US Integrating Advanced Robotic and Autonomous Weapon Systems into Army Units

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Robotics and Autonomous Systems have become increasingly vital in military operations, with significant impacts on defense capabilities. As countries invest in this technology, these systems will shape future conflicts and warfighting.

The United States Army is actively integrating advanced robotic and autonomous systems into its units, spanning ground and aerial platforms, with promising experiments conducted at the operational level. The Army envisions a future where soldier formations are more efficient and lethal due to these advancements.

The U.S. Army's strategy emphasizes integrating autonomous systems and artificial intelligence (AI) into soldier formations to achieve domain superiority, protect soldiers, and provide the military with crucial advantages over adversaries. The U.S. Army Robotics and Autonomous Systems strategy focuses on empowering soldiers, enhancing unit capabilities and human-machine teaming, and achieving transformative operational advancements through the rapid fielding of robotic technologies.

The United States Department of Defense announced on March 22, 2024, that the Army is advancing modernization capabilities by integrating cutting-edge technology and autonomous systems both on the ground and in the air with promising experiments at the operational level.[1]

> "The Army is moving toward a future where soldier formations will be more efficient and lethal" - U.S. Department of Defense.

Members and leadership from the 49th Wing and 49th Security Forces Squadron watch a demonstration of a Vision 60 Q-UGV ground robot in action at Holloman Air Force Base, New Mexico, on April 17, 2023. (Image Credit: U.S. Air Force/Airman 1st Class Isaiah Pedrazzini)

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1. Matthew Olay, Promising experiment signals future integration of advanced tech into Army units, U.S. Department of Defense News, March 22, 2024. https://www.defense.gov/News/News-Stories/Article/Article/3716688/promising-experiment-signals-future-integration-of-advanced-tech-into-army-units/

According to the Pentagon statement, Chief of Staff of the United States Army General Randy George discussed some of the advancements while talking with the Defense One digital media platform in Washington after observing Project Convergence Capstone 4 – an experiment involving the Army, Navy, Air Force, Marines, and Space Force.

The U.S. Army Gen. George said, "We've all seen how the battlefield is changing, [and] we know that you can't have these big C2 [command and control] nodes that are out there." George added, "We know that machines can do a lot of things right now much more effectively and much cheaper, and we're going to have to incorporate them into our formations."

The U.S. Army general received a briefing on the Army's latest experimental capabilities and technology advancements from Gen. James E. Rainey, the commanding general of Army Futures Command, at Project Convergence - Capstone 4, and highlighted the importance next-generation command and control (C2) system capabilities with industry partners.

Project Convergence Capstone 4

The Project Convergence Capstone 4 is the two-phase, joint and multination experiment that took place at Camp Pendleton, California, and the Army's National Training Center in Fort Irwin, California, from February 23 to March 20, 2024.

U.S. Chief of Staff of the Army Gen. Randy George receives a demonstration of next generation command and control (C2) system capabilities from a 1st Infantry Division officer during Project Convergence - Capstone 4 at Fort Irwin, Calif., on March 18, 2024. (Image Credit: U.S. Army/Sgt. Brahim Douglas)

Project Convergence is led by Army Futures Command and involves a series of experiments that allow warfighters an opportunity to experiment with the latest technologies at the operational level and further improve methods for synchronizing as a joint force. It involved all units including the United States Army, Navy, Marine Corps, and Air Force.

More than 4,000 military personnel of the joint force, civilians, contractors, and armed forces from the U.S. and allied forces including the United Kingdom, Australia, Canada, New Zealand, France, and Japan took part in the Army's largest experimentation exercises in beaches, oceans, air and deserts of the U.S. West Coast. Project Convergence Capstone 4 involved more than 200 defense systems and technologies in a real-world environment.

Project Convergence includes a continuous, structured series of demonstrations and experiments at various locations. It ensures that the U.S. Army can effectively overmatch and counter its adversaries in competition and conflict by rapidly and continuously integrating or converging effects across all domains including land, air, sea, space, and cyberspace.

The groundbreaking joint and multinational military experiment exercises enhanced and integrated the state-of-the-art defense capabilities of the U.S. Army units. It strengthened the effectiveness of joint and allied forces, with a particular emphasis on testing advanced air and missile defense systems as well as leveraging sensor capabilities from both drones and aircraft to enhance force protection and targeting strategies.[2]

The U.S. AUKUS partners the UK and Australia also joined the experimentation exercises to test cutting-edge systems and technologies and enhance force readiness with rigorous wargaming and experimenting with developed concepts.

