



Changing the battlefield with quadcopters and fixed-wing VTOLS

SITREP

There are many tactical takeaways and lessons learned from the war in Ukraine – the importance of missile defense, fighting through electronic warfare, and the value of communications satellites in proliferated low-Earth orbit.

Also on that list is the heretofore unseen impact of small unmanned aircraft systems (sUAS) at the tactical level. For brigades, regiments and below, Group 1 and 2 sUAS in the form of quadcopters and fixed-wing vertical takeoff and landing (VTOL) aircraft are already disrupting the way of war.

This includes everything from intelligence, surveillance, target acquisition, and reconnaissance (ISTAR), to carrying small loads, to correcting artillery fire, and delivering kinetics (or being kinetics in the case of loitering munitions).

Ukraine will continue to be the testing ground for sUAS that punch above their weight to create heretofore unthought of possibilities on the battlefield.

There are, however, numerous challenges associated with the maturing of a domestic market for commercial quadcopters into one that can support special operations forces and other military units. The paramount hurdle is that the global market for both platforms and components is dominated by China. It even controls most of the U.S. market for quadcopters used by law enforcement.

Industry, however, has put itself on a fast track to grow such an industry, and organizations like the Defense Industrial Unit have laid down the criteria for what the Defense Department needs in capabilities for small UAS.

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U.S. Marine Corps Cpl. Brian Vile, an intelligence specialist with Marine Rotational Force – Darwin 24.3, operates a drone as part of a counter-unmanned aircraft systems field test at Mount Bunder Training Area, NT, Australia, July 11, 2024. (U.S. Marine Corps photo by Cpl. Miguel A. Reynosa)



ON THE COVER: Navy Petty Officer 1st Class Christopher Boughton pilots a drone at the Port of Gulfport, Miss., May 21, 2024. Photo By: Navy Petty Officer 2nd Class Andrew Waters

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There's a new battlespace called "air-ground littoral" where quadcopters and fixed-wing VTOLs now dominate.

The "air-ground littoral" is not a traditional warfighting domain like air, land, or sea. What it is, though, is a new battlespace. Metaphorically similar to naval littorals that extend from shore to open-water and deep-water zones, the air-ground littoral extends from terra firma to an elevation of several thousand feet.

It's the province of a new way of warfare that includes ISTAR and loitering munitions that barely existed as a concept of operation (CONOP) at the beginning of this decade, and arguably meet the definition of an "evolutionary" battlefield development.

This battlespace is particularly suited to sUAS consisting of Group 1 quadcopters and first-person-view drones, as well as Group 2 sUAS like fixed-wing VTOL aircraft.

It's also a realm that is dominated by a country other than the U.S., especially in the case of quadcopters. That would be China, and we'll discuss that later in the eBrief.

"The air-ground littoral...is where [small UAS] engage and are engaged by ground forces; increasingly it is where sUAS fight one another," U.S. Army Gen. James Rainey, commanding general of Army Futures Command, wrote recently in Army Aviation magazine with co-author James Greer, retired Army colonel, and associate professor and former director of the U.S. Army School of Advanced Military Studies, Ft. Leavenworth, KS.

"Today, above every Russian and Ukrainian unit along the 800-mile line of contact there is a battle fought by and against sUAS in the air-ground littoral. Small UAS are important, but the air-ground littoral phenomenon is only the leading edge of how AI-enabled robotic systems will allow human-machine integrated formations to change land warfare."

Air-ground littoral use cases

Small UAS have come to be the defining feature of air-ground littorals because of their versatility. The use cases and tactical roles for these systems are fairly similar across various Areas of Responsibility such as Europe, the Indo-Pacific and the Middle East; the main differences being mainly a function of geography.



KHARKIV REGION, UKRAINE – JUNE 18: DJI Enterprise model drone that is used as an antenna to amplify the signal of FPV drones loaded with explosives that can hit Russian territory from this position is seen in Vovchansk district of Kharkiv region, Ukraine on June 18, 2024. (Photo by Pablo Miranzo/Anadolu via Getty Images)

The primary use case for Group 1 quadcopters is now on display in Ukraine – the integration of ISTAR packages to spot for artillery or to allow units to conduct ground maneuver. In another use case, these systems are increasingly being used to deliver lethal munitions, giving tactical units as small as companies the ability to fight 10-15 kilometers further than they might normally have been able to, letting them change tempo to either seize or hold terrain.

Base surveillance and defense is another use case applicable to both Europe and the Middle East, where Group 1 UAS would perform those roles against an adversary such as Iran, for example.

