northrop Grumman Corporation (2011).

The U.S. Navy's Unmanned Combat Air System Carrier Demonstration (UCAS-D) complies with the joint platforms envisioned in the 2006 QDR and has strategic deployment considerations.³¹ The U.S. Navy is utilizing the UCAS-D to demonstrate the suitability of an UCAS Air Wing capable of operating in an unrefueled combat radius of 2,100 nautical miles (nm), exceeding current manned capabilities. Furthermore, with autonomous aerial refueling capabilities, loiter time for an UCAS/X-47B is 50 to 100

³¹“future joint air platforms with greater range (independent reach), greater persistence (ability to loiter over the target area), improved stealth (ability to survive in contested airspace), and improved networking (ability to operate as part of a joint multidimensional network) . . . the final Report of the 2006 QDR directed the Department of the Navy (DoN) to “develop an unmanned longer-range carrier-based aircraft capable of being air-refueled to provide greater standoff capability, to expand payload and launch options, and to increase naval reach and persistence . . . to field a low-observable unmanned combat air system (UCAS) that is capable of operating safely off of a carrier deck, and over longer combat ranges than contemporary manned carrier-based aircraft.”

hours (five to ten times longer than a manned aircraft). The UCAS/X-47B can conduct (without refueling) surveillance-strike combat air patrols at ranges out to 2,100 nm, with the capacity of a 4,500 pound weapon payload. In a strictly combat radius comparison, an F-35B Lighting II can operate within a radius of 485nm; F/A-18A-D Hornet within 500nm; AV-8B Harrier II within 300 nautical miles.³² The U.S. Navy’s UCAS-D will allow a dispersed UCAS aircraft carrier force to exert combat power over a significant area not achievable with manned aircraft and mitigate anti-area/area denial (A2/AD) threats (see figure 6).³³

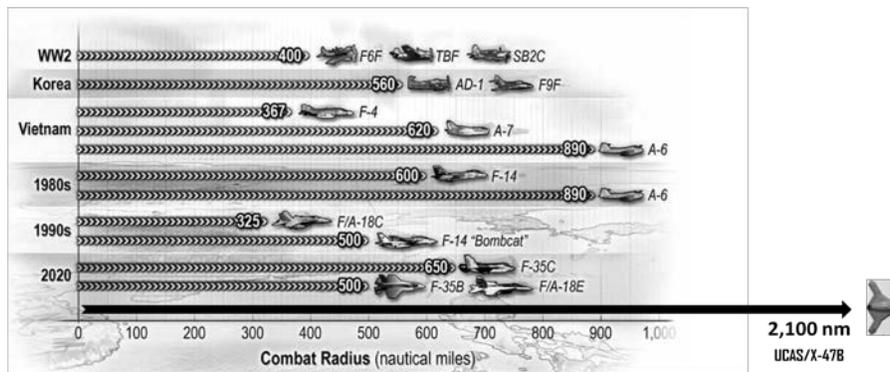


Figure 6. USN Air Carrier Wing Reach

Source: Created by author using data from Mark A. Gunziger, *Sustaining America’s Strategic Advantage in Long-Range Strike* (Washington, DC: Center for Strategic and Budgetary Assessments, 2010), 67.

³²Department of the Navy and United States Marine Corps, *Fiscal Year 2011 Marine Aviation Plan* (Washington, DC: Government Printing Offices, 16 September 2010), Section 17, Platform Quick Reference “Quad” Charts.

³³Thomas P. Erhard, PhD and Robert O. Work, *Range, Persistence, Stealth, and Networking: The Case for a Carrier-Based Unmanned Combat Air System* (Washington, DC: Center for Strategic and Budgetary Assessments, 2008), 2009.

The U.S. Navy's emphasis on unmanned systems supports the 2020 JTF essential tasks of providing operational reach and establishing operational access throughout its operations. The ability to accomplish these tasks depends upon revolutionary unmanned systems in lieu of manned systems. Furthermore, with these unmanned capabilities, a U.S. Navy Numbered Fleet will garner further consideration to be designated as JTF HQ, as recently demonstrated in Operation Odyssey Dawn, which will be further discussed in this thesis.

U.S. Army

The *2009 Robotics Strategy White Paper* prepared by the Army Capabilities Integration (ARCIC) Center and Tank-Automotive Research and Development Engineering Center (TARDEC) focuses on the US Army's path forward in the procurement and employment of robots (also referred to as robotics).³⁴ The Army's use of robots, primarily to support EOD operations in Iraq and Afghanistan demonstrated the ability of unmanned systems to assist Soldiers in a wide range of mission support capabilities. The *2009 Robotics Strategy White Paper* highlights three critical opportunities for further development and procurement of unmanned systems. First, robotics reduces risks to Soldiers; second, robotics enabled platforms will reduce Soldier workloads; and third, robotics enables entirely new capabilities for extended range or stand-off reconnaissance operations. Additionally, the white paper identified and

³⁴Department of the Army. *2009 Robotics Strategy White Paper*, prepared by the Army Capabilities Integration Center and Tank-Automotive Research and Development Engineering Center Robotics Initiative (Washington, DC, 19 March 2009).

evaluated the feasibility of unmanned systems conducting and/or assisting with 32 tasks in the Universal Joint Task List (see Appendix A).

The *2009 Robotics Strategy White Paper* also recognizes and supports the four mission areas highlighted in the 2007 Office Secretary of Defense (OSD) Unmanned Systems Roadmap, (1) ISR - the number one operational commander priority, (2) target identification and designation - the ability to positively identify and precisely locate military targets in real-time, (3) conduct counter-mine warfare - Improvised Explosive Devices (IEDs) resulted in the number one cause of casualties in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF), and (4) chemical, biological, radiological, nuclear, explosive reconnaissance - the ability to detect chemical, biological, radiological, nuclear, and explosive agents and to operate in these contaminated areas.

In addition to robotics and unmanned ground vehicle (UGV) development, the U.S. Army has engaged in manned-unmanned (MUM) trials, integrating UAVs with manned platforms, such as the AH-64D Longbow Block III attack helicopter (also known as the Apache). In a recent MUM proof of concept trial, Lockheed Martin outfitted the AH-64D Longbow Block III, with an Unmanned Aerial Systems Tactical Common Data Link Assembly (UTA).³⁵ The trial successfully demonstrated the Apache's ability to control the payload and flight of an MQ-1C Grey Eagle UAV in flight, validating the UTA's design in which "all goals of this phase of UTA testing were completed with 100 percent success."³⁶ The UTA control system will allow the Apache pilot to control the

³⁵Lockheed Martin, LONGBOW UTA, http://www.f-16.biz/us/products/longbow_uta.html (accessed 12 March 2012).

³⁶Lockheed Martin, "LONGBOW LLC's Data Link Controls UAS from Apache Block III Attack Helicopter for the First Time," <http://www.lockheedmartin.com/>

flight path, weapons system and sensors on the MQ-1C Grey Eagle UAV, initially serving as a forward remote sensor in hostile environments (see figure 7).



Figure 7. Apache Block III with a Gray Eagle UAV (MUM concept)

Source: Defense Update, http://defense-update.com/20111109_apache-block-iii-controls-a-gray-eagle-uav-demonstrating-advanced-manned-unmanned-operations.html (accessed 10 December 2011).

In exploring the capabilities of utilizing unmanned helicopters, the 2010 Army Expeditionary Warrior Experiment (AEWE) validated that the MQ-8 Fire Scout's ability to provide the following capabilities: (1) support unmanned small unit resupply (2) provide the autonomous capability to transport and emplace unmanned ground vehicles/unattended ground sensors into the battlefield, (3) provide dedicated network communications relay, (4) ability to land/takeoff from unimproved surfaces, and (5)

us/news/press-releases/2011/november/LONGBOWLLCsDataLinkContro.html (accessed 12 March 2012).

enhance situational awareness through persistent stare capabilities.³⁷ The AEWE is managed by the Maneuver Battle Lab at Fort Benning, in coordination with TRADOC Army Capabilities Integration Center (ARCIC) allowing for network-enabled small units to experiment in a live field environment with emerging technologies and concepts of operation.

The U.S. Army's emphasis on UMSs (UAVs, robots, and UGVs) will support the four mission areas previously outlined in the 2007 Office Secretary of Defense (OSD) Unmanned Systems Roadmap. The U.S. Army leveraging these UMS capabilities in lieu of manned systems will support the 2020 JTF essential tasks of providing operational reach and establishing operational access throughout its operations. Furthermore, UMSs fully support Army Operating Concept (AOC) constructs; combined arms maneuver (CAM) and wide-area security (WAS).

Army forces conduct combined arms maneuver to gain physical, temporal, and psychological advantages over enemy organizations . . . Army forces integrate the combat power resident in the Army's six war fighting functions . . . to defeat enemies and seize, retain, and exploit the initiative.

Army forces conduct wide area security to consolidate gains, stabilize environments, and ensure freedom of movement and action. Wide area security operations protect forces, populations, infrastructures, and activities.

Army forces capable of combined arms maneuver and wide area security operations are an essential component of the joint force's ability to achieve or facilitate the achievement of strategic and policy goals.³⁸

³⁷Northrop Grumman, "Facts: Northrop Grumman Proves Value of Vertical Unmanned Systems at Army Expeditionary Warrior Experiment," www.northropgrumman.com/media (accessed 14 April 2012).

³⁸Department of the Army. TRADOC Pam 525-3-1: *The Army Operating Concept-2016-2020* (Washington, DC: Government Printing Office, 2010), iii.

U.S. Marine Corps

The *Marine Corps Vision and Strategy 2025* serves as the strategic planning document encompassing its legislated role, functions, and composition in order to conduct operations against hybrid threats in complex environments.³⁹ The supporting operating concepts outlined in this document establish its role as an expeditionary fighting force capable of operating in diverse operating environments. Furthermore, the Marine Corps will be able to lead joint operations and accomplish its missions with Marine Air-Ground Task Force (MAGTF) incorporating manned and unmanned platforms to support combined maneuvers.⁴⁰

The DOTMLPF impact for the Marine Corps is on its: (1) Operating Force Structure; which recognizes the application of unmanned systems across the MAGTF, (2) on the Command Element (CE), which will need to provide persistent ISR in a complex operational environment, and (3) on the Ground Combat Element (GCE), which is tasked to enhance the maneuver capabilities of Marine ground forces within in a complex urban environment.⁴¹

The *USMC Vision and Strategy 2025* further requires: (1) continuous, all weather, precision fires, (2) the ability to rapidly and precisely engage asymmetric targets of

³⁹Department of the Navy and United States Marine Corps, *USMC Vision and Strategy 2025* (Washington, DC: Government Printing Press, 2).

⁴⁰*Ibid.*, 3.

⁴¹*Ibid.*, 20.

opportunity, and (3) that the Aviation Combat Element (ACE) integrate UASs in order to expand the force-multiplying capabilities inherent in unmanned systems.⁴²

The *Marine Corps Unmanned Aircraft System (UAS) Plan* recognizes the capabilities of UASs in lieu of manned aircraft throughout the MAGTF. The key enhancements are ISR, C2, Strike, EW, and combat logistics. The initial organizational change to the MAGTF is the establishment of the Marine Unmanned Aerial Vehicle Squadrons (VMU). Additionally, the Marine Corps will integrate various UAS platforms, such as: (1) small UAS (SUAS), such as the RQ-11 Raven, (2) small tactical UAS (STUAS), such as the Scan Eagle system, (3) Marine Corps Tactical UAS (MCTUAS), currently supported by the RQ-7B Shadow, and (4) future Group-4 MCTUAS, capable of Strike, ISR, and EW capabilities.⁴³ The FY16 end state is that the MAGTF will employ UASs in order to enhance its operational capabilities. Additionally, it will integrate UAS cargo platforms currently being utilized in Afghanistan, to support and execute unmanned logistical support requirements.

North Atlantic Treaty Organization (NATO)

The globalization and the boom of information, computing, networking, satellite and precision technologies all have tremendous implications for the defense and security sector. The extensive use of modern technologies in the offensive campaigns in Kosovo, Afghanistan and Iraq enabled the military to

⁴²Ibid., 21.