The U.S. Army Futures Command deputy commanding general Lt. Gen. Ross Coffman said, "This year, we have increased the threat envelope to 10 times what we did last year. With the entire joint force and our U.K. and Australian teammates and allies, we were able to effectively move data for the first time in an Indo-Pacific scenario at a magnitude we've never seen before." The experiments conducted by the Joint Forces and international partners helped achieve the targets outlined in U.S. Force Design and enhanced the readiness of the U.S. and its allies and partners, particularly amid challenges posed by contested logistics.

U.S. Army Combat Capabilities Development Command experiment division's chief Mindy Gabbert said, "There are plenty of technologies we find out aren't mature enough or don't fill a gap or capability the way we thought, so they get withdrawn way before Capstone 4 takes place."[3]

During Project Convergence Capstone 4, several systems were tested including, the Quadruped Ghost robotic dog (unmanned ground vehicle), the HIVE unmanned aircraft system (UAS), Small Multipurpose Equipment Transport (SMET) vehicles, SkyDome with Drone Hunter counter-unmanned aircraft system, Ghost-X unmanned aircraft system, Tactical Resupply Vehicle-150, and unmanned transport vehicles with autonomous weapon systems. The U.S. Army soldiers also conducted sling load operations with autonomous UH-60 Black Hawk helicopters.

Ghost Robotics Vision 60

VISION 60 Quadrupedal Unmanned Ground Vehicles (Q-UGV) are high-endurance and agile unmanned ground vehicles that provide enhanced situational awareness and support for frontline soldiers and serve as their eyes and ears.

The Quadruped Ghost robot dogs are made for unstructured terrain where a typical wheeled or tracked device cannot operate efficiently. The Philadelphia-based firm Ghost Robotics started building Q-UGV in 2015 and unveiled the prototype of the robotic dog in early 2017.

2. Johannes Schmidt, Marines Drive Innovation, Collaboration Aboard Camp Pendleton for Army's PC-C4, Marine Corps Systems Command, March 19, 2024. https://www.marines.mil/News/News-Display/Article/3712753/marines-drive-innovation-collaboration-aboard-camp-pendleton-for-armys-pc-c4/

3. Matthew Murch, Transforming DOD: PC-C4 prepares for the future battlefield, U.S. Army, Futures and Concepts Center, March 22, 2024. https://www.army.mil/article/274758/transforming_dod_pc_c4_prepares_for_the_future_battlefield/

Since then, the VISION 60 Q-UGVs have been tested in several experiments and exercises and integrated with U.S. Army and Air Force teams.[4]

The size of the Q-UGV is about the same as a full-sized Golden Retriever dog that can be assembled and disassembled in about 15 minutes. It can be used in all weather conditions and extreme temperatures from -45 to 55 °C (-40 to 130 °F).[5]

> "They're unstoppable, with the ability to get right back up from any slip, fall, or failure and keep moving using our proprietary blind-mode operations" - Ghost Robotics.

The $165,000 midsized robot dog can be operated in all difficult terrains including steep sands. It can operate in completely unknown environments and even when it fails, slips, or falls, it is capable of getting "right back up and continue moving," the company said in a statement.

In November 2023, the U.S. Air Force engineers tested the range and various capabilities of the robotic canine in different environments. The robotic dog, equipped with a detector, was also tested to detect Chemical, Biological, Radiological, and Nuclear materials (CBRN) threats.[6]

Ghost Robotics remains focused on making the Q-UGVs "an indispensable tool" and improving its ability to "walk, run, crawl, climb, and eventually swim in complex environments" to keep warfighters and workers safe.

