A RQ-7 Shadow 200 unmanned aerial vehicle takes off for a night mission. The 4th Squadron, 6th Cavalry maintains 24-hour surveillance over the skies of Mosul. (Photo Courtesy of Combat Aviation Brigade, 1st Infantry Division)

Wargaming the Enemy Unmanned Aircraft System Threat

By COL (Ret.) David M. Neuenswander

The downing of two Hezbollah Ababil Unmanned Aircraft Systems (UAS) over Israel, during the 2006 Lebanon War, served as a 'benchmark tactical event' in that war. Although the U.S. military had been looking at ways to defend against enemy UAS prior to 2006, it is safe to say that Hezbollah's use of UAS served as a wakeup call for the entire Department of Defense. This prompted Joint Forces Command's Joint UAS Center of Excellence and Joint Staff J8, Joint Integrated Air and Missile Defense Organization (JIAMDO) to conduct a series of UAS defense events. In addition, since 2008, the U.S. Army has conducted a series of Training and Doctrine Command (TRADOC) funded joint experiments with a significant enemy UAS threat. These experiments included the Fires Battle Lab's Earth Wind and Fire (EWF) 2008 and 2009 experiments and 2010 Army Functional Concepts Integration Experiment (AFCIE) at Fort Sill, Okla., the Mission Command Battle Lab's Omni Fusion 2008 and 2009 experiments at Fort Leavenworth, Kan., and the 2011 Joint Forcible Entry Warfighting Experiment (JFEWE) run by the Maneuver Battle Lab at Fort Benning, Ga. In each of these experiments the U.S. Air Force provided support in the form of personnel, and in several of the larger experiments the Air Force provided modeling and simulation support. This article discusses the major Air Force UAS defense insights gained in the above TRADOC experiments with a focus on the operational level of war, and recommends UAS defense be a topic of discussion at the 2012 Army Air Force Warfighter Talks. To understand the Air Force insights, it is necessary to discuss briefly the UAS categories or groups, the scenarios for the experimentation, and the definition of air superiority with respect to UAS.

UAS categories. Joint Publication (JP) 3-30, Command and Control for Joint Air Operations, categorizes U.S. UAS in five groups described in figure below.

During the Army experiments, the simulations focused

> "Counter UAS is a prevalent problem that we think is only going to get bigger."
>
> — BG Jeff Colt,
> Commander, Joint Unmanned Aircraft System
> Center of Excellence

on Group 3, 4, and 5 UAS and did not include actions against enemy Group 1 and some Group 2 systems. The author acknowledges that the small UAS in Group 1 and 2, often referred to as 'backpack UAS' are a problem; however, unless otherwise noted, the lessons learned and recommendations are for larger Group 2, 3 and 5 UAS. For the purpose of this paper, the author uses the U.S. joint term Unmanned Aircraft System (UAS) for all unmanned systems, including the former unmanned aerial vehicle (UAV) referenced in some of the source documents.

Scenarios. The majority of these experiments were based on variants of the May 2007, TRADOC "Multi-Level Scenario Module 1: 7th Division," produced by the TRADOC Analysis Center (TRAC) at Fort Leavenworth, Kan. The enemy was a 'hybrid threat' as defined in current Army Doctrine, and simultaneously employed both regular and irregular forces. In all of the experiments the Army's 'World Class Red Forces' employed some number of UAS against friendly ground forces in a division operations area. Some experiments had larger numbers of UAS than others; however, regardless of the phase in which the experiment occurred (i.e., JP 5-0 Phase II Seize Initiative, Phase III Dominate, or Phase IV Stabilize) the red forces employed UAS. These experiments focused on conditions at the start of each experiment, rather than the specific 'shaping' prior to entry of the ground forces. How the joint force commander/Joint Force Air Component Commander (JFACC) executed theater wide air interdiction and offensive counter-air campaigns against the enemy UAS threat during the scenario's early Phase II operations remains unknown. Neither the Air Force nor the Army gained a concrete understanding of the numbers, types, and percentages of enemy UAS that could be attritted by air component, special operations forces, and long range Fires prior to introducing ground forces. Electronic warfare and cyber capabilities were not employed against enemy UAS in any of the experiments.

