

CHAIN REACTION —

# A surface vessel just commanded a submarine to launch an aircraft—a unmanned

The world's first multi-domain autonomous, unmanned vehicle chain

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Lockheed Martin

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The US Navy chain of command puts ships, submarines, and aircraft into type commands for operational purposes. Aircraft squadrons and air stations are under the administrative control of the appropriate Commander Naval Air Force. Submarines come under the Commander Submarine Force. All other ships fall under the Commander Naval Surface Force.

It has been that way for a long time, a neat arrangement of platforms and the people who populate them. But a Navy exercise in Rhode Island's Narragansett Bay in August may have upended the traditional chain of command.

The focus of the Annual Navy Technology Exercise (ANTX) was Lockheed Martin's Vector Hawk UAV, a

versatile, four-pound autonomous drone designed for short-range reconnaissance, early-warning, and intelligence-gathering missions. Vector Hawk looks like a pair of chevrons (wings) joined by a small fuselage, tipped with a propeller. It can be configured in the field as a conventional fixed-wing aircraft, a VTOL (vertical takeoff and landing) craft, or as a tilt-rotor, enabling VTOL with transition to fixed-wing flight.

Vector Hawk variants can be hand- or canister-launched from land or water, and they can be launched and flown autonomously. Vector Hawk's canister launch (basically a tube) capability as highlighted during ANTX is significant because it extends small UAV capabilities—that land units have enjoyed for years—to tactical maritime users.

The exercise began with instructions issued from a ground control station to the Submaran, an unmanned surface vehicle (USV) developed by Ocean Aero. The USV relayed the instructions it received via an acoustic modem to a submerged autonomous underwater vehicle (AUV), Lockheed's Marlin Mk.2, which carried Vector Hawk as it cruised below the surface of the Bay.



[Enlarge](#) / The Vector Hawk (left) and Marlin (right).

Upon receiving a command order from Submaran, the Marlin AUV transited to a launch site as instructed, where it then surfaced. Once above water, the Marlin acted on further instruction to ready a canister containing a Vector Hawk. The canister received a GPS position, which was passed to the UAV. Then the top of the canister opened and the Vector Hawk was ejected from the canister, unfolding its airfoils and flying away.

Vector Hawk then proceeded on a predetermined flight path, carrying a payload with a 10 megapixel electro-optical camera, a 640x480 long-wave infrared camera, and a laser illuminator. The Marlin re-submerged and the UAV undertook its ISR mission overhead, transmitting EO and IR video to Submaran, which relayed the images to the ground station. Submaran also provided surface reconnaissance and surveillance. All three autonomous vehicles communicated their operational status to the ground control station, allowing operators to maintain situational awareness and to command and control each asset.

"This was a significant milestone," says Doug Prince of Lockheed Martin business development, unmanned underwater vehicles. "It's the first time that a UAV has been launched from an Autonomous Unmanned Underwater Vehicle. This is the first time that three autonomous vehicles in three different domains [air, surface, and underwater] have worked together to execute a mission. This collaborative demonstration brings us another step forward to realizing a future where different unmanned systems

work in cooperative operations to support ærst responders, military operations, and commercial users."

Despite its light weight, the battery-powered Vector Hawk can carry a variety of payloads and is able to çy for 70-plus minutes, at line-of-sight ranges up to 9 miles (15 kilometers). The launch mode, by hand or via canister, has no impact on its payload capacity according to Lockheed.

The little UAV features fully autonomous çight, landing, and fail-safe modes. The latter ensure it can safely return to the user or auto-land if it suffers a loss of communications with the ground control station or is forced into low-power mode. It can be recovered and relaunched in minutes (it lands conventionally and çoats on water), including time needed to recharge its battery.

Vector Hawk's size is a form of stealth as is its low noise signature, described by Lockheed as "inaudible at operational slant ranges." The UAV operates with a data link which features a high-bandwidth, software-deæned radio, mesh networking (including 3G, 4G, and LTE cellular), over-the-air reconæguration, and is capable of employing a variety of waveforms. Communication/data transfer between the UAV and USV is direct, using the high-bandwidth radio link. Vector Hawk could communicate with Marlin in the same fashion if the sub is surfaced. Otherwise, its data is relayed indirectly to the AUV via the Submaran's acoustic modem.

The combination of platforms and successful launch sequence, free of human intervention, was unprecedented—the world's ærst multi-domain autonomous, unmanned vehicle chain. It's a chain that raises chain-of-command questions.

Should each unmanned vehicle belong to a type command consistent with its domain? Or, given that a single manned platform like a ship could carry and deploy all three vehicles, should the vehicles be free agents, under the command of a çeet or shore command? At present, these unmanned platforms are posited as ISR tools, not active strike or defense platforms. But when they inevitably morph into weaponized craft further in the chain of command, questions will arise.

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