U.S. soldiers take part in a human-machine integration demonstration using the Ghost Robotic Dog and the U.S. Army Small Multipurpose Equipment Transport (SMET) of new U.S. Army capabilities at Project Convergence - Capstone 4. (Image Credit: U.S. Army/Spc. Samarion Hicks)

Key Features
- Max Payload - 10 kg
- Top Speed - 3 M/S
- Max Distance - 10 km
- Max Power Runtime - 3 hours
- Weight - 51 kg
- CPU/GPU - Nvidia Xavier

HIVE UAS

The HIVE Unmanned Aircraft System provides soldiers on the ground with enhanced mission effectiveness and real-time situational awareness while conducting missions. The HIVE provides warfighters an enhanced mission efficiency, sensor performance, and reduced cognitive

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4. VISION 60 Q-UGV, Ghost Robotics Corporation, March 25, 2024. https://www.ghostrobotics.io/vision-60/

5. Jessica Barron, Holloman Air Force Base tests new robotic dogs, KRQE, June 2, 2023. https://www.krqe.com/news/technology/holloman-air-force-base-tests-new-robotic-dogs/

6. Airman Rhea Beil & Master Sgt. Delia Martinez, Barksdale Airman innovates robotic dogs to save lives, Barksdale Air Force Base, United States Air Force, December 21, 2023. https://www.barksdale.af.mil/News/Display/Article/3624012/barksdale-airman-innovates-robotic-dogs-to-save-lives/

workload. BlueHalo employs Artificial Intelligence/Machine Learning (AI/ML) swarm logic capabilities, communications systems, and evolving technologies within an operationally driven system-of-systems framework.

The HIVE UAS can be easily tailored for specific operational requirements and operated in harsh weather conditions. It can be used for various missions ranging from Intelligence, Surveillance, and Reconnaissance to meteorological and atmospheric collection. BlueHalo's Intense Eye Version 3 (IEV3) is best suited to meet the U.S. Army's needs for small unmanned aerial systems.[7]
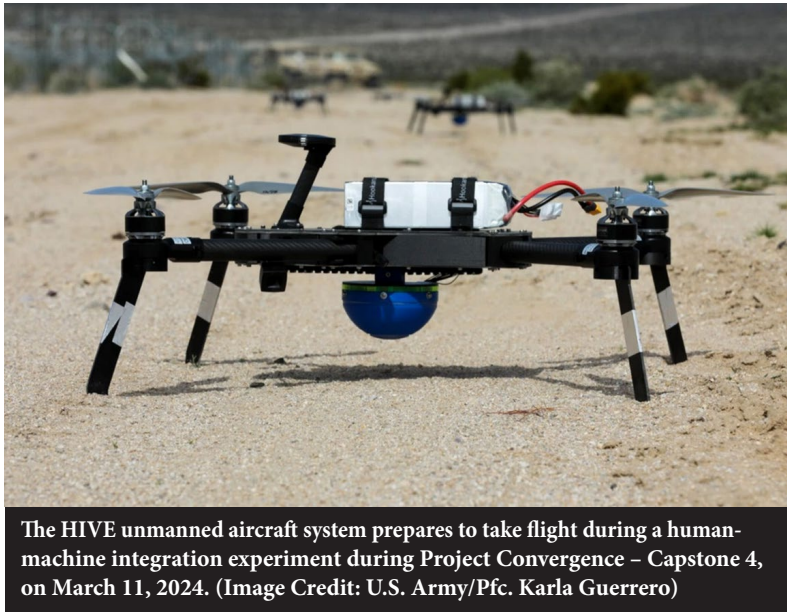
The HIVE unmanned aircraft system prepares to take flight during a human-machine integration experiment during Project Convergence – Capstone 4, on March 11, 2024. (Image Credit: U.S. Army/Pfc. Karla Guerrero)

IEV3 is a 750-mm class 4 rotor Vertical Take-Off and Landing (VTOL) drone. It can be modified for various applications, including autonomous swarming solutions, payload deployment, test targets, fire and rescue operations, and atmospheric profiling.

"The combined capabilities of the light, strong frame with the intelligent software core and autonomous capabilities make the Intense Eye UAS an ideal solution for military and commercial operations" - BlueHalo.[8]

In 2022, the U.S. Army Rapid Capabilities and Critical Technologies Office awarded BlueHalo a $14 million development contract for the HIVE small UAS. According to the BlueHalo statement, the company has "extensive technical experience delivering state-of-the-art capabilities with all aspects of unmanned and counter-unmanned systems including R&D, engineering, fabrication and prototyping, systems development, integration, and test activities."[9]

SkyDome with Drone Hunter system

The U.S. Army units trained with the autonomous SkyDome system with Drone Hunter. The Fortem Technologies' Skydome with Drone Hunter is an autonomous, radar-guided, counter-unmanned aircraft system with modular attachments rapidly firing nets to ensnare enemy UAS.

