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Unmanned Aircraft Systems for Logistics Applications

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Summary

This project evaluated ten potential logistics applications for UAS to determine whether they are technically feasible, operationally feasible, and more cost-effective than other options. This study concentrated on reconnaissance and surveillance tasks to secure logistics convoys through overwatch with UAS; route reconnaissance looking for hazards that might endanger logistics convoys; and surveillance of pipelines, electrical lines, rivers, supply depots, disaster scenes, and pre-deployment theater reconnaissance. (A separate study, conducted by General Dynamics,⁵ evaluated the use of UAS for emergency and routine resupply tasks.) This study also examined the potential for using UAS to locate airdropped cargo that misses the drop zone and to retrograde critical unserviceable items expeditiously.

We used a combination of Army data, interviews, and prior research to compile information for analysis. The research team made use of Combined Information Data Network Exchange (CIDNE) and FusionNet databases to sample the frequency and intensity of enemy attacks on logistics convoys and assets. We drew on recent research at RAND for insights into installation and pipeline security, the improvised explosive device (IED) problem, and the optimal employment of UAS. We interviewed Army personnel recently returned from operational theaters with practical experience in logistics operations, and we

⁵ General Dynamics, *AR 5-5 Study: Future Modular Force Resupply Mission for Unmanned Aircraft Systems (UAS)*, prepared for Commanding General, Combined Arms Support Command and Department of the Army, G-4, General Dynamics Information Technology, February 24, 2010.

interviewed civilian contractors tasked with the security of pipelines and electrical lines in Iraq to understand those tasks more fully. Based upon the available data and our best efforts to understand current threats, we made estimates to help us determine which UAS applications are likely feasible and infeasible, beneficial and not, and cost-effective.

The study looks out to the year 2024 but also discusses how technology changes beyond that could affect the value of UAS. For many reconnaissance and surveillance tasks, we found that with current technology and costs, UAS are either not feasible or not cost-effective options in conditions similar to those experienced in Iraq; however, the case improves with conditions more like those found in Afghanistan. In all environments, the relative value of UAS will improve with the miniaturization and improvement of sensors; the appearance of new, small, less-expensive UAS; and improved network bandwidth. The relative values of options are highly sensitive to the value that the United States places on damages from enemy attacks and to the cost structure of UAS-based solutions for detecting and avoiding enemy action. Thus, the Army should continue to evaluate its options through the lens of life-cycle costs for UAS relative to the cost avoidance they provide by detecting potentially deadly and destructive enemy activities.

Table S.1 summarizes general findings about the feasibility and benefits of UAS for logistics applications.

The table lists six considerations and their tendencies in terms of favoring or not favoring UAS-based solutions. The first is cost. As the systems become cheaper or sensors become smaller, allowing small UAS to be used for logistics applications, UAS-based solutions are more favorable. But if the systems remain expensive, UAS-based solutions are not favorable for the challenges confronting logistics units.

Terrain is the second factor. If future Army operations take place in theaters where complex terrain and long distances render other alternatives for reconnaissance and surveillance infeasible, UAS are a good solution. If future operations most frequently occur in theaters with more open terrain and shorter distances that lend themselves to non-UAS solutions, then UAS would be less attractive.

Enemy tactics, techniques, and procedures (TTPs) are the third consideration. Circumstances in which adversaries tend to mass, or

Table S.1
Factors Influencing UAS-Based Solutions

Consideration	Factors Favoring UAS-Based Solutions	Factors Not Favoring UAS-Based Solutions
Cost of UAS	Cheaper (e.g., class II) systems	Expensive (e.g., Predator derivative) systems
Terrain	Complex, line-of-sight issues; large scale that renders fixed cameras, etc., infeasible	Open, open-broken terrain; relatively small scale that enables non-UAS solutions
Enemy TTPs	Tendency to mass, linger near site of interest to them	Short-dwell operations, low mass, refusal to hold terrain
Value of damage or loss that could be avoided through reconnaissance and surveillance	High costs from enemy actions	Low costs resulting from enemy actions
Weather	Conditions conducive to UAS flight and sensor operations	Conditions that hinder flight or sensor operations
Bandwidth	Low bandwidth puts premium on point-to-point UAS-operator systems	Abundant bandwidth that supports robust networks

linger, or otherwise present relatively easily observed behaviors would favor the employment of UAS. If the enemy minimizes its profile by conducting hit-and-run, short-dwell attacks, refuses to mass, and refuses to hold terrain or to become clearly associated with a piece of terrain, those behaviors are unfavorable for UAS operations.

The value of damage or loss that could be avoided through reconnaissance and surveillance may be among the most sensitive of considerations bearing on the utility of UAS. The U.S. experience in recent operations in both Afghanistan and Iraq reflects large swings in the numbers of incidents and the numbers of IED events over the course of time. If a future enemy were to surge and sustain attacks inflicting high costs on U.S. forces, such circumstances favor the use of UAS. The opposite development would also hold true, and low costs from enemy action would not favor UAS-based solutions.