⁴³Department of the Navy and United States Marine Corps, *FY 2011 Marine Aviation Plan* (Washington, DC: Government Printing Office, 16 September 2010), 6-2.

achieve an unprecedented operational tempo and precision, and to win wars in the course of several weeks, instead of years.⁴⁴

The NATO Defense Security Committee published a report authored by Pierre Claude Nolin (Canada), *Transforming the Future of Warfare: Network-Enabled Capabilities and Unmanned Systems*, focusing on network-enabled capabilities (NEC) and unmanned systems to assume missions in lieu of personnel or manned platforms in future conflict scenarios.⁴⁵

An information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision-makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization. In essence, [network-centric warfare] translates information superiority into combat power.⁴⁶

The report asserts that NEC and unmanned systems are different technological development programs; however, “emerging drone technology is a physical extension of NEC and those NEC C4ISTAR systems will increasingly depend on Unmanned Aerial Vehicles (UAVs) as a tool to collect intelligence and reconnaissance data and even to

⁴⁴NATO Parliamentary Assembly, Pierre Claude Nolin (Canada), General Rapporteur, 175 STC 07 E bis -*Transforming the Future of Warfare: Network-Enabled Capabilities and Unmanned Systems*. 2007 Annual Session, I-1.

⁴⁵The Defense and Security Committee (DSC) examine ongoing operations, partnerships and programs to find how NATO can continually improve its effectiveness as an ally. The DSC focus: (1) military effectiveness, (2) interoperability, (3) defense transformation, (4) defense budgets, (5) organization of NATO military structure, (5) operational relations with other international organizations, particularly the European Union, and (6) progress of candidate and partner countries in meeting standards for integration into NATO operations and partnerships, i.e. STANAG 4856.

⁴⁶NATO Parliamentary Assembly, Pierre Claude Nolin (Canada), General Rapporteur, 175 STC 07 E bis -*Transforming the Future of Warfare: Network-Enabled Capabilities and Unmanned Systems*. 2007 Annual Session, II-A-4.

attack targets.”⁴⁷ The inherent benefits of NEC enabled unmanned systems are the reduction of Soldiers and increased survivability. Additionally, the report recognizes the inherent benefits outlined in DoD roadmaps, such as: (1) reduction of personnel/logistical footprints within the area of operation, (2) assumption of the 3D (dull-dirty-dangerous) missions, (3) the use of ground or underwater drones in demining operations. It further proposes a price incentive comparison. A F-16 fighter aircraft costs \$30 million; a MQ-9 Reaper with a similar payload capacity costs approximately \$7 million. Moreover, a UCAV could be a cheaper alternative to manned fighter programs. One F-35 Joint Strike Fighter costs \$100 million; an F-22 Raptor \$200 million, while the estimated costs of X-45 UCAV is \$40 million.⁴⁸ Additionally, UAS upgrades are flexible and can be tailored to meet emerging threats. In contrast, manned systems place “very strict limitations on the size, shape, speed, altitude and many other technical characteristics of an aircraft. Without these limitations, engineers can create machines that would change our understanding of what an aircraft can do and it could look like.”⁴⁹ This NATO report further highlights two points: (1) the extent of UMS proliferation, which extends to 32 countries, developing more than 250 different UAV models, (2) UMS customers encompass, Europe, Middle East, North Africa and Asia, which are expected to capture nearly 40 percent of the global market.⁵⁰

⁴⁷Ibid., III-A-38.

⁴⁸Ibid., 8.

⁴⁹Ibid., 9.

⁵⁰Ibid.

DoD Publications

The purpose of reviewing DoD Joint publications is to analyze the doctrinal guidance on establishing a JTF and determine if the 2020 JTF will be postured to integrate and execute operations utilizing unmanned systems.

JP-1, *Doctrine for the Armed Forces of the United States* outlines the fundamental principles that guide the employment of US military forces in a Joint environment. It states that: (1) the strategic security environment is extremely fluid and that the Joint Force must be prepared to address emerging peer competitors and hybrid threats, (2) it will operate under the concept of Unified Action (UA), which refers to the synchronization, coordination, and/or integration of the activities of governmental and non-governmental entities to achieve unity of effort. Furthermore, UA demands maximum interoperability between all forces, units, and systems in order to operate together effectively across the spectrum of operations.⁵¹

JP 3-0, *Joint Operations*, provides the JTF guidance on planning, preparing, executing, and assessing joint military operations. It outlines six basic Joint functions which are common to most joint operations: (1) command and control, (2) intelligence, (3) fires, (4) movement and maneuver, (5) protection, and (6) sustainment. Furthermore, it addresses (a) organizing for joint operations, (b) organizing the joint force, and (c)

⁵¹Chairman, Joint Chiefs of Staff, Joint Publication (JP) 1, *Doctrine for the Armed Forces of the United States* (Washington, DC: Government Printing Office, March 2007, Incorporating Change 1, March 2009).

conducting joint operations across the range of military operations, which includes the phasing of a joint operation.⁵²

JP 3-33, *Joint Task Force Headquarters* (JTF HQ), outlines the formation and employment of a JTF HQ to command and control joint operations. It also outlines the JTF HQ organization and staffing and duties and responsibilities of the directorates, for the purpose of this thesis, the author will primarily focus on the J2 (Intelligence), J3 (Operations), and J4 (Logistics) and further describes the JTF functional commands; Joint Forces Air Component Commander (JFACC), Joint Forces Land Component Commander (JFLCC), Joint Forces Maritime Commander (JFMCC), and the Joint Forces Special Operations Commander (JFSOC).⁵³

JP 5-0, *Joint Operation Planning*, forms the core of joint doctrine for joint operation planning throughout the range of military operations. It outlines: (1) the role of joint operation planning, (2) strategic direction and joint operation planning, (3) operational art and operational design, and (4) the joint operation planning process (JOPP).⁵⁴

Additional Joint Publications relevant to JTF operations and to the discussion of UMS integration are: (1) JP 3-30, *Command & Control for Joint Air Operations*, (2) JP 3-31, *Command & Control for Joint Land Operations*, and (3) JP 3-32, *Command &*

⁵²Chairman, Joint Chiefs of Staff. Joint Publication (JP) 3-0, *Joint Operations* (Washington, DC: Government Printing Office, 11 August 2011).

⁵³Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-33, *Joint Task Force Headquarters* (Washington, DC: Government Printing Office, 16 February 2007).

⁵⁴Chairman, Joint Chiefs of Staff, Joint Publication (JP) 5-0, *Joint Operations Planning* (Washington, DC: Government Printing Office, 11 August 2011).

Control for Joint Maritime Operations. Together, these set forth the doctrine for joint operations to their respective functional components; to include interagency and multinational operations. For example, JP 3-30 outlines the responsibilities for the JFACC such as command and control of joint air operations across the range of military operations. The UMS operational considerations for the JFACC were highlighted in the Joint Capability Area (JCA) discussion and further refined in the USAF *Unmanned Aircraft Systems Flight Plan 2009-2040*, which envisions a networked family of UASs. These next generation UASs will operate autonomously and provide an exponential degree of operational capabilities which will be managed by the designated Joint Force Air Component Commander (JFACC).

The discussion regarding the perceived future hybrid threat operating environment, from both DoD and academic institutions, has been clearly defined and adopted. *Training Circular 7-100, Hybrid Threat*, describes the hybrid threat and outlines the manner in which this future threat may operationally organize against US forces and allows for further discussion in the integration of UMSs to mitigate threats in this operating environment in lieu of manned platforms and/or personnel.

Hybrid threats (HT) are innovative, adaptive, globally connected, networked, and can possess a wide range of technologies, including the possibility of weapons of mass destruction (see figure 8). Hybrid Threat (HT) strategy is multi-dimensional conducted in four strategic-level courses of action, (1) strategic operations aim is to preclude the JTF from intervening in the HT area of operation/influence,(2) regional operations-actions against regional adversaries and internal threats,(3) transition operations- HT continues to pursue its regional goals while dealing with the development of outside intervention with the potential for overmatching the HT's capabilities, and(4) adaptive operations-

actions to preserve the HT's power and apply it in adaptive ways against overmatching opponents.⁵⁵

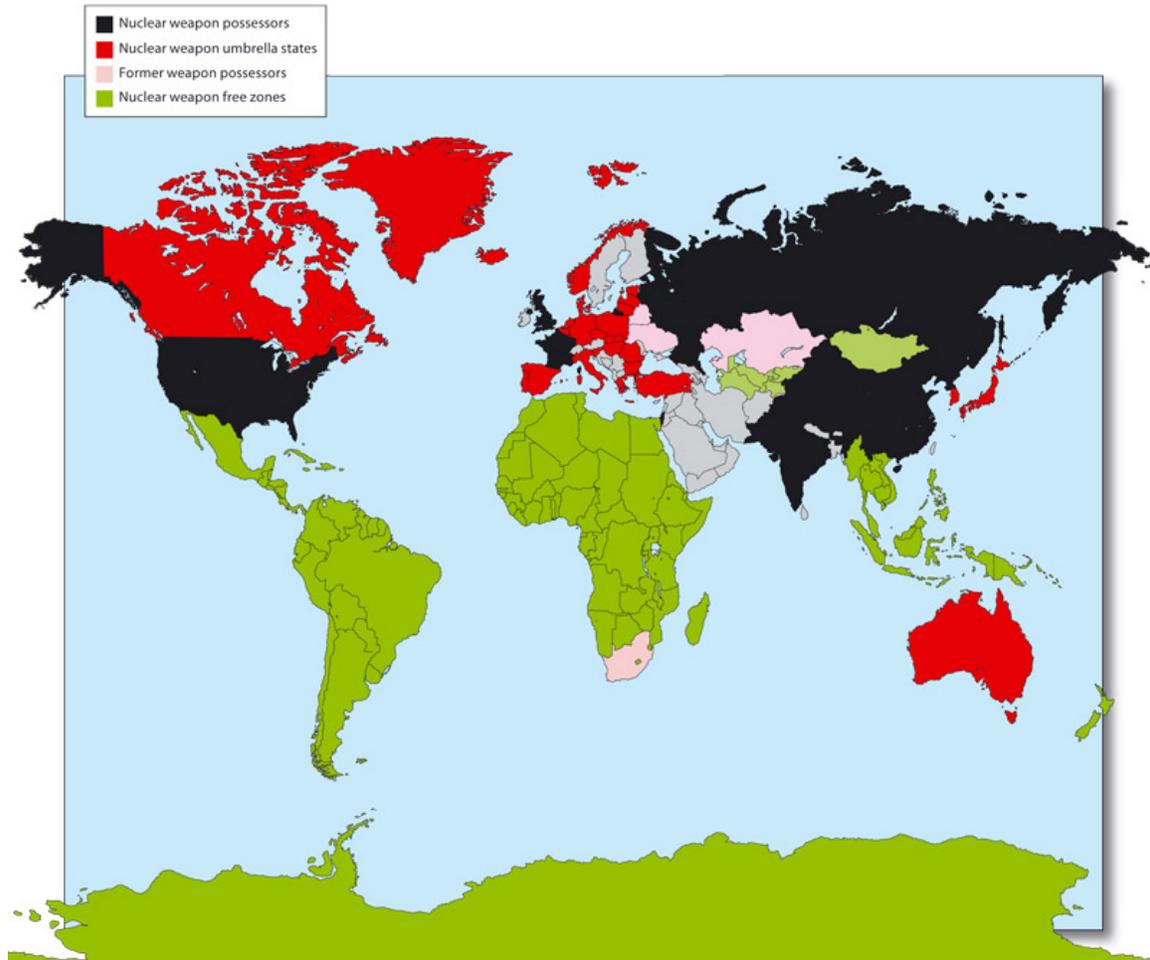


Figure 8. WMD proliferation map

Source: The International Campaign to Abolish Nuclear Weapons, <http://www.icanw.org/nuclear-map/> (accessed 15 December 2011).

⁵⁵Department of the Army, Training Circular 7-100, *Hybrid Threat* (Washington, DC: Government Printing Office, 29 November 2010), 1-1. (Headquarters, U.S. Army Training and Doctrine Command (TRADOC) is the proponent for this TC. The preparing agency is the Contemporary Operational Environment and Threat Integration Directorate (CTID), TRADOC G-2 Intelligence Support Activity (TRISA) –Threats).