7. BlueHalo Autonomous Systems, Harnessing Proxy Operations for Amplified Multi-Mission Impact, BlueHalo, March 25, 2024. https://bluehalo.com/c-uas-autonomous-systems/autonomous-systems/

8. BlueHalo Press Release, BlueHalo and Alpine Partner for Break-Through Innovations in Unmanned Systems, BlueHalo, October 10, 2023. https://bluehalo.com/bluehalo-and-alpine-partner-for-break-through-innovations-in-unmanned-systems/

9. Tiffany Sevieri, BlueHalo Awarded Army RCCTO HIVE Contract for the Development of Offensive Swarming UAS, BlueHalo, March 26, 2024. https://bluehalo.com/bluehalo-awarded-army-rccto-hive-contract-for-the-development-of-offensive-swarming-uas/
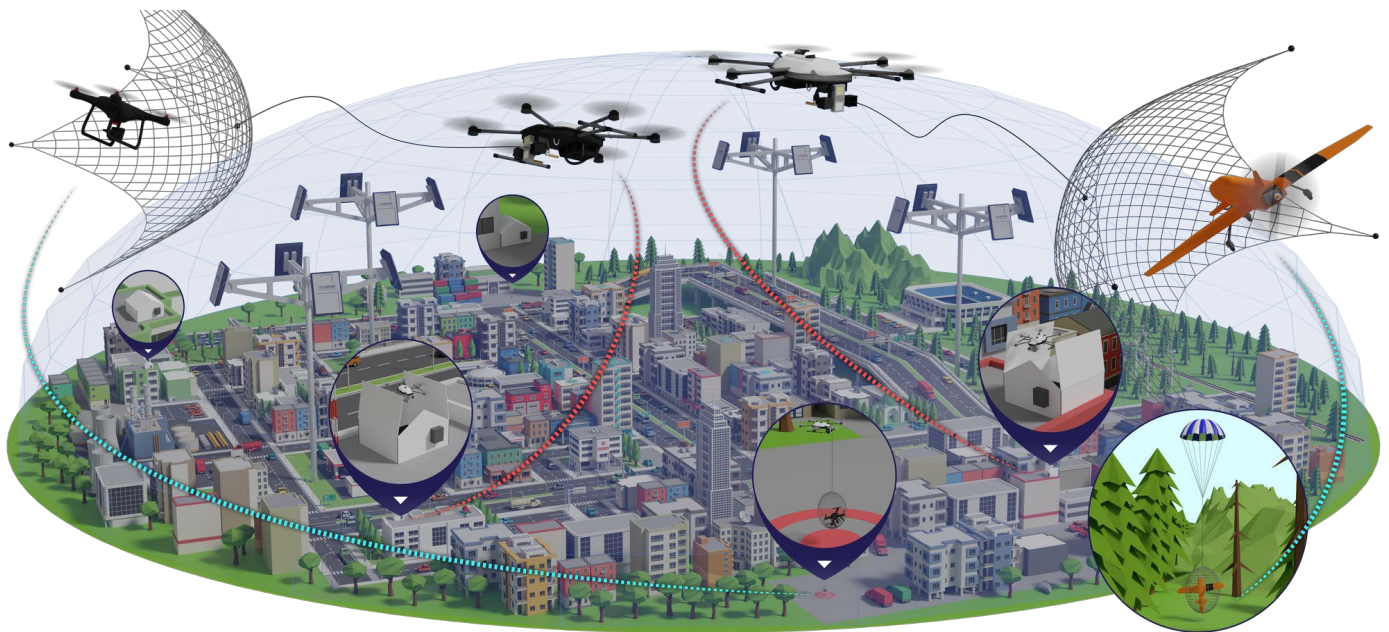
Concept mapping of how the SkyDome C-UAS solution works. (Image Credit: Fortem Technologies)

The SkyDome platform includes drone detection radars that can detect, locate, and classify enemy drones on the operator's screen. After the drone is detected, the operator can launch a DroneHunter F700 interceptor armed with NetGuns and DrogueNet to capture both rotary and fixed-wing aircraft.[10]

The DroneHunter Counter-Unmanned Aircraft System (C-UAS) is a fully autonomous and maneuverable counter-drone system with superior speed and agility compared to other same-class drones. The C-UAS can effectively counter rogue drones in difficult weather conditions both during the day and night time. It has six vertical rotors that allow it to hover and can also be used to protect ships from drone threats.