All of the experiments assumed a JFACC who also served as the airspace control authority (ACA) and area air defense commander (AADC). When required, the JFACC was the supported commander for the theater-wide air interdiction campaign and the supported commander for counter-air. Air Force personnel simulated an air operations center (AOC), control reporting center (CRC), air support operations center (ASOC), and tactical air control parties (TACP) at division and below for the experiments. Army personnel simulated Air Defense Artillery fire control officers (ADAFCO) and were co-located with the appropriate Air Force CRC elements to simulate a sector air defense command (SADC). The SADC allowed the experiment JFACC to simulate the AADC 'commit and engagement authorities' within the experiments.

Air superiority as it relates to the enemy. JP 1-02 defines air superiority as, "that degree of dominance in the air battle of one force over another that permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force." With respect to enemy UAS, each component, land, sea, and air, gets a vote on what constitutes 'prohibitive interference.' During the above listed experiments there were two questions that were difficult to answer. The first being: how many UAS does the enemy have to fly over the land component area of operations before they become a prohibitive interference? Which leads to the second question: if the enemy can fly his UAS in proximity to friendly ground forces, does the U.S. have air superiority?

The answers to both questions often fall into the dreaded 'it depends' category. With respect to the number of enemy systems, much depends on what the ground forces are doing at the time, and what mission the enemy UAS is conducting. A single UAS directing long range precision Fires on a forcible entry can have devastating effects on friendly troops. Whereas multiple short range systems not linked to Fires might have a lesser effect on ground troops conducting stability operations.

It is important to note that the U.S. has been engaged in 10 years of war with air supremacy. JP 1-02 defines air supremacy as, "that degree of air superiority wherein the opposing air force is incapable of effective interference." Whether or not the U.S. can achieve air supremacy in the face of an opponent who has effective UAS systems remains to be seen; air supremacy was not achieved in any experiments listed above.

INSIGHTS. Observations obtained during the experiments led to the for-

Group	Max. Takeoff Weight (lbs.)	Operating Altitude (ft.)	Air Speed (kts.)	Unmanned Aircraft System Models
1	0-20	<1200 AGL	100	Wasp III, TACMAV, RQ-14A/B, Buster, BATCAM, RQ-11B, FPASS, RQ-16A, Pointer, Aqua/Terra,
2	21-55	<3500 AGL	<250	Scan Eagle, Silver Fox, Aerosonde
3	<1320	<18000 MSL	<250	RQ-7B Shadow, RQ-15 Neptune, XPV-1 Tern, XPV-2 Mako
4	>1320	<18000 MSL	Any	MQ-5B Hunter, MQ-8B Fire Scout/Navair, MQ-1C ERMP, MQ-1A/B/C Preditor
5	>1320	<18000 MSL	Any	MQ-9C Reaper, RQ-4 Global Hawk, RQ-4N BAMS

Above Ground Level (AGL), Mean Sea Level (MSL)

mulation of the following seven major Air Force UAS defense insights.

INSIGHT 1: The joint force must counter enemy UAS. Throughout the experimentation when the enemy could consistently fly UAS systems in the vicinity of friendly ground forces, the supported commanders generally felt the enemy UAS were a 'prohibitive interference.' Thus, using the joint definition of air superiority, one would assume that a consistent enemy UAS threat creates a prohibitive influence and logically this means the U.S. did not have air superiority. The only way to prevent consistent enemy UAS activity was to defeat either the enemy aircraft, ground stations (including crews), or communications. Therefore, if the joint force cannot effectively counter the enemy UAS, then air superiority cannot be achieved.

INSIGHT 2: UAS defense is a joint endeavor. Shortly after the 2008 electronic warfare (EWF) experiment at Fort Sill, Okla., both the Air Force and the Army agreed to bring the Joint UAS Center of Excellence (JUAS COE) into the experiments to assist with UAS defense. From the outset, the UAS experts guided the Air Force/Army team towards a joint solution that linked air and ground based radar, optical, and electronic sensors from multiple services (experimentation included Navy Aegis) to create a common operating picture enabling UAS defense. Systems included all current Air Force and Army radars, E-3, counter-rocket and mortar (C-RAM), Army Joint Land-Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS), SENTINEL, and various current and future short-range air defense systems. In addition, the EWF experiments had Army high altitude airship (HAA) with a variety of systems. These Army ground and air based systems, coupled with Air Force and Navy airborne and ship based radars, were critical to the UAS defense fight. The JUAS COE participated in multiple experiments prior to the organization disbanding in 2011.