Air-ground littoral operations in the Indo-Pacific, however, do present different challenges than the two other AORs.

"Indo-Pacific is a wild card because it's such a massive amount of the Earth and very different geographic considerations," said Benjamin Jensen, senior fellow for Futures Lab in the International Security Program at the Center for Strategic and International Studies (CSIS). "In one sense, from the Army side [and the] air-ground littoral, there's definitely a role for how you actually project combat power through that lower AGL (above ground level) to conduct essentially what we might call an anti-landing operation. The Japanese have actually done quite a bit on this and soon there's going to be a new joint doctrinal note on beach defense.

"That is an interesting role because in theory when you start to integrate artificial intelligence and machine learning, and you have adversaries trying to seize large beach heads it's actually tailor-made for semi-autonomous weapon systems.

You're not worried about as much collateral damage when it's Chinese LCACs (amphibious assault hovercraft) and LCUs (landing craft) trying to come towards the beach."

To engage in that watery littoral transition area, the algorithms will have to be trained differently in order to optimize the sUAS and their munitions for that environment. Said Jensen: "It's find the enemy, kill the enemy, or at least hold the enemy sufficiently at risk."

A market the U.S. doesn't control

The demand for sUAS quadcopters and fixed-wing VTOLs from special forces and other units would normally portend well for both industry and the Defense Department. However, the worldwide market for quadcopters, in particular, is completely owned in the present tense by Chinese manufacturers such as DGI. As a point of reference, there's general consensus among experts that the global market for both drone platforms and drone components is between 85 and 90 percent Chinese controlled.

Another reality is that the manufacturers of these systems are primarily all commercial companies, as opposed to organizations focused on supplying militaries such as General Atomics and Israel Aerospace Industries.

"The use cases that we see outside of Ukraine are primarily commercial," said Trent Emeneker, project lead for the Defense Innovation Unit's Blue UAS program, which is working to address these challenges. "Within the US, the market is 98 to 99 percent commercial, 1 to 2 percent military."

A substantial portion of the commercial market, 20-25 percent, is law enforcement and public security, estimates Emeneker. The rest is hobbyists, drone racing leagues, pipeline and utility surveillance, and video filming, to name some of the larger categories.

That begs the question: given Chinese dominance in the small UAS market and its market interventions to sustain that dominance, can the U.S. grow a commercial base to produce sUAS at sufficient scale that they can be integrated into warfighting formations?

"This is likely the hardest problem that we think about solving all the time," said Emeneker. "In talking with our industry partners we have to provide firm demand over a period of years to allow them to make the necessary investments in tooling, workforce, and flow through to their subs and their sub-subs to develop the manufacturing capacity that we

would need. To date, we haven't been able to do that. The DoD market alone is not large enough to drive enough demand to send that signal. We know the problem, we know the likely solution, but how do we get there?

"To use an example from law enforcement, if I'm a local police department and I have the choice between paying \$2,000 or \$3,000 for a Chinese-made platform or four-to-five X that for one that's not Chinese made that frankly for their use case is probably not quite as good. I pick the cheap Chinese one all the time and it's that vicious demand cycle.



An unmanned aerial vehicle delivers a payload to the ballistic missile submarine USS Henry M. Jackson around the Hawaiian Islands, Oct. 19, 2020, during an event designed to test and evaluate the tactics, techniques and procedures of U.S. Strategic Command's expeditionary logistics and enhance the readiness of strategic forces. Photo By: Navy Petty Officer 1st Class Devin M. Langer

"Breaking it is hard. If you listen to our elected leadership and our policymakers, they recognize that and we continue to see attempts and solutions coming out. But it's a problem that's hard to solve because there's no one button to push."

Along that line, industrial mobilization will likely depend on some sort of government support, according to Jensen.

"The government would have to assume more risk and basically subsidize some of those industries getting off the ground. If I was king for a day, I would write in a provision for the [next] NDAA that we need a cross-service concept for large-scale small UAS employment that we can use to set DOTMLPF standards and help harmonize industrial investment and scalability. Right now we're innovating \$1 million at a time 1,000 times and failing to scale it.

"We need a coherent study that looks across the entire DOTMLPF continuum, not just how many small UAS do I



Marine Corps Lance Cpl. Donte Mathews flies an unmanned aircraft system during a mortar range event at Camp Lejeune, N.C., Jan. 17, 2023. Photo By: Marine Corps Cpl. Michael Virtue

need. What's my concept of support? How do I recharge them, rearm them? What type of training facilities do I need to make sure soldiers are proficient? We need it at an institutional and operational level. It can't be each service solve this at the tactical level on their own."