It is a multifunctional and versatile platform with different modes that can be selected autonomously by each drone, such as pursue mode, attack mode, defense mode, and tow-away mode. Several DroneHunters can be coordinated by the SkyDome Manager command and control system to counter multiple threats.

The DroneHunter uses NetGuns modular attachments to take down both group-1 and group-2 large drones. The NetGun projectiles trap the enemy's drone using a net and tow it away via a tether to a safe location for forensics or disposal.

The AI-enabled DroneHunter F700 weapon system has a high field success rate with more than 4,500 captured drones. The system can be operated alone or together with multiple units and can be equipped with different payloads and countermeasures to monitor and safeguard critical infrastructure, troop deployment, forward base, and military base.[11]

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10. The SkyDome System, Fortem Technologies, March 26, 2024. https://fortemtech.com/products/

11. DroneHunter F700, Fortem Technologies, March 26, 2024. https://fortemtech.com/products/dronehunter-f700/

Ghost-X Unmanned Aircraft System

Ghost-X is a modular, expeditionary, and extended-range unmanned aircraft system platform that can be assembled by a single operator in less than 2 minutes and deployed in the most challenging environments. It can be used for surveillance and security as well as targeting and force protection missions.

The California-based Andruil Industries' Ghost-X system is not just a drone but an artificial intelligence and Intelligence, Surveillance, and Reconnaissance (ISR) system built for soldiering purposes. It has upgraded propulsion, communications, and dual-battery endurance which provides greater operational range and payload capacity. The multiple payload and sensor types provide enhanced situational awareness and mission flexibility, while the multiple layered advanced navigation and communications technologies enable resilience in low connectivity and denied environments.

"Ghost hosts onboard compute with advanced computer vision algorithms to autonomously detect, classify, and track objects of interest while intelligently navigating the terrain and airspace." – Anduril.

According to Anduril Industries, the Ghost-X UAS is built to "meet the current and future demands of operators in the most challenging environments." It is capable of flying longer, covering more distance, and carrying more payloads, which provides the operator an extended reach to effectively complete missions in harsh conditions.[12]

Key Features
- Endurance - 75 min (cruise)
- Range - 15.5 miles (25km)
- Payload - 20 lbs (9kg)
- Weight (dual batteries) - 55 lbs (25kg)

U.S. Army Staff Sgt. Stetson Manuel, an infantryman and Robotics and Autonomous Systems platoon sergeant from Alpha Company, carries the Ghost-X Unmanned Aircraft System during experimentation at Project Convergence - Capstone 4 at Fort Irwin, Calif. (Image Credit: U.S. Army/Sgt. Charlie Duke)

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12. Ghost-X, Anduril Industries, March 25, 2024. https://www.anduril.com/hardware/ghost-autonomous-suas/

Tactical Resupply Vehicle-150

The London-based Malloy Aeronautics' T150 (or TRV-150) is a remote-controlled uncrewed electric Vertical Take-Off and Landing (eVTOL) air cargo drone. The T-150 is capable of delivering food, goods, fuel, medical supplies, military hardware, parts, equipment, weapons, and ammunition to soldiers on the battlefield.

The T-150's flight can be controlled using a laptop and the remote pilot can set waypoints for autonomous delivery. The autonomous drone has eight propellers and eight electric motors and is equipped with batteries that can be easily removed and replaced which allows it to perform multiple missions.[13]

It can fly during both day and night time and carry a 68 kg (150lb) payload at a cruise speed of 108 km/h (67 mph). The drone has been successfully tested in all weather conditions including rain, snow, and gusty wind conditions, as well as in desert and sea.[14]

During the first phase of Project Convergence Capstone 4, T-150 drones took off from the deck of the Marine Corps Warfighting Laboratory's Stern Landing Vessel to test its ability to reach the shore and complete its journey back to the ship.