Virtually all of the 20-plus JUAS COE recommendations involved linking sensors of one service or functional component with sensors or systems of another. The JUAS COE also recommended further study of time-sensitive dynamic retasking of airborne ISR and electro-optical sensors to enable air defense visual identification.

> "After all, the great defense against aerial menace is to attack the enemy's aircraft as near as possible to their point of departure."
>
> — Winston Churchill

INSIGHT 3: Enemy UAS are part of the counter-air campaign. Because UAS are part of the enemy air threat, the joint force should make every effort to target them on the ground. Quoting from JP 3-01, Countering Air and Missile Threats:

"Offensive counter-air (OCA) operations normally have a high-priority as long as the enemy has the air and missile capability to threaten friendly forces and the JFC does not have the degree of air superiority desired to accomplish the objectives required for the end state. OCA operations reduce the risk of air and missile attacks, allowing friendly forces to focus on their mission objectives. The preferred method of countering air and missile threats is to destroy or disrupt them prior to launch using OCA operations conducted over enemy territory.

Therefore, if the joint force believes enemy UAS will create problems for any component, these systems should be considered in the joint intelligence preparation of the operational environment (JIPOE) and enemy UAS should be added to the joint integrated prioritized targets list (JIPTL) in accordance with JP 3-60, and targeted from the outset of the engagement. There was little doubt enemy UAS were a valid threat in the experiments. Paraphrasing from the Air Force after action report for EWF 2009, "numerous enemy UAS, operating at low altitude over the division's AO, negatively affected both Fires deconfliction and airspace control."

One of the hardest tasks for the air component during these experiments dealt with controlling high-speed fighters operating at low altitude over the ground commander's AO. The fighters were forced to drop down to identify and engage low, slow-moving enemy UAS, often in close proximity to friendly UAS and rotary wing aircraft. More on this issue later; however, the more enemy UAS that can be defeated on the ground prior to entering the ground commander's area of operations, the better. In future conflicts, enemy UAS must be part of the counter-air campaign with both kinetic and non-kinetic attack options. Finally, to fully understand the threat from enemy UAS, future Air Force/Army experimentation events need to include a realistic UAS defense effort at the beginning of Phase II, whether or not the ground force has entered the theater or not.

INSIGHT 4: Airspace control and Fires deconfliction are tough to do with enemy UAS in your airspace. In accordance with JP 3-01, airspace control is defined as, "a process used to increase operational effectiveness by promoting the safe, efficient, and flexible use of airspace." As mentioned earlier, these experiments were conducted with a JFACC acting as the ACA in accordance with joint doctrine. The JFACC/ACA is responsible for producing the airspace control plan ACP (for approval by the JFC) and the airspace control order (ACO) for joint operations. The ACA takes airspace requests from the components and builds airspace control measures and fire support coordination measures into the ACO. If conflicts arise during the ACO planning process, the ACA's staff makes every effort to resolve the conflict to allow the airspace requesters and Fires planners a reasonable expectation that they will have access to the airspace they request. Once the ACO is published, changes must be handled in real-time by the agency that controls the airspace. If two entities, whether aircraft or Fires, attempt to occupy the same airspace at the same time, the controlling agency gives the nod to the entity with the highest priority. The more uncertainty in the joint operations area, the more real-time changes are required to the ACO, which leads to more real-time airspace control by the controlling agencies. The ACA can delegate authority to control airspace to component airspace control elements; however, only the joint force commander (JFC) 'owns' airspace. During all of the experiments defensive counter-air aircraft

were given the highest priority and frequently had to enter airspace reserved for other users to deal with enemy UAS.

In addition to the airspace control responsibilities the JFC levies on the ACA, and in accordance with JP 3-01, the JFC normally will designate the JFACC as the AADC and the supported commander for counter-air. The JFACC/AADC develops, integrates, and distributes a JFC approved joint area air defense plan (AADP). Further, the JFC grants the AADC the necessary command authority to deconflict and control engagements and to exercise real-time battle management.

The JFC delegates the JFACC/AADC the authorities of identification (ID), commitment, and engagement. The JFACC/AADC conducts decentralized execution of air defense through regional and sector air defense commands (RADCs and SADCs) and can delegate these commands ID, commit, and engagement authority. RADCs and SADCs control the air defense mission from the surface up to whatever altitude is required, including space. The JFACC/AADC does not delegate air defense authority to the ACA's airspace control agencies; he/she delegates it to air defense commands. This means that ACA delegated airspace does not come with the authority to conduct air defense (other than self defense by aircraft or short range ground systems).