The foreseeable WMD/CBRNE planning considerations for the 2020 JTF are: (1) proliferation of nuclear weapons; (2) neighboring nuclear armed states in conflict, such as Pakistan/India or North Korea/Japan; (3) conducting operations in a CBRNE contaminated environment, such as in the event of a nuclear reactor meltdown. The WMD/CBRNE scenario will require remote engagement with platforms possessing increased standoff capabilities, a dispersion of forces, and persistent ISR and Strike capabilities. In this scenario, the U.S. Naval forces will be forced to operate from dispersed platforms; U.S. Army and USMC ground forces will be restricted from establishing Intermediate Staging bases (ISBs) and operating within a land based area of operation. The U.S. Air Force, in support of ISR and Strike missions, will be forced to rely on UAVs to mitigate the residual effects of CBRNE agents for an indefinite period of amount of time. The impact of a WMD/CBRNE operating environment to the 2020 JTF is the emphasis on utilizing UMSs throughout the air, land, and sea domains in lieu of manned systems or personnel in order to accomplish its mission. (see Annex A).

Academic Publications

The two prolific academic writers on robotics/unmanned systems and their impact on future military operations are Dr. Robert Finklestein and P.W. Singer. In “*Robotics in Future Warfare*” Dr. Finklestein, President of Robotic Technology Inc, focuses on his rationale for robots in future warfare. The focus is on the “three D’s”; dirty, dull, and dangerous operations that robots can assume. Furthermore, those robots are expendable, maneuverable, have a faster response time, indefatigable, autonomous, and incorporate

emerging technology which is a far superior option than human Soldiers.⁵⁶ In *Wired for War - The Robotics Revolution and Conflict in the 21st Century*, P.W. Singer, Director of the 21st Century Defense Initiative at Brookings Institute, focuses on the ongoing robotic revolution within the Department of Defense and its implications for 21st century warfare, the “dawn of robotic warfare.” He further highlighted in his book that with the end of Operation Desert Shield/Storm (ODS) military leaders assumed that the public’s tolerance of Vietnam level casualties had dramatically diminished, leading Major General (Retired) Robert H. Scales to state that in the new era of warfare that “dead Soldiers are America’s most vulnerable center of gravity.”⁵⁷ Furthermore, U.S. State Senator John Warner (Virginia), former Senate Armed Services Committee Chairman, went on record to state that “in my judgment this country will never again permit the armed forces to be engaged in conflicts which inflict the level of casualties we have seen historically... so what do you do? You move toward the unmanned type of military vehicle to carry out missions which are high risk in nature.”⁵⁸

In November 2011, the Brookings Institute chaired a panel “The Future of Land Wars: Intense, High-Tech, Urban, Coastal” with current and retired Army officers and professional analysts which provide relevant insights for future UMS procurement and employment considerations. Colonel (COL) Gian Gentile, United States Military

⁵⁶Dr. Robert Finklestein, “Robotics in Future Warfare” (presented to the Panel on Robotics and Contemporary/Future Warfare Conference on the Strategic Implications of Emerging Technologies, US Army War College Strategic Studies Institute, 14-16 April 2009).

⁵⁷Singer, *Wired for War*, 59.

⁵⁸*Ibid.*, 60.

Academy (USMA) history professor, stated that “we should absolutely avoid building a future ground force optimized for wars like Iraq and Afghanistan ... future land battlefields demand a ground force built around the pillars of firepower, protection and mobility, moreover, this future ground force needs to be able to move and fight in dispersed, distributed operations.”⁵⁹ His insight(s) were further expanded on by Lieutenant General (LTG) (retired) Dave Barno, a Senior Fellow for the Center for a New American Security, stating that the “ typical land battlefield of 2021 will be a complex, often urbanized environment where battles are often fought inside the dense urban sprawl that increasingly proliferates along the edges of the world's great cities enabling small units to reliably leverage networked technology for access to fires, to employ unmanned and robotic adjuncts and operate mobile fighting systems will be a key sector for investment” (see figure 9).⁶⁰

⁵⁹David Axe, “The Future of Land Wars: Intense, High-Tech, Urban, Coastal,” 30 November 2011, <http://defense.aol.com/2011/11/30/the-future-of-land-wars-intense-high-tech-urban-coastal/> (accessed 15 December 2011).

⁶⁰Ibid.

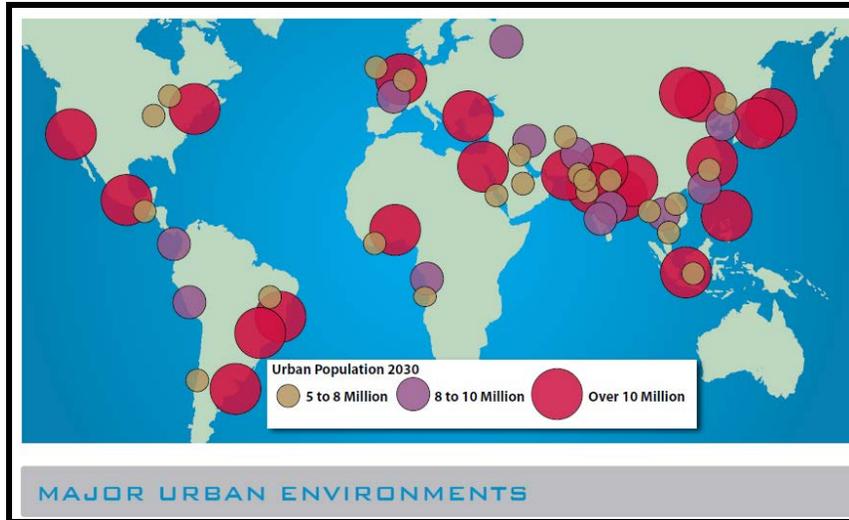


Figure 9. Urban population centers (2030)

Source: Joint Operating Environment (JOE) 2010, 57.

Lastly, P. W. Singer, stated that “more than 40 percent of the world's population already lives in cities with populations of more than 1 million . . . the megacity, an urban agglomeration of more than 10 million people . . . there are 22 such megacities, the majority in the developing countries of Asia, Africa and Latin America. By 2025, there will be another 30 or more . . . megaslums that house millions of young, urban poor--the angry losers of globalization.”⁶¹

Foreign UMS Capabilities Considerations

The rise of the People's Republic of China (PRC) as a major international actor stands out as a defining feature in the 21st century strategic landscape.⁶² The People's

⁶¹Axe.

⁶²Department of Defense, Office of the Secretary of Defense, Annual Report to Congress - Military and Security Developments Involving the People's Republic of China, 2011, I.

Liberation Army (PLA) strategic focus is to compete equally with the US military in certain areas, such as submarine warfare, space, and cyber warfare. In December 2011, China placed in operation a satellite navigation service that is designed to provide an alternative to the U.S. Global Positioning System (GPS), which will assist the Chinese military to identify, track and strike U.S. ships in the region in the event of armed conflict.⁶³ The Beidou Navigation Satellite System provides initial positioning, navigation and timing services to China and its surrounding areas.⁶⁴ According to the assessment of Professor Tan Kaijia, a weaponry expert with the PLA's National Defense University, "China has made substantial progress in intelligent control systems, precise measuring-controlling systems and computer information processing for military uses."⁶⁵

The development and manufacture of Chinese of unmanned systems over the past 30 years have been often based on U.S. UAV/UCAV concepts (see table 2).

⁶³Jeremy Page, "China Launches Own Global Positioning System," *The Wall Street Journal* – Asia Technology, 27 December 2011, <http://online.wsj.com/article/SB10001424052970203479104577123600791556284.html#ixzz1hlsK5e1W> (accessed 27 December 2011).

⁶⁴Ibid.

⁶⁵UAVs in active service reveal China's growing interest in military robots, *Defense Professionals*, 2 October 2009, <http://www.defpro.com/news/details/10219/> (accessed 27 December 2011).

Table 2. Chinese UAV/UCAV Development

Chinese UMS ⁶⁶		US equivalent	Industry	Date displayed
WuZhen-5	UAV	AQM-34N Fire-Bee	Beijing University of Aeronautics & Astronautics	1981/1999
ASN-206/207	UAV.	MQ-1 Predator	Xi'an ASN Technology Group Company	1996
WuZhen-2000	UAV	RQ-4 Global Hawk	Guizhou Aviation Industry Group	2000 Zhuhai Air Show
HARPY	UAV	TBD	Israel Aerospace Industries (IAI)	O/A 2000
ANJIAN “Dark Sword”	UCAV	TBD/X-47B	UNK	2006 Zhuhai Air Show.
Xianglong “Sour Dragon”	UAV	RQ-4 Global Hawk	Chengdu Aircraft	2006 Zhuhai Air Show (China)
Yilong	UAS	MQ-1 Predator	UNK	2008 Zhuhai Air Show
CH-3	UCAV	X-47B	China Aerospace S &T Corporation	2008 Zhuhai Air Show

Source: Created by author with information gathered from Defense Professionals website, <http://www.defpro.com/news/details/10219/> (accessed 27 December 2011).

⁶⁶Ibid.

In addition, China has developed anti-access capabilities such as over-the horizon (OTH) radars that can locate and fix U.S. Navy Carrier Strike Groups (see figure 10). This comprehensive development of Chinese anti-access/area-denial (A2/AD) capabilities will mitigate traditional U.S. power projection capabilities such as uncontested deployment of ground forces, aircraft formations in regional airbases, and the uncontested employment of combat aircraft to support ground operations.

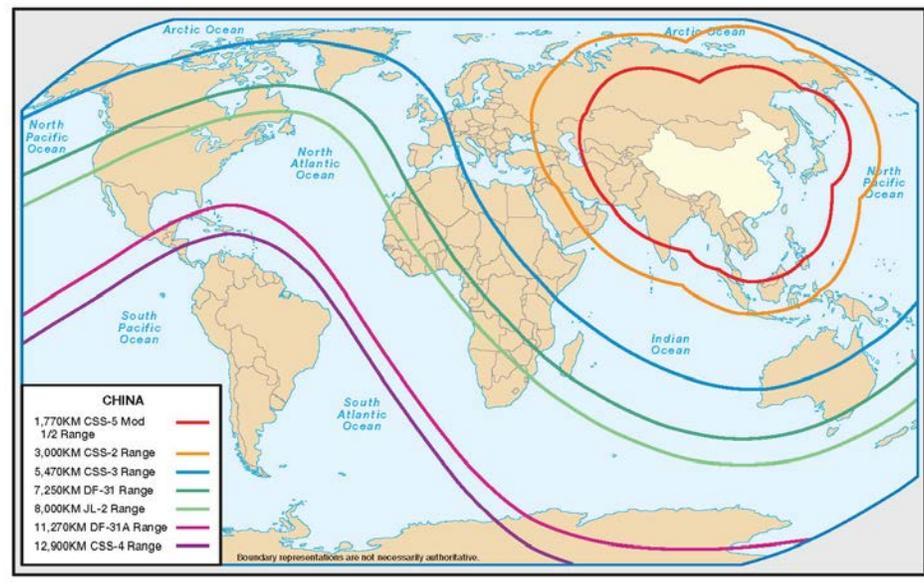


Figure 10. Chinese Medium and ICBM ranges.

Source: Department of Defense, “Military Power of the People’s Republic of China 2007” (Report to Congress Pursuant to the National Defense Authorization Act Fiscal Year 2000, Washington, DC), 19.

In respect to the current OEF operating environment it is relevant to recognize Pakistan’s availability, and procurement of UMS, primarily UAVs. Pakistan at the outset of the U.S. Global War on Terrorism (GWOT) requested and was denied UMS platforms

by the United States. Therefore, Pakistan engaged in procuring UAV concepts and systems, both domestically and on the international market.

Pakistan entered into a deal with the Italian firm, Selex-Galileo, in order to produce UAV's at their Kamra Air Weapons Complex. The Pakistan Navy acquired rotorcraft drones from foreign sources. The Pakistani Army has pursued partnerships with China, and local manufacturers to continue to develop more advanced platforms within the country.⁶⁷ For example, the Burraq is a high endurance/long range (HE/LR) over the horizon armed UCAV aircraft that is being developed in partnership with China (includes weapons development, control systems development, propulsion, airframe, ground control stations).⁶⁸

UMS Commercial Proliferation

Unmanned aerial vehicles (UAVs) represent one of the brightest, fastest-growing segments in the aerospace and defense industry . . . move beyond strategic reconnaissance and surveillance and into roles previously filled by manned jet fighter aircraft, combat helicopters, and even special operations forces on the ground . . . will provide battlefield situational awareness, fire support from the air, covert surveillance, and applications no one has thought of yet.⁶⁹

The proliferation of UMS has led to the establishment of multinational organizations such as the Association for Unmanned Vehicle Systems International

⁶⁷“Say hello to Pakistan’s first domestically produced armed drone: The Burraq UCAV,” 5 December 2011, <http://www.techlahore.com/2011/12/04/say-hello-to-pakistans-first-domestically-produced-armed-drone-the-burraq-ucav/> (accessed 15 December 2011).