Key Features
- Maximum Payload: 68kg (150 lb)
- Maximum range: 70+ km (44 miles)
- Flight time: 36 minutes
- Cruise Speed: 108 km/h (67 mph)
- Propellers: 8
- Electric Motors: 8
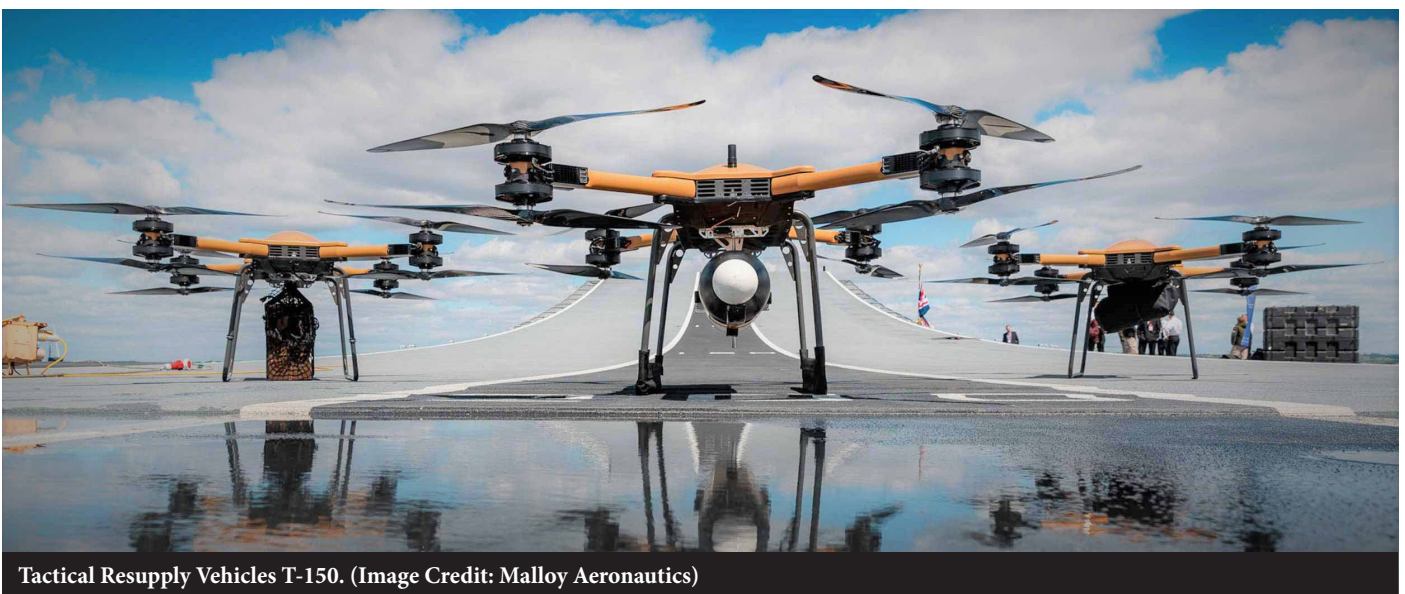
Tactical Resupply Vehicles T-150. (Image Credit: Malloy Aeronautics)

13. Electric VTOL News, Malloy Aeronautics T150, The Vertical Flight Society, March 20, 2024. https://evtol.news/malloy-aeronautics-trv-150/

14. T150/TRV150, Malloy Aeronautics, March 24, 2024. https://www.malloyaeronautics.com/t150.html/

Small Multipurpose Equipment Transport Vehicle

The Small Multipurpose Equipment Transport (SMET) is an eight-wheeled transport vehicle with robotic technology for dismounted soldiers. It is an equipment-carrying "robotic mule" and can be used for combat missions, combat support, and combat service support functions and payloads.[15]

The SMET features a hybrid-electric powertrain and can be operated by a remote control. The unmanned ground vehicle can significantly reduce the load for the soldiers on a battlefield. The robotic equipment transport vehicle can be weaponized with the R600 autonomous system. The R600 remote weapon system has advanced surveillance capabilities that can assist soldiers in accomplishing missions in any future operational environment. R600 can be configured with various weapon systems including Javelin Surface-to-air missile, Stinger air-defense system, Coyote, and Advanced Precision Kill Weapon System (APKWS) rockets.[16]

Electro Optic Systems' R600 remote weapon system offers sophisticated ballistic solutions and integrates modern surveillance capabilities with rapid engagement features. It has a dual weapon configuration which allows operators options from a range of firepower, including .62 mm, 12.7 mm, and 40 mm automatic grenade launchers, for different mission requirements.