Based on more than 10 years of combat activity in Iraq and Afghanistan, the ACO process works fairly well in an environment where the U.S. has air supremacy. For the most part, supported commander's airspace requests are approved without fear of the airspace being taken away by another supported commander with a higher priority (this discussion deliberately excludes special operations forces).

Conversely, without air superiority, when the JFACC/AADC responds to a low altitude UAS threat over a ground commander's AO, joint doctrine requires the JFACC to coordinate with the supported ground commander. Because of their time-sensitive nature, DCA operations require streamlined coordination and decision-making processes. To be effective, air defense assets, particularly fighters, must fly their flight tracks and altitudes with respect to the threat, rather than in preplanned airspace or

Soldiers of Detachment 1, Company B, 116th Brigade Special Troops Battalion, 116th Brigade Combat Team train on flying and maintaining RQ-7B Shadow unmanned aircraft systems (UAS) at Camp Shelby, Miss. (Photo by SSG Andrew H. Owen, U.S. Army)

routes built into the ACO. Air defense intercepts over a ground AO require real-time air battle management and real-time deconfliction with ACMs and FSCMs. Observations have shown that even a few enemy UAS over a ground commander's AO can cause airspace control to break down if the JFACC/AADC cannot control engagements and conduct real-time battle management while deconflicting with Fires and other airspace users.

INSIGHT 5: Airspace control without air superiority demands positive ID, and when required, positive control. If enemy UAS are present over an area of operations, then the JFACC must fight for air superiority while simultaneously conducting other operations, including those in support of the ground commander. Until air superiority is achieved, the AADC requires a higher level of control to conduct air defense than the ACA requires for airspace control. The AADCs requirements to provide threat warnings, control engagements, and exercise real-time battle management necessitate the ability to rapidly move from procedural control, to positive control—at least until air superiority is achieved. Forces conducting distributed operations solely with 'procedural control' do so at a much higher risk when enemy aircraft are present. Air defense elements must have real-time visibility of all friendly aircraft and the ability to communicate with them in real-time to conduct effective UAS defense operations. This is in keeping with joint air defense doctrine which states, "unity of effort, centralized planning and direction, and decentralized execution have proven to be vital tenets for countering air and missile threats that may have an engagement window of only a matter of minutes."

INSIGHT 6: Joint air ground integration cell (JAGIC) TTP can assist ground commanders in the UAS defense fight. The Air Force integrated its ASOC and TACP personnel with Army Fires, airspace command and control (AC2), aviation, and Air and Missile Defense (AMD) personnel at the division level in the '08 and '09 EWF experiments, as well as the 2010 AFCIE and the 2011 JFEWE. This placed Air Force and Army command and control (C2) personnel into a single C2 cell with authority delegated by their respective commanders to integrate and control their component assets. According to both joint and Air Force doctrine, an ASOC is the primary control agency component of the Theater Air Control System for the execution of close air support (CAS) and is directly subordinate to the air operations center (AOC) in direct support of its assigned Army echelon. The ASOC is delegated authority from the JFACC over the air component sorties operating in direct support of that Army echelon. The ASOC does not have authority over air defense forces; however, air component systems conducting defensive counter-air operations over a ground commander's area of operations will normally coordinate with the ASOC to deconflict from Fires and organic Army aviation assets.

For the past six years, the Air Force and Army have been developing the JAGIC. During experimentation with JAGIC, the ACA delegated a volume of airspace, either below a coordinating altitude or within a high density airspace control zone (HIDACZ) to the cell to conduct airspace control on behalf of the ACA in support of the supported division. While the JAGIC is not delegated air defense ID, commit, or engagement authority from the JFACC/AADC, it is the organization the RADC or SADC coordinates when air defense assets enter airspace controlled by the Air Force/Army team at division.