⁶⁸Ibid.

⁶⁹Military and Aerospace Executive Briefing: Unmanned aircraft applications proliferate, and represent one of the few growing markets in an otherwise-shrinking defense budget, <http://www.militaryaerospace.com/executive-briefings/2011/unmanned-aircraft-applications-proliferate.whitepaperpdf.render.pdf>. (accessed 14 April 2012).

AUVSI).⁷⁰ In recognition of the impact within the aerospace and defense industry, the AUVSI's Unmanned Systems North America 2012 Symposium at Mandalay Bay Resort & Casino, Las Vegas, Nevada, will feature the latest issues, trends and developments impacting the unmanned systems and robotics community.⁷¹

In respect to U.S. Defense firms, they have until recently been restricted from generating UAV export revenue due to the Missile Technology Control Regime (MTCR) Category I export control restrictions.⁷² These restrictions strongly discourage export of such platforms to Asia and the Middle East. These markets are serviced by foreign UAV manufacturers and exporters such as Israel, Singapore, and South Africa. In response, American UAV manufacturers redesigned their existing military platforms to fall under the far less restrictive MTCR Category II. General Atomics, focusing in Asia and the Middle East, introduced the Predator XP, designed for overseas buyers. In Asia, General Atomics continues to prioritize Predator B sales to Australia, Japan, and South Korea.

Notes on Methodology

The purpose of this section is to highlight the research methodology that will be used to answer the primary research question: Will the 2020 JTF be postured to utilize

⁷⁰The Association for Unmanned Vehicle Systems International (AUVSI) is the world's largest non-profit organization dedicated to the advancement of unmanned systems and robotics—represents 7,000 members and more than 500 corporate members from 60 allied countries involved in the fields of government, industry and academia, at www.auvsi.org.

⁷¹AUVSI homepage, <http://www.auvsishow.org/auvsi12/public/enter.aspx> (accessed 1 April 2012).

⁷²Eddie Walsh, "Predator Maker Redesigns UAV To Boost Exports," *AolDefense*, 15 November 2011, <http://defense.aol.com/2011/11/15/predator-maker-redesigns-uav-to-boost-exports/> (accessed 1 December 2011).

mandated unmanned systems? In chapter 1 the secondary research questions were identified. In chapter 2 the literature associated with the primary and secondary research questions was discussed. The author's intent is to provide a definitive answer for the secondary research questions, within the limitations outlined in chapter 1. Additionally, it's feasible that simply generating a discussion from the secondary research questions to gain an understanding its relevance to the primary research question may be all that is required. With this intent, conclusions will be drawn for each secondary research question. Therefore, a description of the methodology to be used will follow the following framework.

SRQ #1: What future training will be required for the JTF to employ UMSs? The purpose of this question is to gain an understanding and identify future training requirements for the JTF to employ UMS. In order to generate UMS training requirements, DoD in conjunction with the Services must understand the capabilities of UMS and how they will integrate and support operational reach and provide operational access in the JTF area of operations (JOA). These future training requirements will be outlined in chapter 4–conclusions.

SRQ #2: How will the incorporation of robust UMS capability impact the organization of a JTF in 2020? The purpose of this question is to gain an understanding (or identify) the impact on the organization of a JTF with the integration of revolutionary unmanned systems. In order to generate JTF task organization analysis, DoD in conjunction with the Services must understand the capabilities of UMS and what capabilities can be accomplished by UMS in lieu of manned systems.

Conclusions and Recommendations

In chapter 3, preliminary conclusions will be provided for the secondary research questions; chapter 4 will provide a final conclusion for each secondary research question and the primary research question. Table 3, provides a reference chart of the research methodology.

Table 3. Research Methodology

SRQ	Purpose	Ends	Ways	Means
1. What future training will be required for the JTF to employ UMSs?	Gain an understanding of anticipated future UMS capabilities & required staff training	Training requirements & principal staff directorates identified	Examine Service & Functional Component Commander mission requirements	Review Joint publications; UMS academic publications; Service specific UMS roadmaps; JTF case studies
2. How will the incorporation of robust UMS capability impact the organization of a JTF in 2020?	Identify mission requirements for the JTF and staff directorates in which UMS can be employed in lieu of manned platforms	JTF task organization recommended	Examine Functional Component Commander mission requirements	Review Joint publications; UMS academic publications; Service specific UMS roadmaps; JTF case studies

Source: Created by author.

CHAPTER 3

ANALYSIS

The purpose of chapter 3 is to present the findings of the research in order to answer the primary research question: Will the 2020 JTF be postured to utilize mandated unmanned systems? As discussed in Chapter 2, JP 3-33, Joint Task Force Headquarters, outlines the doctrinal framework to establish a JTF HQ and its Functional Component Commands. The understanding of the capabilities, duties, and responsibilities of the staff functions and commands will facilitate the analysis of UMS integration in its operations.

Functional Component Commands

A functional component command is composed of forces of two or more DoD Services in which the Service component commander with the preponderance of forces is designated as the functional component commander (see table 4).

Table 4. Functional Component Command Considerations

	JTF HQ	JFACC	JFLCC	JFMCC	JFSOC
USA	X		X		X
USN	X	X		X	X
USAF	X	X			X
USMC	X	X	X	X	X

Source: Created by author using data from Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-33, *Joint Task Force Headquarters* (Washington, DC: Government Printing Office, 16 February 2007).

Joint Forces Air Component Commander (JFACC)

A JFACC will be designated based on having the preponderance of air assets and the ability to effectively plan, task, and control joint air operations. The responsibilities of the JFACC include, planning, coordinating, and monitoring joint air operations and the allocation and tasking of joint air operations forces.⁷³ The operational consideration is the integration of UMSs described in Chapter 2 (UAVs will be predominate in the JFACC)

⁷³Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-33, *Joint Task Force Headquarters* (Washington, DC: Government Printing Office, 16 February 2007), III-5.

throughout the JFACC subordinate division in lieu of manned systems; primarily the Combat Operations and ISR Division (see figure 11).

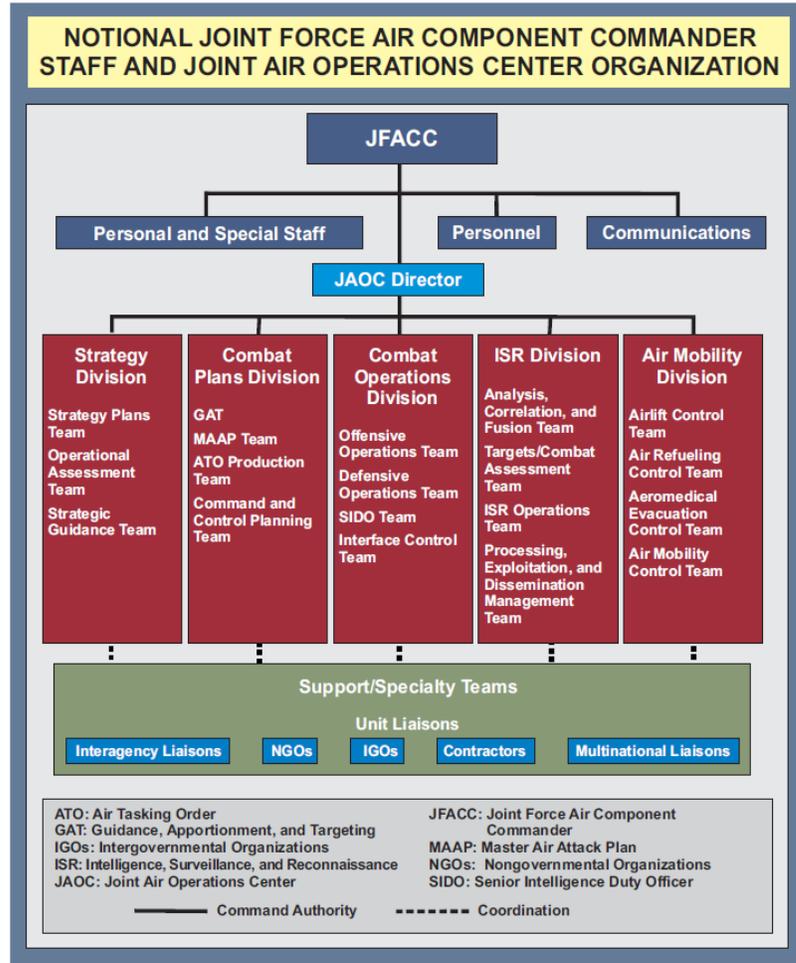


Figure 11. Notional JFACC Composition

Source: Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-33, *Joint Task Force Headquarters* (Washington, DC: Government Printing Office, 16 February 2007), III-6.

Joint Forces Land Component Commander (JFLCC)

The designation of a JFLCC typically occurs when forces of more than one Service component participate in a land operation and the CJTF determines that doing this will achieve unity of command and effort among land forces.⁷⁴ The essential planning consideration for a JFLCC is the availability of ports of debarkation and the mutual support possible between land forces. A JFLCC can consist of an Army corps or MAGTF (see Table 2). The operational consideration is the integration of UMSs described in Chapter 2 (UGVs, UGSs, and UAVs) throughout JFLCC operations in lieu of manned systems and/or personnel.

Joint Forces Maritime Component Commander (JFMCC)

The essential task of a JFMCC is to command and control joint maritime operations. These forces, generally, consist of ship formations, marines and Special Operation Forces (SOF). Typical JMFCC missions include: sea control, maritime power projection, deterrence, strategic sealift, forward maritime presence, and sea basing operations.⁷⁵ The operational consideration is the integration of UMSs described in chapter 2 (USVs, UUVs, UAVs) throughout JFMCC operations in lieu of manned systems and/or personnel.

Joint Forces Special Operations Commander (JFSOC)

The JFSOC generally will be the commander with the preponderance of SOF and appropriate command and control structure to conduct operations. Additionally, the

⁷⁴Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-33, III-7.

⁷⁵Ibid., III-9.

JFSOC may establish a joint special operations air component commander (JSOACC) responsible for planning and executing joint special operations air activities. This includes the responsibility to coordinate, allocate, task, control, and support the assigned and attached joint special operations aviation assets.⁷⁶ The operational consideration is the integration of UMSs described in Chapter 2 (USVs, UUVs, UAVs, UGVs, and UGSs) throughout JFSOC operations in lieu of manned systems and/or personnel.

Joint Task Force Directorates

The operational considerations of UMS integration does not solely rest on the Services as they execute their missions as a functional component command, but, also to the JTF staff. As discussed in chapter 1, the 2020 JTF will be required to leverage cutting-edge information technologies to ensure a secure and collaborative command and control network. These requirements will generate training requirements for the staff to plan and execute operations with UMSs in lieu of manned platforms. A key impact will be on the JTF Chief of Staff (COS) who serves as the key staff integrator. The COS is responsible for the establishment and management of staff processes and procedures that support the JFC decision making process.⁷⁷

The impact to the JTF J2 will be on the Joint Intelligence Support Element (JISE). The JISE is the hub of intelligence activity in the Joint Area of Operations (JOA) which requires persistent awareness and is characterized by net-centric and fused operations. Therefore, the impending UMS training requirements support battle space awareness

⁷⁶Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-33, III-11.

⁷⁷Ibid., II-8.

(BA) and the Tasking, Production, Exploitation, and Dissemination (TPED) process to translate sensor data into a common picture becomes apparent. Furthermore, the projected UMS platforms with their requirement to operate with full autonomy will extend their BA persistence capabilities from days to weeks across all of the domains.

The impact to the J3 will be to support and execute Force Application (FA) missions which are focused on maneuver and engagement. The Joint Operations Center serves as the focal point for all operational matters and the current operations (CUOPS) element is staffed by J-3 air, land, maritime, and special operations watch officers. The projected UMS platforms will be able to assume air, ground, and sea operations in lieu of manned platforms and/or personnel. Additionally, the J3 (Operations Directorate) will need to leverage UMS protection platforms that will assist in FORCEPRO tasks, such as FOB security, obstacle construction/breach, sophisticated explosive ordnance disposal, and casualty extraction and evacuation. The J-4 provides the foundation of combat power, by air, land, and sea. Additionally, the J-4 must understand the capabilities of all UMS mobility assets as they become available throughout sustainment and operations. The discussions of the UMS capabilities across the services support these requirements and require successful integration in order to support the JFC's decision making process and execution of its assigned missions.