The fifth consideration is weather. Conditions that do not challenge aircraft flight parameters (e.g., wind velocity, wind shear, very cold temperatures) or sensor operating parameters (e.g., minimum safe

altitudes, cloud cover, rain, lightning), tend to favor the use of UAS. If weather is severe enough to interfere with flight operations or sensor performance, those conditions are unfavorable for UAS-based reconnaissance and surveillance solutions.

The final consideration is bandwidth. If a future theater is austere and bandwidth is therefore scarce (and perhaps oversubscribed), then simple, point-to-point, UAS-to-operator systems could prove valuable, depending upon the other considerations treated in this discussion. On the other hand, if bandwidth is abundant and supports robust networks, then specific logistics-oriented UAS-based approaches would be less attractive, and the priority would be on ensuring access to the theater network and the information available from shared assets.

For example, the benefit of UAS will depend in part on how well other elements of the command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) network perform in the future. For instance, if the Under Secretary of Defense for Intelligence (USD(I)) Lieutenant General John Koziol's 2024 vision of extremely high-bandwidth networked C4ISR eventuates and the Army can operate in Afghanistan and future theaters supported by a much richer, denser C4ISR network, then ownership of UAS for any specific tasks will be less critical because the network will quickly provide information from all of them in a theater.

The following summarizes our assessments of the potential for applying UAS to specific logistical missions:

- The likely value of using UAS for convoy overwatch—the practice of shadowing a convoy with an armed UAS as the convoy proceeds along its route—varies with theater conditions. In conditions similar to those experienced in Iraq, we found this application to be operationally and technically infeasible. In particular, the short enemy dwell times and long distances limit value. However, conditions similar to those in Afghanistan, where the length of convoy routes and the difficulty of the terrain render non-UAS solutions impractical (e.g., the United States could not maintain mast-mounted cameras for the circumference of the ring road), are more favorable for the use of UAS.

- The promise of using UAS for route surveillance also varies by theater conditions. Given enemy behavior in Iraq, UAS have a probability of detecting enemy presence along routes and pipelines of just roughly 11 percent and less near the end of the UAS's orbit, when it has to turn around, leading to low UAS value.⁶ Afghanistan offers different challenges. There, enemy behavior, which enables longer dwell times near targets, is more favorable to the use of UAS. Less favorable in Afghanistan are the weather conditions and terrain (e.g., high winds, rain, and steep ridges that may break line-of-sight or cause other issues). Technology might provide some relief, for example, if the Army is able to deploy long-endurance aerial communications relays to overcome line-of-sight problems.
- Ascertaining river navigability using light detection and ranging (LIDAR) aboard a UAS is technically infeasible, although this assessment could change if LIDAR systems can be successfully miniaturized and ruggedized to maintain calibration.
- UAS have a cost-effective role in fixed-site security as an integral part of larger security and surveillance systems typically dominated by radars and fixed cameras.
- UAS could be flown in support of theater reconnaissance prior to the deployment of Army forces. Doing so raises questions of operations security (OPSEC) because the UAS's presence, if detected, might lead the enemy to conclude that U.S. military action is imminent. UAS do not appear to offer an advantage, though, over the many Defense Intelligence Agency (DIA) and National Ground Intelligence Center (NGIC) operations support products that would be available to answer logisticians' questions about a new theater.
- UAS could be valuable for locating cargo that misses a drop zone.
- Retrograde of critical unserviceable items via UAS is feasible but does not deliver a clear benefit for most items. This is because reducing the time of evacuation to maintenance does not reduce

⁶ There is, however, utility in discovering pipeline damage early, and a potential deterrent effect from having UAS observed operating in the area.

the number of spares the Army must buy or reduce the amount of uncertainty about the availability of spares, key sources of cost in the supply chain. The extreme vast majority of the retrograde time for sustainment maintenance to repair repairable spares arises from the supporting brigade supply support activity back to sustainment maintenance, not the first leg on the battlefield.

After careful examination of common themes found in the UAS concepts, we have concluded that the fundamental near-term force protection problem confronting the logistics community is situational awareness: the ability to understand one's environment, to detect threats, and to know one's own location and the locations of the enemy and friendly units. Situational awareness has become key to survival for U.S. Army units, including logistics formations. Logistics units no longer operate in secure rear areas where enemy threats are minimal; instead they face the same threats as combat formations once they leave the safety of a forward operating base's (FOB's) perimeter. Logistics units do not, however, have the same density of command, control, communications, computers, and intelligence (C4I) equipment as combat arms units and, as a result, have more difficulty sustaining robust situational awareness. It is this situational awareness deficit that some have proposed to overcome with UAS, which do have a role to play in a network that includes other assets.