DefenseTech: U.S. Navy Plans to Fly First Drone Swarm This Summer

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The U.S. Navy's LOw-Cost Unmanned aerial vehicle Swarming Technology (LOCUST) is a prototype tube-launched UAV. The LOCUST program will make possible the launch of multiple swarming UAVs to autonomously overwhelm and adversary. (U.S. Navy photo via YouTube)

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What happens when a swarm of slow, low-performance drones attacks a modern warship? With defense systems able to knock down supersonic cruise missiles and fast jets, small drones ought to be a turkey shoot. In fact, the situation plays out very differently.

The U.S. Navy is a leader in the area of swarm warfare, the threat has been analyzed in a number of papers from the Naval Postgraduate School analyze the threat. Some of these are classified, but a 2012 paper by Loc Pham, "UAV Swarm Attack" is open and makes uncomfortable reading.

The paper posits a simple scenario: a Navy destroyer is attacked by five to ten drones simultaneously from all directions in conditions of good visibility. The drones are assumed to be made of off-the-shelf hobbyist components, controlled covertly from a nearby fishing vessel. Some of them are visually guided, others resemble the Israeli "Harpy" loitering drone which has radar guidance.

The defenders look well-prepared. The Aegis air defense system is one of the best in the world, with an integrated suite of sensors and weapons including jammers, decoys, Standard surface-to-air missiles, a five-inch gun and two Phalanx weapon systems, each with a multi-barreled 20mm canon spitting out seventy-five rounds a second. Aegis was assumed to be supplemented with six heavy machine guns on the deck.

The reason for the extra machine guns is that Aegis is not well suited to dealing with the threat. The small drones have a tiny radar signature, and by the time they are spotted they are too close to be engaged by missiles or the five-inch gun. The Aegis jammers are not designed to affect the drones' control system and cannot affect them. All the work has to be done by the Phalanx and the machine guns at close range. With the drones coming it at 155 mph, the defenders have just fifteen seconds between detection (at less than a mile) and impact. It is vital that defenders pick a different target each, otherwise some drones take fire from several weapons while others slip through unscathed.

The team ran several hundred simulations, and found that on average 2.8 out of eight attackers got through. Even when the defenses were substantially upgraded — better sensors and more machine guns and Phalanx — at least one drone gets through every time. And that's just with eight drones incoming. With a larger number — ten, twenty, fifty — the defenders would still only get the first seven or so.

This weakness means it makes sense to attack a ship with a large number of cheap drones than one missile costing the same, and that's exactly what the Navy's Low-Cost UAV Swarming Technology (LOCUST) program aims to do. The aim is to have thirty drones flying together without having to be individually controlled, maintaining separation safely like a flock of birds. They are different from any other drone in that the operator does not control an individual aircraft, but pilots the whole swarm as a single unit.

Dr. Lee Mastroianni, LOCUST's project manager, believes the whole swarm can be made cheaper than a missile, and at $1.2 million for a Harpoon anti-ship missile he may be right. Locust is currently based on $15,000 Coyote drones. Of course these carry a much smaller warhead — but accurate targeting may be more important than the size of the warhead that hits. Knock out a ships' radar, and it is a sitting duck for other weapons.

Mastroianni plans to have the his first swarm of 30 drones flying next summer.

The UAV Swarm Attack study highlighted the weakness of current defenses against swarms of drones. Timothy Chung, a scientist at the Naval Postgraduate School in Monterey, is looking at defensive swarms to take out the attackers. His project's official name is "A System-of-systems Testbed for Unmanned Systems Swarm versus Swarm Development and Research," but Chung calls it "Aerial Combat Swarms."

Chung is staging a contest for swarms of small drones carry out simulated battles as a way of evaluating tactics and technology. His basic scenario is a 50-versus-50 encounter in which the Blue defenders attempt to stop Red attackers from getting through. Nobody knows much about drone-versus-drone combat yet, especially on this scale. How much autonomy do the drones need? How can the swarm commander stay in control in a fast-moving action? How do quality and quantity balance out in battling swarms?

With manned aircraft, the pilot's life counts for a lot; but swarming drones are expendable and high "casualties" do not matter. This is a very different world to the dogfights we have seen before.

The battles will be fought with small drones even cheaper than those used in LOCUST, but the tactics they discover may shape the future of warfare.

When a swarm of drones heads for an American carrier some time in the future, they might be intercepted by a defensive swarm. What happens next — whether the aircraft on the carrier's deck are destroyed, or whether the attackers are beaten off — will depend on which side has the best grasp of an entirely new form of warfare.