Case Studies

Historically, creating a joint task force (JTF) has come with its share of forming and planning difficulties . Typically, a Service two or three-star headquarters will be designated as the JTF for a crisis or contingency and will receive augmentation from the Services to fill the capability gaps within the JTF. Most situations require JTFs to be established rapidly, and the lag time in

receiving augmentation, coupled with the inexperience of augmentees in joint operations, has proven an ineffective and unsuccessful model.⁷⁸

The first case study for this thesis is the designation of the V Corps HQ as Combined Joint Task Force-7 (CJTF-7) for Operation Iraqi Freedom (OIF I/II- June 2003-May 2004). The overall analysis of CJTF-7 is outside the scope of this thesis; the intent is to: (1) analyze the doctrinal guidance that was followed in establishing CJTF-7 in the dominant operating environment for DoD and the Services at the time, and (2) to determine if the lessons observed allow for future considerations in establishing a JTF under a similar operating environment utilizing unmanned systems in lieu of manned systems and/or personnel. Additionally, the JTF Odyssey Dawn (JTF OD) case study will highlight future considerations for integrating and operating from a mobile C2 platform with unmanned systems in lieu of manned systems.

CJTF-7 Background

In April 2003, the commanding general of 1st Armored Division (1AD), Major General (MG) Ricardo Sanchez was designated the commander of V Corps (Germany) and promoted to Lieutenant General (LTG), concurrently while deploying his division (1AD) from Germany to Kuwait. At this point the Combined Forces Land Component (CFLCC) HQ had been designated the responsibility for Phase IV (establish security) operations. On 17 May, V Corps was officially notified of its designation as a CJTF with

⁷⁸Walter E. Carter, Jr, "The Joint Enabling Capabilities Command: A Rarity within the Conventional Force," *Joint Forces Quarterly* 64 (January 2012): 19.

a Relief in Place/Transfer of Authority (RIP/TOA) set for 15 June 2003, less than 30 days to prepare for assuming responsibility for all operations in Iraq.⁷⁹

Challenges

The immediate challenges faced by CJTF-7 were to support operations at the tactical, operational and theater strategic level. It was unable to initially do so, due to it being grossly understaffed and lacking strategic communications and capability. The end result, was that it took six to eight months for CJTF -7 to become fully operational and capable (FOC); which was roughly at the 75 percent completion date of its 12 month rotation. In COL (R) Mansoor's assessment "CJTF-7 lacked the link between the strategic ends and tactical means that would ensure a successful outcome."⁸⁰ For the foreseeable hybrid-threat environment, six to eight months to become FOC will result in mission failure.

Analysis

For the 2020 JTF assigned to a similar operating environment, UMSs will provide strategic communications, C2, and ISR throughout the phasing of operations; Phase 0 (shape), Phase I (deter), Phase II (seize the initiative), and Phase III (dominate), which will exploit the initiative and dictate the operational tempo. The follow on phases, Phase IV (establish security) and Phase V (enable civil authority) can incorporate UMSs with

⁷⁹Donald P. Wright, *The United States Army in Operation Iraqi Freedom, May 2003-January 2005: On Point II: Transition to the New Campaign; With the Contemporary Operating Study Team* (Washington, DC: Government Printing Office, June 2008).

⁸⁰Peter R. Mansoor, *Baghdad at Sunrise: A Brigade Commander's War in Iraq*. (New Haven: Yale University Press, 2008), 109.

land forces, providing capabilities normally performed by manned platforms or personnel.

The second case study for this thesis is the designation of the U.S. Navy 6th Fleet as the HQ for JTF Odyssey Dawn in support of operations in Libya.

JTF Odyssey Dawn (Libya) Background

In March 2011, U.S. Africa Command (USAFRICOM) established Joint Task Force Odyssey Dawn (JTF OD) under the command of Admiral Samuel Locklear III, commander of U.S. Naval Forces Europe – Africa, to support United Nations Security Council Resolutions (UNSCRs) 1970 and 1973. The JTF mission was to (1) provide humanitarian assistance, (2) support noncombatant evacuation (NEO) operations, (3) enforcement of a maritime exclusion zone and (4) enforcement of a no-fly zone within the JOA Libya.⁸¹ In the span of three weeks, JTF OD conducted a coalition air campaign against Libya's integrated air defense systems and halted Libyan government forces from advancing against rebel-held population centers. On March 31, JTF OD transferred command and control of the operation to NATO; re-designated as Operation Unified Protector.

Challenges

The JTF was composed of U.S. personnel and foreign liaison officers with additional augmentation with a Joint Deployable Team (JDT) provided by the United States Transportation Command (USTRANSCOM) Joint Enabling Capabilities

⁸¹JTF Odyssey Dawn website, <http://www.naveur-navaf.navy.mil/odysseydawn/index.html> (accessed 10 March 2012).

Command (JECC). The JTF OD staff was headquartered and certified aboard the USN 6th Fleet Command and Control ship the USS Mount Whitney (LCC/JCC 20). The JTF consisted of a JFMCC, JFACC, and JFSOC. A JFLCC was not established. However, a USMC battalion deployed as an Air Contingency Battalion (ACB) to serve as a Battalion Landing Team for the 26th Marine Expeditionary Unit (MEU) in the event landing forces were required throughout JOA Libya. In the conduct of an after action review (AAR) the inclusion of a designated JFLCC was deemed essential for mission planning and force employment.

JTFs should consider the composition of the adversary when forming its own structure, even if ground troops are not employed on the friendly side. Filling every key position of a JTF staff will enhance understanding of the operational environment and can multiply the effects and outcomes of the planning process and subsequent operation execution. In future operations where U.S. ground forces are not employed, consideration of a JFLCC team to conduct planning and provide input covering some or all of the functions is essential.⁸²

Analysis

The JTF OD mission merits further evaluation of future missions that can be assumed by unmanned systems in lieu of manned systems, such as strike coordination and reconnaissance, defined as a mission flown for the purpose of detecting targets and coordinating or performing attack or reconnaissance on those targets (also known as

⁸²Gregory K. James, Larry Holcomb, and Chad T. Manske, "Joint Task Force Odyssey Dawn: A Model for Joint Experience, Training, and Education," *Joint Forces Quarterly* 64 (January 2012): 26.

SCAR see table 5).⁸³ Furthermore, UMSs support all the steps of the Dynamic Targeting Steps, such as find, fix, track, target, engage, and assess.⁸⁴

Table 5. JTF OD Manned- Unmanned Mission Matrix

Task	Manned Platform	UAS	USV	UUV	UGV
Destroy shoreline defenses	X	X (SCAR)	X		
Interdict military ground convoy	X	X (SCAR)			X
Destroy hardened positions	X	X (SCAR)	X		X
Conduct EW	X	X (MQ-M/L)			
Maritime Search and Rescue	X	X	X	X	
Destroy surface ship (s)	X	X (SCAR)	X	X	
Provide SA/C2	X	X (BAMS)	X		X
WMD-E ⁸⁵	X	X	X		X

Source: Created by Author

⁸³Headquarters, Department of the Army. Field Manual (FM) 3-60.2. *Multi-Service Tactics, Techniques, and Procedures for Strike Coordination and Reconnaissance* (Washington, DC: Government Printing Office, November 2008).

⁸⁴*Ibid.*, 31.

⁸⁵Weapons of Mass Destruction-Elimination (WMD-E) was not a specified task for JTF OD, the implied planning consideration becomes apparent with presence of the Rabta chemical weapons facility, which was estimated to contain 23T of mustard gas and 1,300T of precursor chemicals. WMD elimination operations are actions to systematically locate, characterize, secure, disable, or destroy WMD programs and related capabilities (ATTP 3-11, *Multi-Service Tactics, Techniques, and Procedures for Weapons of Mass Destruction Elimination Operations*, 10 December 2010, 1-1).

In summary and comparison, CJTF-7 faced the challenges of (1) unclear mission focus, (2) conflict in levels of authority, (3) inadequate staff augmentation, (4) lack of strategic communications, and (5) an estimated six to seven months for the CJTF to become fully operational & capable (FOC). In comparison, JTF OD provided a mobile platform with (1) mission focus, (2) levels of authority clearly established, (3) critical staff was augmented by the JECC, (4) strategic communications was provided by the JCSE, and (5) the JTF was FOC and completed all assigned tasks within a three week period.

From Major Combat Ops Risk	To Platforms	Acceptable Level of Risk
Indirect fires vs.	UA	High
	Fighter/attack fixed wing	Medium
	Manned rotary wing	Low
	Tanker/airlift/civilian	Low
UA vs.	UA	High
	Fighter/attack fixed wing	Medium
	Manned rotary wing	Medium
	Tanker/airlift/civilian	Low
Fighter/attack fixed wing vs.	UA	Medium
	Fighter/attack fixed wing	Medium
	Manned rotary wing	Low
	Tanker/airlift/civilian	Low
Manned rotary wing vs.	UA	Medium
	Fighter/attack fixed wing	Low
	Manned rotary wing	Medium
Tanker/airlift/civilian vs.	UA	Low
	Fighter/attack fixed wing	Low
	Manned rotary wing	Low
	Tanker/airlift/civilian	Low

Figure 12. Notional Risk Chart for the employment of UMS
Source: Department of the Air Force, Air Force Doctrine Document 3-52, *Air Space Control* (Maxwell AFB, AL: Government Printing Office, 2 February 2011), 55.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The purpose of Chapter 4 is to answer the primary research question; will the 2020 JTF be postured to utilize mandated unmanned systems? In order to answer this question, two secondary research questions have been analyzed.

UMSs have provided great capability throughout operations in OEF /OIF and are being designed to provide exponentially greater capabilities within the next 8-10 years that will dramatically impact the way the 2020 JTF executes its missions (see table 6). This thesis did not cover the broad spectrum of UMS development which ranges from nanotechnology (machines that are the size of a hummingbird, or smaller) utilizing SWARM technology to unmanned submarines. This thesis only covered the time period from the present to the year 2020, a period of eight years. The Service UMS Roadmaps extend beyond 2030 and to speculate about the capabilities that will become available in the next 18 years is beyond the scope of this thesis. Furthermore, excluded were numerous academic institutions, such as the Stanford Research Institute (Robotics and Artificial Intelligence Center), Florida Institute for Human and Machine Cognition, and QinetiQ that actively engage with DoD R&D and continue to expand on the estimated 7,000 unmanned/robot systems that are being utilized throughout the Global War on Terrorism.

Table 6. UMS Technology Roadmap (2012-2020)

		2012	2020	
Interoperability	Technology	Common Data links & Encryption	Common data standards across all services and platforms	Synergistic operation through the exchange, interpretation and action on data from coalition systems
	Capability	Common ground stations	Common autonomy capabilities across platforms	
Autonomy	Technology	Multi-sensor data fusion	Intelligent control	Force structure reduction and full, reliable autonomous control during complex mission sets
	Capability	Environmental understanding and adaptation	Autonomous collaboration	
Airspace Integration	Technology	Ground based Sense and Avoid	Airborne Sense and Avoid	UAS unfettered access to national and international airspace
	Capability	Missions in low density airspace	Dynamic operations for Medium and Large UAS	
Training	Technology	High Fidelity Simulators/Trainers	Universal Ground Control Station	TBD
	Capability	Manned/Unmanned Teaming	Universal Pilots and Operators	
Manned-Unmanned Teaming	Technology	UAV FMV and target data to manned aircraft	Cognitive machine learning	TBD
	Capability	MUMT-2 (air to air to ground)	Unmanned scout and attack	

Source: Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036* (Washington, DC: Government Printing Office, October 2010), 89.