DIU Blue UAS Cleared List

The ability to scale UAS production is also a criteria for inclusion on DIU's Blue UAS Cleared List of sUAS and their components. The purpose of the Blue List is to let special forces and other military units know which platforms and components are government verified for acquisition to meet their specific needs. Platform and component manufacturers from China, Russia, North Korea, Iran, and Venezuela need not apply.

"When we add platforms to the Blue List, we do look at company viability," said Emenecker. "That's everything from, do they have the financial runway that they're going to need to start making the platform, [to] what is their manufacturing capacity now, [to] what is it realistically in three months, six months, a year? What does it take for them to ramp and scale? We do look at those things because a company that can make five systems a month doesn't meet any [military] need or demand that we could have outside of some limited use cases."

The Blue UAS List consists of 16 Group 1 and 2 UAS platforms: 14 quadcopters and two fixed wing. It also includes what they call the Blue UAS Framework, which includes components like cameras, radios, or even software. There are 12-15 companies on the Framework, for a total of about 30 aircraft and component companies approved to sell to the DoD.

Blue UAS was established about five years ago, and DIU is planning a few changes to keep the List relevant.

"As you see today on our flying platforms, we have Group 1 and Group 2," said Emenecker. "But we know that there is a clear user-identified need for FPV platforms — the first person view [UAS] that you see in Ukraine that are primarily used for one-way attack missions.

"We know that there is a demand for longer-range ISR platforms and what we would call Group 3 or longer-endurance Group 2. Those are going to be fixed-wing platforms, and we're moving to incorporate those."

Toward the end of 2024, DIU also plans to kick off an annual competitive refresh challenge. Companies presently on the List will have to compete to stay on, and organizations not on the list will have an opportunity to show what they've got. The goal, said Emenecker, is to let the marketplace derive the best outcomes.

VIEWPOINT FROM RED CAT

PROVIDING AN ASYMMETRIC ADVANTAGE WITH QUADCOPTERS AND FIXED-WING VTOLS

Red Cat's new family of systems includes a common ground control system for three aircraft: the American-made Teal 2 quadcopter and the Edge 130 Blue, a VTOL fixed-wing system – both of which are on the Defense Innovation Unit's Blue List – and a new FANG™ line of first-person view (FPV) drones of different sizes and capabilities. We discuss the asymmetric advantage of these systems with Red Cat Founder and CTO George Matus.



Red Cat CTO and Teal Drones Founder George Matus.

Breaking Defense: Tell us about Red Cat and its two main subsidiaries: Teal Drones and FlightWave.

George Matus: Red Cat (Nasdaq: RCAT) is a drone technology company founded by our CEO Jeff Thompson in 2018. We develop robotic hardware and software primarily for U.S. government and NATO allies. Our mission is to provide critical situational awareness and enhance the effectiveness and safety of military and security operations around the world. Red Cat provides American-made technology products to the drone industry through its two wholly owned subsidiaries: Teal Drones and FlightWave.

Red Cat acquired Teal in September 2021. Teal is a Salt Lake City-based drone company that I founded in 2015. Post acquisition, Teal started to evolve from our roots in consumer drones to address the needs of public safety and national security use cases. Our company built the first mass produced drone built entirely in the U.S., with Department of Defense compliant components, and today has a factory staffed with over 100 employees.

In the summer of 2024, Red Cat acquired FlightWave Aerospace Systems. This was a strategic move to build out a family of small unmanned systems. FlightWave is an industry leader in Vertical Take-off and Landing (VTOL) drone, sensor and software solutions.

This acquisition brought the Edge 130, a Blue UAS approved military-grade system into Red Cat's product line. The strategy was to expand Teal's capabilities with extended range and endurance, additional payloads, and broader use in maritime environments.

What's the significance of being on the Blue List?

Teal was one of the first Blue UAS-approved companies going as far back as 2020. The Blue UAS effort was started by the

Defense Innovation Unit (DIU) to establish a trusted supply of drones to the U.S. Government. This stamp of approval means being compliant in both supply chain and cyber security, and follows a regimented process to ensure a company and its products meet all of the associated requirements.

Teal was the first U.S. company to ever mass produce this category of drone in America and was prepared to be part of Blue UAS as soon as the program was created.