In all of these experiments, JAGIC showed significant promise in the fight against enemy UAS by integrating Army tactical ADA into the theater air defense architecture enabling direct coordination with AADC C2 nodes. Air Force air battle managers within the JAGIC rapidly passed threat UAS—first detected operating over the division AO

The 163rd Reconnaissance Wing MQ-1 Predator is shown during post flight inspection at dusk from Southern California Logistics Airport, formerly George Air Force Base, in Victorville, Calif. (Photo by Master Sgt. Stanley Thompson, U.S. Air Force)

to the JFACC's SADC and the Army Air Defense Artillery fire control officer (ADAFCO). Both the SADC and the ADAFCO were able to rapidly identify and engage enemy UAS that were identified on the common operating picture (COP) using the best asset available. The JAGIC also increased battlespace awareness by advising track producers of the correct ID when JAGIC had situational awareness of a track being reported incorrectly. In a few instances, the decision was made to re-role available close air support (CAS) aircraft to engage the threat. Information flow, up the chain, worked well in virtually every experiment and provided the supported ground commander rapid access to joint air defense capabilities. In addition, JAGIC members were able to find and target enemy UAS launch sites within the division AO and destroy the UAS prior to launch.

JAGIC also conducted a limited amount of real-time Fires deconfliction and control of ACMs to allow air defense fighters to operate in the division controlled airspace. As would be expected, these tasks were easier in airspace with a low density of firing systems and ACMs, and harder as the density increased.

Unfortunately, JAGIC was less capable of passing information about enemy air threats down the chain. As mentioned previously, the JFACC/AADC has a requirement to provide timely threat warnings and control air-to-air engagements. Due to the distributed nature of mission command, the Army does not have a single element with authority, visibility, and rapid communications with all Army assets, to include aviation assets, operating within the airspace in the time required to conduct UAS defense activities. This required authority does not infer that the Army C2 elements have the power to change the asset's mission or issue new 'mission type orders,' it merely needs the ability to know what is flying where and to move them out of the way either to affect that asset's survival, or to enable a higher priority.

INSIGHT 7: Army air defense assets require a standard 'call for air defense' tactics, techniques and procedures (TTP). Thus far in this article, there has been no discussion of short range air defense (SHORAD). Army air defense elements experimented with a number of different systems in the above-listed TRADOC experiments. The air defense community relies on a COP composed of feeds from a number of sensors including Airborne Warning and Control System (AWACS), ground and ship based radars, and other systems such as the Army Joint Land-Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS). The COP displays friendly systems and raw data for systems that are unknown. One of the primary tasks of air defense elements is to identify unknown tracks and tag them as enemy, friendly or unknown.

In many cases, the first person detecting a small, slow enemy UAS will be a Soldier on the battlefield. If the Soldier can confirm the UAS is an enemy system, he/she has taken the first and often hardest step in the UAS defense-kill chain and conducted the ID. Getting what the Soldier knows on the COP so the UAS can be engaged by either SHORAD or other air defense assets is the next important step; however, a standard service or joint air defense request system for visual ID does not currently exist.

The Army and Air Force need to develop a joint air defense request system that would include request network and TTP to enable radar and/or COP operators to correlate visual detections from ground units and enable follow-on engagements.

U.S. Air Force participation in Army experimentation has resulted in a number of significant insights for the Air Force/Army team, among them UAS defense. Taken holistically, these experiments have identified UAS defense as a joint endeavor from the outset. Enemy UAS must be considered in Phase II targeting and affect the JFC's ability to gain and maintain air superiority. Effective UAS defense operations require the joint force to fuse air and ground based sensors in a real-time common operating picture enabling the force to detect and engage threat UAS using lethal and non-lethal options. Command and control of air defense assets must allow rapid UAS engagement, while simultaneously providing threat warnings and controlling individual UAS attacks without fratricide. All of this must occur while integrating UAS defense operations with airspace control and Fires. If this sounds hard, it's because it is.

As future experiments unfold, it is critical the joint force understands the UAS threat and options for dealing with it in order to validate required capabilities and identify gaps. This must include the small 'backpack' Group 1 UAS that were not part of these experiments. At some point, the AF/Army team needs to conduct a Phase II, UAS defense event to develop a realistic expectation of attrition on enemy UAS in scenarios requiring forcible entry operations.

Finally, the author recommends UAS defense be a topic in the 2012 Army - Air Force Warfighter Talks. This topic should include kinetic and non-kinetic options for engaging enemy UAS and the required level of command and control to engage these time-sensitive targets. It should also include a way ahead for a 'call for air defense' TTP, as discussed in insight #7, to ensure distributed ground forces have the capability to defend against enemy UAS. As part of the warfighter talks, both services need to have a frank discussion on the effect of enemy UAS with respect to the current concept of air superiority. The U.S. cannot afford to give up the high ground, regardless of the type of threat a potential enemy brings to bear.★★

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