The impact for DoD and pertinent for this thesis is how will these revolutionary systems impact the DOTMLPF process, more specifically the 2020 JTF. At which echelon will there be a centralized entity to integrate these unmanned systems and operational capabilities for the 2020 JTF? Will these occur at the Geographic Combat Commander (GCC) level, or with the Service Component Commands who will then

advise the GCC upon establishing a JTF? With the consensus that the future operating environment will be hybrid, which includes A2/AD threats, the emphasis for establishing a fully operational and capable (FOC) based on the JTF OD model, mitigating the CJTF-7 operational challenges, becomes a further opportunity for Senior leadership to consider: “jointness is not automatic; it must be continually updated through joint integrated joint force development activities to provide relevant capabilities that are responsive to the security environment.”⁸⁶

The establishment of a UMS consolidated proponenty within an appropriate CJCS directorate, such as the J7/ Joint Force Development and Integration (JFDID) division should be considered. The JFDID serves as the primary agent for developing and monitoring the implementation plans for joint experimentation and concept development.⁸⁷ Additionally, the USSTRATCOM Joint Functional Component Command for Intelligence, Surveillance and Reconnaissance (JFCC-ISR) merits consideration. The JFCC-ISR is responsible for aligning processing, exploitation, and dissemination (PED) capacity with ISR allocation to provide enablers necessary to deliver intelligence to combatant command. This recommendation is based on that all UMSs primarily serve as an ISR platform which can be re-configured to strike platforms.

All leaders and organizations that can directly impact UMS integration must support a culture of innovation, emphasizing the capabilities provided by these unmanned

⁸⁶Joint Forces Quarterly, “Joint Doctrine Update,” *JFQ* 64 (1st Quarter 2012): 148.

⁸⁷The author makes this recommendation based on the availability of unclassified sources. A discussion on the dissolution and capabilities of U.S. Joint Forces Command is outside the scope of this thesis.

systems throughout their formations. Therefore, the author offers a relevant outline from General (retired) Don A. Starry who found himself in a similar period of transformation, which required him to “bring clearly a focused intellectual activity in the matter of any change.”⁸⁸ In this case, the integration and employment of UMSs in lieu of manned systems or personnel throughout military operations.

1. There must be an institution or mechanism to identify the need for change.
2. There must be a spokesperson for change.
3. The spokesperson must build consensus amongst a wide audience.
4. There must continuity among the architects of change.
5. Changes proposed must be subjected to trials to determine their relevance.

All of the above have been presented throughout this thesis. For example, the mechanism for change has been identified as the FY2001 NDAA. The spokesman for change has been identified as academic writers and organizations, such as P.W. Singer and the AUVSI. The spokesman who must build consensus is present within the U.S. Congress, such as Congressman Howard P. “Buck” McKeon (R-CA), Chairman of the Congressional Unmanned Systems Caucus (CUSC), which recognizes the overwhelming value of unmanned systems in the scientific, intelligence, law enforcement, and homeland security communities.⁸⁹ Additionally, consensus is needed within the U.S. House Robotics Caucus which focuses on: (1) educating members of Congress and

⁸⁸GEN (R) Don A. Starry, “To Change an Army,” *Military Review* 63, no. 3 (March 1983): 20-27. This article is adapted from an address made by GEN Starry, 10 June 1982, to the US Army War College Committee on a Theory of Combat, Carlisle Barracks, PA. CGSC Copyright Registration #11-270 C/E.

⁸⁹Congressional Unmanned Systems Caucus (CUSC), <http://uavc.mckeon.house.gov/>.

congressional staff on current & future research and development, and utilization initiatives and (2) ensure that the nation remains globally competitive as the robotics industry expands and further affects the way we live our lives.⁹⁰ The continuity amongst the architects of change is reflected in the Services UMS roadmaps, many of which extend well beyond the timeline discussed in this thesis. Finally, the changes proposed must be subjected to trials to determine that their relevance is present in the DoD R&D directorates and amongst the commercial industry trials/programs that have been highlighted in this thesis.

Secondary research question conclusions

SRQ #1: What future training will be required for the JTF to employ UMSs?

In the DOTMLPF analysis process, *training* examines how we prepare our forces to fight and determine methods of improvement to offset war fighting capability gaps. It addresses the following questions: (1) is the issue caused by lack of or inadequate training? (2) does training exist which addresses the issue? and (3) do personnel affected by the issue have access to training?

Analysis of these questions reveals that the Services each participate in collective training throughout their respective training centers. The U.S. Army Combat Training Centers (CTC) offer the opportunity to fully integrate the UMS platforms outlined in this thesis to support the Army's Operating Concept; specifically, combined arms maneuver and wide-area security (CAM/WAS). Additionally, the Joint Multinational Readiness

⁹⁰U.S. House Robotics Caucus, <http://www.roboticscaucus.org/>.

Center (JMRC) in Grafenwoehr, Germany allows for the integration of U.S. and Coalition UMS programs and training.

The U.S. Navy's participation in a fleet exercise/joint task force exercise (FLEETEX/JTFEX) requires that it integrate all its forces in a multi-dimensional, multi-threat environment, in which UMS can range from UAVs, USVs, UUVs, and UGSs. In this respect, a JTFEX allows all participants to train with emerging systems and technology, such as UMS.

The U.S. Air Force engages in counter-UAV(C-UAV) scenarios, such as, Black Dart, Blue Knight, and Red Flag. The purpose of Black Dart is to determine DoD's ability to detect and counter enemy UAS systems in flight.⁹¹ The purpose of Blue Knight is to simulate air to air combat between UAVs, which due to the proliferation of UAVs is a realistic expectation in the near future and an operational concern for the 2020 JTF.⁹² The feasibility of Red Flag exercises extends to training USAF pilots in fighter interdiction, attack, defense suppression, airlift, air refueling, and reconnaissance.⁹³ The majority of these missions have been determined capable of being assumed by UAVs by the USAF *Unmanned Aircraft Systems Flight Plan 2009-2047* in lieu of manned systems.

⁹¹Holly Jordan, "AFRL, ASC team demonstrate Black Dart technology," posted 16 October 2006 and updated 14 December 2006, <http://www.wpafb.af.mil/news/story.asp?id=123034602> (accessed 20 February 2012).

⁹²Sgt. Josh LeCappelain (USA), "Blue Knight 2010 demonstration concludes in Nevada," <http://www.jfcom.mil/newslink/storyarchive/2010/pa112210.html> (accessed 20 February 2012).

⁹³414th Combat Training Squadron, "Red Flag," <http://www.nellis.af.mil/library/flyingoperations.asp> (accessed 22 February 2012).

In respect to the case studies and for future JTF operational considerations, a critical component for JTF OD was provided by the Joint Enabling Capabilities Command (JECC/USTRANSCOM). The JECC is a collection of high-demand joint capabilities ready to immediately support joint force commander requirements worldwide. The JECC provides mission-tailored, ready joint capability packages to Combatant Commanders in order to facilitate the rapid establishment of Joint Force Headquarters and to fulfill Global Response Force Execution and Bridge Joint Operational requirements.⁹⁴

The two critical enablers provided by the JECC were a Joint Deployable Team (JDT) consisting of experienced joint planners in planning and execution of the full range of joint military operations. Additionally, they provided expertise in operations, plans, knowledge management, intelligence, and logistics. Second, a Joint Communications Support Element (JCSE) delivered secure, reliable, and scalable command, control, communications, and computer (C4) capabilities to JFC's, U.S. Special Operations Command, and other agencies. The JSCE provided essential C4 support, ranging from small mobile teams to full-sized JTF headquarters that immediately establish and then expanded the communications capability of a JTF headquarters. Furthermore, the JCSE can access the full range of DoD and commercial networks.⁹⁵

SRQ #2: How will the incorporation of robust UMS capability impact the organization of a JTF in 2020?

⁹⁴Department of the Army, United States Transportation Command, JECC, <http://www.transcom.mil/jecc/> (accessed 5 February 2012).

⁹⁵Ibid.

In the DOTMLPF analysis process, *organization* examines how we are organized to fight and if there is a better organizational structure or capability that can be developed to solve a capability gap. It addresses the following questions: (1) where is the problem occurring?, (2) what is the mission focus of those organizations?, and (3) are Senior leaders aware of the issues?

Analysis of this question reveals that the Services are incorporating the organizational changes to incorporate UMS with the end state to reduce personnel/logistical footprints and exponentially enhance its operational capabilities. The USAF has established a robust Remote Piloted Aircraft (RAP) program for its officers, to include a career field and UAV formations. The USN is engaged in UMS programs that have strategic implications, such as strategic forward presence. The United States Marine Corps is restructuring their MAGTF to incorporate UMSs. The U.S. Army is primarily focusing on UGVs and UAVs to support future land operations. The challenge for Senior leaders, both military and civilian, is the integration of UMSs and its reduced personnel footprint to support the 2020 JTF. The experience of a JTF HQ taking almost eight months to become fully operational & capable (FOC) is not an option. The capabilities of UMS have the ability to reduce the length of operations from months to weeks.

Answer to the Primary Research Question

So, will the 2020 JTF be postured to utilize revolutionary unmanned systems? At this time all available information to the author indicates that the 2020 JTF will have the basic organizational framework to incorporate unmanned systems. Additionally, the services have initiated the organizational changes to integrate UMSs with the understanding that an end state is for these systems to reduce the personnel and logistical

footprints throughout military operations. However, at this time, unclassified sources have not provided a definitive answer to the integration of UMSs to support the 2020 JTF. The CJCS has directed the Services with a specified and essential task; the 2020 JTF will be required to leverage cutting-edge information technologies to ensure a secure and collaborative C2 network in an operational environment encompassing hybrid threats, A2/AD threats, and the proliferation of advanced unmanned systems. The CJTF -7 case study highlighted lessons observed that cannot be repeated in establishing a JTF in the future operating environment in order to accomplish the specified task(s) outlined by the CJCS. Additionally, the JTF OD case study highlights the future considerations of integrating UMS to accomplish missions traditionally executed by manned platforms and/or personnel.

Recommendations

The 2020 JTF will be postured to utilize revolutionary unmanned systems, if the following recommendations are implemented:

1. Establish a Joint UMS Directorate to assist combat commanders in the integration and training of a JTF utilizing the aforementioned UMSs. Additionally, this UMS directorate would establish an UMS Lexicon that would provide a common language and end the debate of how to properly classify an UMS platform, for example is a Reaper an UAV or UAS? The current ALFUS document provides a starting point on codifying a DoD UMS Lexicon which can be adopted by other government, civilian, and academic organizations.

2. Services must continue to leverage their respective training centers and exercises to fully exploit the incorporation of UMSs throughout their operations and

provide recommendations to the CJCS on how to best integrate UMS platforms and formations within the 2020 JTF. For example, the U.S. Army is currently conducting discussions on the future task organization of its Battlefield Surveillance Brigade (BfSB) which provides ISR to the supported Division commander and higher echelons. The ability to integrate UAS, UGV and UGS (Unattended Ground Sensors) will exponentially increase the ISR capabilities for the commander while reducing the personnel and logistical requirements; to include mitigate AD/A2 threats.

3. DoD must encourage a culture of innovation with specific emphasis on UMS throughout all of its echelons. As UMSs continue to develop its capacity for autonomy and replace manned systems and personnel, leaders must consider the new tactical and operational capabilities these systems provide. It can be argued that at the tactical level, U.S. Service members readily adapt, however, military organizations as a whole are often deliberate to accept change due to the invested time and resources in supporting their respective Services strategic considerations. Additionally, DoD must encourage institutional training on UMS which can dissuade potential Service hindrance to change and allow for discourse amongst leaders regarding the impact of UMS integration into their respective Services and for the 2020 JTF.

4. DoD expands the capabilities of organizations, such as the JECC, to train Joint officers on the incorporation and execution of staff processes utilizing UMSs. The notional JTF HQ structure will likely remain the same; however, as UMSs reduce mission accomplishment from months to weeks, the feasibility of an organization such as the JECC becomes apparent. An end state for UMS incorporation throughout the Services is the reduction of personnel/formation footprint throughout its operations.

Therefore, DoD must continue to support UMS development, and specific to this thesis to ensure that the 2020 JTF is postured to integrate and accomplish its essential tasks utilizing unmanned systems in lieu of manned platforms.

Recommendations for further research

While the aforementioned recommendations are of most importance, there continues to be room for further discussion and analysis on this ever-evolving topic. These topics and areas for further research include (1) UMSs impacts all three levels of war, (2) the Services doctrinal framework, (3) continuing impact to the DOTMLPF process, and (4) impact on Joint, Interagency, Intergovernmental, and Multinational (JIIM) planning considerations and integration.

GLOSSARY

Air interdiction. Air operations conducted to divert, disrupt, delay, or destroy the enemy's military surface capabilities before it can be brought to bear effectively against friendly forces, or to otherwise achieve objectives that are conducted at such distances from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required (Joint Publication 3 -03, Joint Interdiction, 14 OCT 2011, GL-4).