What's driving the requirements for quadcopters? What are the missions and payloads they're most suited for?

Quadcopters are being used for many different use cases across enterprise, public safety, and defense. Teal's products are dual-use such that they can be deployed across each of these verticals.

Specific to defense, we're now seeing that drones are currently the most impactful technology in war. When we consider what to design and build, we essentially combine three methods: first we listen carefully to end-users and their feedback, we design toward official requirements provided by our government customers, and third we use our experience to fill in any gaps we see to make the best product possible and delight our users.

Our drones are fully modular, interoperable, and designed to be similar to smartphones, where they have powerful compute and sensors onboard that allow advanced software and applications to run on top of that. Our flagship product right now is the Teal 2 which is being deployed across the country and with allied countries around the world.

For our new line of FPV drones, the most appropriate missions are short-range, any environment ISR (intelligence, surveillance, and reconnaissance) with the option for delivery of kinetic effects.

Now with Red Cat's acquisition of FlightWave, we're introducing a fixed-wing VTOL system into our product line. The Edge 130 is a longer-range high-endurance ISR aircraft and rounds out our family of systems. This is the world's most affordable and first backpackable family of systems.

Describe this new family of systems that Red Cat announced at Eurosatory.

In the context of defense, there is a paradigm shift underway on the architecture of battlefields. Increasingly, the U.S. Department of Defense and ministries of defense globally are moving away from conventional platforms that are large and extremely expensive, and are beginning to adopt small, low-cost products that provide true asymmetric advantages.

Red Cat is at the forefront of this sea change. Our goal is to give warfighters the tools they need to be successful on the modern battlefield. That was the genesis of the Red Cat Family of Systems. What we announced at Eurosatory includes three aircraft with complementary capabilities and a common Ground Control System (GCS).

The core of the family is the Teal 2 quadcopter. It is an American made drone that's designed to "Dominate the Night". Weighing under three pounds, it features a high-resolution dual EO/IR sensor, modular architecture, powerful onboard compute, and a wide variety of software integrations for autonomy and AI. It's ruggedized to be used in any environment and harsh weather conditions, while also offering field repairability on all subsystems.

The next entrant into the family of systems is the Edge 130 Blue, a VTOL fixed wing system that can be assembled and launched in just one minute by a single user to capture and stream high-resolution aerial imagery with long-range capability. Still weighing under four pounds and being backpackable, the Edge 130 can fly for over 2 hours, an industry-leading endurance among all Blue UAS approved drones today.

Rounding out the Family of Systems is a new FANG line of first-person view (FPV) drones of different sizes and capabilities. The first in the line of FPV drones provides precision strike capabilities and gives warfighters the option to combine the ISR capabilities of the rest of the family.

What is Red Cat's ability to manufacture at scale?

Our factory in Salt Lake City houses both our R&D team and manufacturing team. We've designed our products and infrastructure to scale with demand into the thousands of drones per month. Our vetted supply chain vendors enable the company to source the components needed to build these drones at those large volumes. Having R&D integrated very deeply enables for agile development and innovation. Our factory, with its state of the art tools and processes, combined with our world class team, is helping America to rebuild its drone industrial base which we believe is vital to our national security.

Tell us about Partners and the consortium.

We believe that no single company can protect this country alone. A few months ago we announced the Red Cat Futures Initiative to solve this problem. The RFI is a robotics and autonomous systems consortium designed to bridge critical UAS technology gaps for warfighters. It is an independent, industry-wide community of partners dedicated to putting the most advanced and interoperable uncrewed aircraft systems into the hands of warfighters.

As a leader in the drone industry, we developed and launched this initiative to support the Pentagon's desire to accelerate innovation for its Replicator Initiative and the need for low-cost, autonomous systems across air, land, sea, and subsea environments.

The consortium will collaborate to ensure requirements-based UAS production that meets the needs of specific missions, as well as reduce vendor lock-in and promote innovation and interoperability. The RFI will also engage in R&D and government advocacy that accelerates technology maturation. The RFI brings together the most innovative UAS hardware and software companies focused on AIU/ML, swarming, FPV, command and control, charging/power, payloads and others based on the needs of warfighters.

At launch in May 2024, the founding partners included Ocean Power Technologies, Sentien Robotics, Primordial Labs, Athena AI, Unusual Machines, Reach Power, and MMS Products. The shared goal of RFI is advocacy, integrations, and co-marketing that bridges considerable tech gaps in the UAS industry through modular open architecture. I am very excited to be partnering with so many amazing companies,