The Small Multipurpose Equipment Transport can also be used for casualty evacuation. During the PC-C4 human-machine integration exercise, soldiers used SMET with different configurations, including evacuation, armed with a Javelin anti-tank weapon, and other remote deployment firepower systems.[17]

British unmanned, eight-wheeled, all-electric, transport vehicles armed with autonomous weapon system from the Experimentation and Trails Group provide support to dismounted U.K. Soldiers in an urban environment at Fort Irwin, Calif, March 11, 2024. (Image Credit: U.S. Army/Pfc. Ivan Hernandez)

UK's Experimentation and Trails Group

The United Kingdom's Experimentation and Trails Group (ETG) participated in the PC-C4 and tested advanced military systems and technologies. The ETG is a "Future Soldier" organization that supports the experimentation of advanced weapon systems and trial activities of the Army.[18] More than 600 British Army soldiers took part in the U.S.-led experimentation exercises and trained with several autonomous systems and military technologies.

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15. Matthew Murch, Transforming DOD: PC-C4 prepares for the future battlefield, U.S. Army, Futures and Concepts Center, March 22, 2024. https://www.army.mil/article/274758/transforming_dod_pc_c4_prepares_for_the_future_battlefield/

16. EOS, R600, Electro Optic Systems, March 26, 2024. https://eos-aus.com/defence/firepower-systems/r600/

17. Lockheed Martin, Unmanned Platforms and Beyond: Javelin's Growing Platform Integration, Lockheed Martin News, March 25, 2024. https://www.lockheedmartin.com/en-us/news/features/2024/unmanned-platforms-and-beyond-javelins-growing-platform-integration.html/

18. UK Army, Experimentation And Trials Group, United Kingdom Ministry of Defence, March 13, 2024. https://www.army.mod.uk/our-future/modernise/experimentation/experimentation-and-trials-group/

The ETG tested several defense technologies including small remote-controlled ground drones, JIM Compact multifunction infrared long-range binoculars, All Terrain Electric Mission Modul (ATeMM), and remote-controlled robotic dogs.

The allied soldiers also trained with Robotic Platoon Vehicles (RPVs) with mounted machine guns and unmanned eight-wheeled all-terrain transport vehicles armed with an autonomous weapon system that can support dismounted soldiers in an urban environment.[19]

> *"Hands-on approach to innovation during experiments like PC-C4 can be very advantageous when compared to more conventional, top-down innovation"* - U.S. Army Gen. Randy George.

General George said that during the experimentation exercise, he observed several scenarios where advanced technology was integrated into the Army's formations. General George highlighted that he observed, "a light infantry company that was operating in a simulated urban environment while incorporating robotic dogs and unmanned aircraft systems to sense the environment."

Gen. George highlighted that "There's nothing like testing… in the environments that you know you're going to need to operate in; this isn't about testing something in a showroom. This is actually getting to use [the technology] where they're going to use it … and I think that's where we do our best learning."

While commenting on the timeline for the integration of advanced technologies and modernization, U.S. Army General Randy George said that it depends on future budgets. He stressed, "We do have a sense of urgency," but noted that there is no specific date or timeline for modernization and the Army is focused on "incremental improvement."

U.S. Army Staff Sgt. Stetson Manuel, a Robotics and Autonomous Systems platoon sergeant and infantryman, assembles the Ghost-X Unmanned Aircraft System during the Project Convergence Capstone 4, on March 11, 2024. (Image Credit: U.S. Army Staff Sgt. LaShic Patterson)

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19. The UK Army, British troops in major war-fighting experiment, United Kingdom Ministry of Defence, March 13, 2024. https://www.army.mod.uk/news-and-events/news/2024/03/british-troops-in-major-war-fighting-experiment/

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Cover Image:
U.S. Soldiers assigned to the MCoE Experimental Company, 1st Battalion, 29th Infantry Regiment, 316th Cavalry Brigade, based out of Fort Moore, Ga., take part in a human machine integration demonstration of new U.S. Army capabilities at Project Convergence - Capstone 4 in Fort Irwin, Calif., on March 18, 2024. (Image Credit: U.S. Army/Sgt. Brahim Douglas)

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