Cognizance Levels or Levels of Cognizance. The levels of what a UMS can know or understand based on its sensory processing capability: Level 1. Data or observed data, initially processed forms after measured by sensors. Level 2. Information, further processed, refined and structured data that is human understandable. Level 3. Intelligence, knowledge, combat and actionable information. Further processed for particular mission needs. Directly linked to tactical behaviors.

Common Operational Picture (COP). A single identical display of relevant information shared by more than one command; to facilitate collaborative planning and situational awareness.

Cooperative Engagement. A method of engagement for destroying enemy forces, employing sensors and shooters not resident on the same platform.

Controlling Element. The part of a UMS that provides a method for a human to control it remotely.

Information Superiority. Information, information processing, and communications networks are at the core of every military activity. The development of a concept labeled *the global information grid* (GIG) will provide the network-centric environment required to achieve this goal. Interoperability is the foundation of effective joint, multinational, and interagency operations, a mandate for the joint force of 2020 especially in terms of communications, common logistics items, and information sharing. Information systems and equipment that enable a common relevant operational picture must work from shared networks.

Markers. (physical or electronic). A visual or electronic aid used to mark a designated point for such tactical purposes as route following, determination of bearings, courses, or location, and key items or points of interest, including landmine markers, minefields markers, and area NBC decontamination markers.

Material Solution. Correction of a deficiency, satisfaction of a capability gap, or incorporation of new technology that results in the development, acquisition, procurement, or fielding of a new item (including ships, tanks, self-propelled weapons, aircraft, etc., and related software, spares, repair parts, and support equipment, but excluding real property, installations, and utilities) necessary to equip, operate, maintain, and support military activities without disruption as to

its application for administrative or combat purposes. In the case of family of systems and system of systems approaches, an individual materiel solution may not fully satisfy a necessary capability gap on its own.

Non-materiel solution. Changes in doctrine, organization, training, materiel, leadership and education, personnel, facilities, or policy (including all human systems integration domains) to satisfy identified functional capabilities. The materiel portion is restricted to commercial or non-developmental items, which may be purchased commercially, or by purchasing more systems from an existing materiel program. The materiel portion must comply with all acquisition policies.

Operator Control Unit (OCU). Also referred to as operator control interface (OCI) or human interaction control unit. The computer(s), accessories, and data link equipment that an operator uses to control, communicate with, receive data and information from, and plan missions.

Precision Engagement. The effects based engagement that is relevant to all types of operations. Its success depends on in-depth analysis to identify and locate critical nodes and targets. The pivotal characteristic of precision engagement is the linking of sensors, delivery systems, and effects.

Point and Shoot. A subset of cooperative engagement that allows a soldier or platform to designate a target for lethal engagement by another platform. The information is immediately displayed on the COP. Point and Shoot implies the immediacy of effects and generally occurs within the same echelon.

Remotely Guided. An unmanned system requiring continuous input for mission performance is considered remotely guided. The control input may originate from any source outside of the unmanned system itself. This mode includes remote control and teleoperation.

Sensor to Shooter. The information link from a target acquisition capability to the weapons platform(s) that engage(s) the target.

Standoff. Detection or lethality efforts intended to suppress an enemy threat from a position outside the range of the enemy threat.

Unattended Ground sensors (UGS). Small, low cost, robust sensors, capable of operating in the field for extended periods of time (30 days or more). They will consist of modular groups of sensors utilizing tailorable ground sensing technologies, such as seismic, magnetic, infrared, acoustic, radio frequency, and CBRN detection, and other advanced sensing capabilities. UGSs self-organize into a networked sensor array (sensor web) by locating the most efficient gateways for transmission of information.

APPENDIX A

Universal Joint Task List (UJTL) UMS feasibility evaluation matrix

UJTL	UJTL Description (Task description to be executed by an unmanned system)	Schedule	Cost	Complexity	Total	Feasible within next five years (2015)	UJTL Schedule	UJTL Cost	UJTL Complexity	UJTL Total	UJTL Feasible within next five years (2015)
L1-A	Surface area transport and delivery of equipment and supplies using bipedal conveyer	2	3	3	9	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L1-B	Aerial cargo transport and delivery of equipment and supplies using bipedal conveyer	2	3	3	9	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L2	Cargo packaging and pallet assembly	2	3	3	9	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L3-A	Packaged warhousing, inventory management, prioritization, retrieval and preparation for movement	2	3	3	9	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L3-B	Loose binning, warhousing, inventory management, prioritization, retrieval and preparation for movement	2	3	3	9	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L4	Chair and lift operations	2	1	2	5	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L5	Chair and lift operations	2	1	2	5	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L6-A	Indoor yard lift and short movement operations	2	1	2	5	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L6-B	Outdoor yard lift and short movement operations	2	1	2	5	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L7-A	New design for warhousing discharge equipment ship to shore	2	2	2	6	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
L7-B	Refurbish for warhousing discharge equipment ship to shore	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
L8	Robotic re-arming	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
L9	Soldier Sustainability: Improved Soldier Strength and Endurance and Transport of Equipment and Supplies in Support of Unmanned Manned	2	1	1	4	No	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	No
S1-A	Provide unarmed perimeter security of military installation/airfield, ammunition storage area, chemical weapons storage area, CONUS, unarmed, static	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
S1-B	Provide perimeter security of military installation/airfield, ammunition storage area, chemical weapons storage area, FOB exterior, armed, static	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
S1-C	Provide perimeter security of military installation/airfield, ammunition storage area, chemical weapons storage area, FOB interior, armed, mobile	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
S1-D	Provide perimeter security of military installation/airfield, ammunition storage area, chemical weapons storage area, FOB exterior, armed, mobile	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
S2-A	Remotely scan personnel and vehicles entering restricted areas, found at Entry Control Point	2	3	3	8	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
S2-B	Remotely scan personnel and vehicles entering restricted areas, mobile	2	3	3	8	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
S3	Detect, identify, assess, report, and provide warning, in event of a hazardous spill	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
S4	Remove and clean up hazardous materials from contaminated areas	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
S5	Chemistry evaluation	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$500K)	3 = Low	3 = Low	3 = Low	Yes
E1-A	Conduct terrain scan for navigational purposes	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
E1-B	Conduct terrain scan for radiability and location of burn/synthchemicals	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
E2-A	Overcome and report obstacles	3	2	3	8	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
E2-B	Overcome and report obstacles	3	2	3	8	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
E2-C	Overcome and report obstacles	3	2	3	8	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
E3-A	Conduct forward operations, suppress obstacles, and report obstacles	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E3-B	Conduct forward operations, suppress obstacles, and report obstacles	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E3-C	Conduct forward operations, suppress obstacles, and report obstacles	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E4-A	Move and employ material, construct obstacles, establish security, Remote control and tele-operation	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E4-B	Move and employ material, construct obstacles, establish security, Fully autonomous	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E5	Mark, record and report obstacles	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E6-A	Conduct fire-fighting operations, Remote control and tele-operation	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E6-B	Conduct fire-fighting operations, Fully autonomous	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E7-A	Enhance for airfield, FOBs etc. Fully autonomous	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E7-B	Enhance for airfield, FOBs etc. Fully autonomous	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E8-A	Detection and removal of explosives, surface and sub surface on land or water, Remote control and tele-operation	2	2	2	6	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
E8-B	Detection and removal of explosives, surface and sub surface on land or water, Fully autonomous	2	2	2	6	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
M1-A	Conduct primary operations, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M1-B	Perform maintenance, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M2-A	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M2-B	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M3	Perform battlefield fire aid	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M4	Recover battlefield casualties	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M5	Disposal of medical waste	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
M6	Conduct primary operations, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M7	Perform maintenance, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M8	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M9	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M10	Perform battlefield fire aid	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M11	Recover battlefield casualties	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M12	Disposal of medical waste	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
M13	Conduct primary operations, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M14	Perform maintenance, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M15	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M16	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M17	Perform battlefield fire aid	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M18	Recover battlefield casualties	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M19	Disposal of medical waste	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
M20	Conduct primary operations, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M21	Perform maintenance, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M22	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M23	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M24	Perform battlefield fire aid	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M25	Recover battlefield casualties	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M26	Disposal of medical waste	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
M27	Conduct primary operations, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M28	Perform maintenance, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M29	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M30	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M31	Perform battlefield fire aid	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M32	Recover battlefield casualties	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M33	Disposal of medical waste	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
M34	Conduct primary operations, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M35	Perform maintenance, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M36	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M37	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M38	Perform battlefield fire aid	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M39	Recover battlefield casualties	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M40	Disposal of medical waste	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
M41	Conduct primary operations, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M42	Perform maintenance, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M43	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M44	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M45	Perform battlefield fire aid	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M46	Recover battlefield casualties	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M47	Disposal of medical waste	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low	3 = Low	3 = Low	Yes
M48	Conduct primary operations, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M49	Perform maintenance, CONUS	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M50	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M51	Perform maintenance, Visual range	3	3	3	9	Yes	3 = Low (< 5 years) 2 = Mid (0.5 years)	2 = Mid (0.5 years)	3 = Low	3 = Low	Yes
M52	Perform battlefield fire aid	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M53	Recover battlefield casualties	1	1	2	4	No	1 = High (> 5 years) 2 = Mid (0.5 years)	1 = High (> \$10M)	2 = Mid	2 = Mid	No
M54	Disposal of medical waste	2	2	3	7	Yes	2 = Mid (0.5 years) 3 = Low (< \$10M)	3 = Low			

APPENDIX B

Interoperability across UMS Domains Vignette, 2030s Scenario

1. a. A former Soviet-era, *Akula* class, nuclear-powered attack submarine sails out of a rouge state undetected by reconnaissance satellites and detected by a US Navy underwater surveillance grid, triggering an unmanned underwater vehicle (UUV) to deploy and tether itself to the submarine.

1. b. Every three hours the UUV transmits a low-power position report which is received by an orbiting communications relay, the Baton One, an EQ-25 (UAS) operating at 75,000 ft. The EQ-25 is an extreme-endurance UAS, capable of operating for two months on station without refueling.

1. c. By the third day of sail, the submarine is heading toward the mid-Pacific and the Hawaiian Islands. The decision is made to deploy a naval anti-submarine warfare (ASW) ship to intercept and track the submarine. The following day, the submarine reverses course and the ASW ship turns for Pearl Harbor.

1. d. A Broad Area Maritime Surveillance (BAMS) UAS, MQ-4C, is launched from Guam to in order to track the beacon. Autonomously descending with its internal airborne sense and avoid (ABSAA) system the BAMS UAS is able to visually acquire the UUV, detached from the submarine. The submarine's position and intent are now unknown.

1. e. Ten days later, seismic disturbances are detected 150 miles southeast of Anchorage, Alaska. An interagency DoD/homeland defense reconnaissance UAS is launched and detects a radiation plume. The UAS maps the plume as it begins spreading over the sound, and a U.S. Coast Guard offshore patrol cutter employs its unmanned helicopter to drop buoys with CBRN sensors to measure fallout levels. The plume begins to spread over the sound and threatens the city of Valdez. The port of Valdez, the largest indigenous source of oil for the United States, is effectively under quarantine.

1. f. Due to the growing contamination of the local environment, disaster response officials request US military unmanned CBRNE support. The amphibious transport dock ship USS *New York* anchors near an entrance to Prince William Sound and begins

operations with its unmanned surface vehicles (USVs) and MQ-8 Fire Scout unmanned helicopters. An EQ-25 orbit is established over the Sound to ensure long term, high-volume communication capability in the high-latitude, mountainous region. The EQ-25 UAS is capable of handling all the theater data relay requirements.

1. g. A USV proceeds to the focus of contamination and lowers a tethered remotely operated vehicle (ROV) to conduct an underwater search for the source and finds the open hull of the *Akula* class submarine. The ROV places temperature gradient sensors on the hull and inserts gamma sensors into the exposed submarine compartments.

1. h. The radiation plume has now encompassed the evacuated town of Valdez, and MQ-8 Fire Scout fly repeated sorties to the town, dock, and terminal areas to deploy unmanned ground vehicles (UGVs) with sensors and collect samples for analysis.

1. i. With conditions deteriorating, two unmanned Homeland Defense CBRN barges fitted with cranes, containers, and remote controls arrive from Seattle. Over the next two weeks, ROVs equipped with cutting torches, grappling fixtures, and operating from USVs, one remotely operated submersible barge is able to work around the clock and recover the exposed fuel sources and to isolate them in specially designed containers. A second barge similarly retrieves sections of the crippled submarine. Both barges operate with a high degree of autonomy, limiting exposure of personnel to the radioactive contamination.

1. j. The UGVs continue monitoring contamination levels and collecting samples, but now also start conducting decontamination of the oil terminal control station and the local power and water facilities. Highly contaminated soil is placed into steel drums, and larger UGVs are used to dig pits and bury contaminated building and pipeline materials.

1. k. Advanced sensor technology and control logic allows the UGVs to operate around the clock with human operators serving solely in a monitoring function. USVs are used to collect carcasses floating in the Sound and bring them to shore for disposal. UASs fly continuously at low altitude to monitor and map the declining radiation contours, at medium altitude to map cleanup operations, and at high altitude to relay control commands and data from the nearly one hundred unmanned vehicles at work.

1. 1. Decontamination, refueling, and repair shops have been established in nearby Cordova to service the vehicles and aircraft and on the USS *New York* to service the boats and submersibles, thereby, conducting the largest demonstration of interoperability between air, ground, and maritime unmanned systems.⁹⁶

⁹⁶This vignette offers an example of the increased capability and flexibility inherent in unmanned systems as DoD continues to field unmanned technologies and integrate resulting systems into its existing force structure. Adopted from the U.S Department of Defense, *The Unmanned Systems Integrated Roadmap, FY 2011 -2036*, 6.

BIBLIOGRAPHY

Books

- Mansoor, Peter R. *Baghdad at Sunrise: A Brigade Commander's War in Iraq*. New Haven: Yale University Press, 2008.
- Singer, P. W. *Wired for War: The Robotics Revolution and Conflict in the 21st Century*. New York: Penguin Press, 2009.

Government Documents

- Chairman, Joint Chiefs of Staff. *Chairman's Strategic Direction to the Joint Force*. Washington, DC: Government Printing Office, 6 February 2012.
- . Joint Publication (JP) 1, *Doctrine for the Armed Forces of the United States*. Washington, DC: Government Printing Office, March 2007, Incorporating Change 1, March 2009).
- . Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*. Washington, DC: Government Printing Office, as amended through 15 November 2011.
- . Joint Publication (JP) 3-0, *Joint Operations*. Washington, DC: Government Printing Office, 11 August 2011.
- . JP 3-03, *Joint Interdiction*. Washington, DC: Government Printing Office, 14 October 2011.
- . JP 3-30, *Command and Control for Joint Air Operations*. Washington, DC: Government Printing Office, 12 January 2010.
- . JP 3-31, *Command and Control for Joint Land Operations*. Washington, DC: Government Printing Office, 29 June 2010.
- . JP 3-32, *Command and Control for Joint Maritime Operations*. Washington, DC: Government Printing Office, 8 August 2006, Incorporating Change 1, 27 May 2008.
- . JP 3-33, *Joint Task Force Headquarters*. Washington, DC: Government Printing Office, 16 February 2007.
- . JP 3-52, *Joint Airspace Control*. Washington, DC: Government Printing Office, 20 May 2010.

- . JP 5-0, *Joint Operation Planning*. Washington, DC: Government Printing Office, 11 August 2011.
- Department of the Air Force. Air Force Doctrine Document 3-52, *Air Space Control*. Maxwell AFB, AL: Government Printing Office, 2 February 2011
- . *Unmanned Aircraft Systems Flight Plan 2009-2047*. Washington, DC: Government Printing Office, 18 May 2009.
- Department of the Army. Field Manual (FM) 3-0, *Operations*. Washington, DC: Government Printing Office, 2008.
- . Field Manual (FM) 3-60.2. *Multi-Service Tactics, Techniques, and Procedures for Strike Coordination and Reconnaissance*. Washington, DC: Government Printing Office, November 2008.
- . *Robotics Strategy White Paper*. Prepared by Army Capabilities Integration Tank-Automotive Research and Development Engineering Center Robotics Initiative, Washington, DC, 19 March 2009.
- . TRADOC Pam 525-3-1, *The Army Operating Concept*. Washington, DC: Government Printing Office, 2010.
- . Training Circular 7-100, *Hybrid Threat*. Washington, DC: Government Printing Office, 29 November 2010
- Department of Defense. *FY2009–2034: Unmanned Systems Integrated Roadmap*. Washington, DC: Government Printing Office, 2009.
- . “Military Power of the People’s Republic of China 2007.” Report to Congress Pursuant to the National Defense Authorization Act Fiscal Year 2000. Washington, DC.
- . *Unmanned Systems Integrated Roadmap FY2011-2036*. Washington, DC: Government Printing Office, October 2010.
- Department of the Navy and United States Marine Corps, *Marine Corps Vision and Strategy 2025*. Washington, DC: Government Printing Press.
- . *Fiscal Year 2011 Marine Aviation Plan*. Washington, DC: Government Printing Office, 16 September 2010.
- Maneuver, Aviation and Soldier Division. “Initial Capabilities Report for Unmanned Systems (Air, Ground, and Maritime).” Prepared for a Material Development Decision, draft version 2.2. Fort Monroe, VA, 2010.

Wright, Donald P. *The United States Army in Operation Iraqi Freedom, May 2003-January 2005: On Point II: transition to the New Campaign; With the Contemporary Operating Study Team*. Washington, DC: Government Printing Office, June 2008.

Periodicals/Journals

414th Combat Training Squadron. "Red Flag." http://www.nellis.af.mil/library/flying_operations.asp (accessed 22 February 2012).

Axe, David. "The Future of Land Wars: Intense, High-Tech, Urban, Coastal." 30 November 2011. <http://defense.aol.com/2011/11/30/the-future-of-land-wars-intense-high-tech-urban-coastal/> (accessed 15 December 2011).

Carafano, James Jay, Ph.D., Andrew Gudgel, and Alane Kochems. "The Pentagon's Robots: Arming the Future." *Competitive Technologies for National Security: Review and Recommendations*. Heritage Special Report (29 February 2008).

Carter, Walter E. Jr. "The Joint Enabling Capabilities Command: A Rarity within the Conventional Force." *Joint Forces Quarterly* 64 (January 2012): 19.

Gunzinger, Mark A. *Sustaining America's Strategic Advantage in Long-Range Strike*. Washington, DC: Center for Strategic and Budgetary Assessments, 2010.

James, Gregory K., Larry Holcomb, and Chad T. Manske. "Joint Task Force Odyssey Dawn: A Model for Joint Experience, Training, and Education." *Joint Forces Quarterly* 64 (January 2012): 26.

Jordan, Holly. "AFRL, ASC team demonstrate Black Dart technology." Posted 16 October 2006 and updated 14 December 2006. <http://www.wpafb.af.mil/news/story.asp?id=123034602> (accessed 20 February 2012).

LeCappelain, Sgt. Josh (USA). "Blue Knight 2010 demonstration concludes in Nevada." <http://www.jfcom.mil/newslink/storyarchive/2010/pa112210.html> (accessed 20 February 2012).

Munoz, Carlo. "CNO Bets on Underwater Drones for Future Fleet." *AolDefense*, 19 August 2011. <http://defense.aol.com/> (accessed 10 November 2011).

———. "Navy Arms Its First Unmanned Vehicle, Fire Scout." *AolDefense*, 9 November 2011. <http://defense.aol.com/> (accessed 20 November 2011).

———. "Navy tries MH-60 Seahawks with unmanned helos." *AolDefense*, 9 November 2011. <http://defense.aol.com/> (accessed 12 November 2011).

- Popular Mechanics*. "Air Strike 2025, The Radical Plan to Reinvent the Air Force." March 2010: 59.
- Schneider, Barry R., and Lawrence E. Grinter, eds. "Battlefield of the Future: 21st Century warfare issues." *Air War College Studies in National Security*: no. 3, September 1998.
- Starry, GEN (R) Don A. "To Change an Army" *Military Review* 63, no. 3 (March 1983): 20-27.
- Walsh, Eddie. "Predator Maker Redesigns UAV To Boost Exports" *AolDefense*, 15 November 2011. <http://defense.aol.com/2011/11/15/predator-maker-redesigns-uav-to-boost-exports/> (accessed 1 December 2011).

Internet Sources

- "A160T Hummingbird unmanned helicopter proves resupply capability for U.S. Marines." <http://www.armybase.us/2010/03/a160t-hummingbird-unmanned-helicopter-proves-resupply-capability-for-u-s-marines/> (accessed 28 December 2011).
- "Military Increasingly Looking to Robots to Clear Waterways of Dangerous Mines." 27 July 2007. <http://www1.whdh.com/news/articles/national/MI56402/> (accessed 27 November 2011).
- "Say hello to Pakistan's first domestically produced armed drone: The Burraq UCAV." 5 December 2011. <http://www.techlahore.com/2011/12/04/say-hello-to-pakistans-first-domestically-produced-armed-drone-the-burraq-uav/> (accessed 15 December 2011).
- Congressional Unmanned Systems Caucus (CUSC). <http://uavc.mckee.house.gov/> (accessed 17 January 2012).
- Department of the Army. United States Transportation Command, JECC. <http://www.transcom.mil/jecc/> (accessed 5 February 2012).
- JTF Odyssey Dawn website. <http://www.naveur-navaf.navy.mil/odysseydawn/index.html> (accessed 10 March 2012).
- Lockheed Martin. "LONGBOW LLC's Data Link Controls UAS from Apache Block III Attack Helicopter for the First Time." <http://www.lockheedmartin.com/us/news/press-releases/2011/november/LONGBOWLLCsDataLinkContro.html> (accessed 12 March 2012).
- . "LONGBOW UTA" http://www.f-16.biz/us/products/longbow_uta.html (accessed 12 March 2012).

Military and Aerospace Executive Briefing: Unmanned aircraft applications proliferate, and represent one of the few growing markets in an otherwise-shrinking defense budget. <http://www.militaryaerospace.com/executive-briefings/2011/unmanned-aircraft-applications-proliferate.whitepaperpdf.render.pdf>. (accessed 14 April 2012).

Northrop Grumman. "Facts: Northrop Grumman Proves Value of Vertical Unmanned Systems at Army Expeditionary Warrior Experiment." www.northropgrumman.com/media (accessed 14 April 2012).

The International Campaign to Abolish Nuclear Weapons. <http://www.icanw.org/nuclear-map/> (accessed 15 December 2011).

U.S. House Robotics Caucus. <http://www.roboticscaucus.org/> (accessed 15 January 2012).

Other Sources

Defense Professionals. <http://www.defpro.com/news/details/10219/> (accessed 27 December 2011).

Ehrhard, Thomas P., and Robert O. Work. *Range, Persistence, Stealth, and Networking: The Case for a Carrier-Based Unmanned Combat Air System*. Washington, DC: Center for Strategic and Budgetary Assessments, 2008.

Federal Agencies Ad Hoc Autonomy Levels for Unmanned Systems Working Group Participants. *Autonomy Levels for Unmanned Systems (ALFUS) Framework, Volume I: Terminology Version 1.1*. Edited by Hui-Min Huang, National Institute of Standards and Technology, September 2004. www.nist.gov/el/isd/ks/upload/NISTSP_1011_ver_1-1.pdf. (accessed 20 September 2011).

Finklestein, Dr. Robert. "Robotics in Future Warfare." Presented to the Panel on Robotics and Contemporary/Future Warfare Conference on the Strategic Implications of Emerging Technologies, US Army War College Strategic Studies Institute, 14-16 April 2009.

Krepinevich, Andrew, Barry Watts, and Robert Work. "Meeting the Anti-Access and Area-Denial Challenge." Washington, DC: Center for Strategic and Budgetary Assessments, 2003.

Krepinevich, Jr. Andrew F. "The Conflict environment of 2016: A Scenario-Based Approach." Washington, DC: Center for Strategic and Budgetary Assessments, October 1996.

NATO Parliamentary Assembly, Pierre Claude Nolin (Canada), General Rapporteur, 175
STC 07 E bis -*Transforming the Future of Warfare: Network-Enabled
Capabilities and Unmanned Systems*. Annual Session, 2007.

Van Tol, Jan with Mark Gunziger, Andrew Krepinevich, and Jim Thomas. "AirSea
Battle: A Point-of-Departure Operational Concept." Washington, DC: Center for
Strategic and Budgetary Assessments, 2010.

Watts, Barry D. "The Maturing Revolution in Military Affairs." Washington, DC: Center
for Strategic and Budgetary Assessments, 2011.

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