HUMAN-MACHINE INTEGRATION:

Tactical-Level Employment and the EXFOR RAS Platoon

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A Soldier in Alpha Company, 1st Battalion, 29th Infantry Regiment, operates a ground robot during the human-machine integration experiment for Project Convergence – Capstone 4 at Fort Irwin, CA, on 11 March 2024. (Photo by SSG LaShic Patterson)

What is HMI? Human-machine integration (HMI) provides the U.S. Army with integrated formations that blend Soldiers with robotic and autonomous vehicles. "It's about putting those two things together in an optimal way that makes the Army better."[1] Army senior leaders — informed by experimentation, current conflict lessons learned, and the current/projected state of robotics and autonomous systems (RAS) technologies — have determined that maintaining the U.S. Army's edge in both mounted and dismounted close combat requires leveraging HMI-enabled formations to the maximum extent. This is best expressed by their top-line messaging regarding robotics:

1. Machines will not replace humans, but the right combination of humans and machines can optimize formations.
2. "No blood for first contact." Use robotic systems to shape first contact with the enemy.

This article shares the experiences of the Army's only Experimentation Force (EXFOR) and seeks to inform the introduction of HMI RAS capabilities into U.S. Army Forces Command (FORSCOM) formations. GEN James Rainey, commanding general of Army Futures Command (AFC), has stated, "Units will leverage their integrated robotics and autonomous systems (RAS) in persistent experimentation to meet learning demands that will inform concept refinement, force design, capabilities development, funding decisions, and future experimentation."

Current HMI RAS Capabilities and Technology

Small Multi-Purpose Equipment Transport (S-MET) **—** a program of record (PoR) system designed to provide infantry brigade combat teams (IBCTs) a method of offloading weight traditionally carried by the Soldier. This platform has been adapted with the addition of an autonomy kit and payloads to transition from load carrying to the execution of other military tasks.

ORIGIN (An uplifted S-MET with various Modular Mission Payloads (MMPs) **—** NOT a PoR robotic vehicle and is still experimental. It is capable of mounting a Common Remotely Operated Weapons Station-Javelin (CROWS-J) .50cal/Mk19, a vertical mast-mounted 360-degree camera for reconnaissance, a smoke-generating Screening Obscuration Module, a tethered unmanned aerial system (UAS) for persistent surveillance with an electro-optical infrared (EO/IR) camera, or a multi-pack loitering munitions launcher.

Medium-Range Reconnaissance (MRR) UAS surrogate **—** a company echelon teleoperated or waypoint-enabled intelligence, surveillance, and reconnaissance (ISR) UAS that provides full-motion video (FMV). The current

system is a surrogate on loan from Anduril. Anduril and other companies are competing to win the award for the company-level (group 2) UAS directed requirement.

Short-Range Reconnaissance (SRR) UAS — a platoon echelon PoR UAS in its second tranche (fielding) that is a teleoperated or waypoint-enabled ISR UAS that provides FMV.

Hunt and Releasable Kill (HaRK) UAS — a surrogate for a weaponized medium-range UAS that drops guided and unguided drop/glide munitions (equivalent to an 81mm high explosive mortar round).

Low Altitude Stalk and Strike Ordnance (LASSO) — a PoR to deliver a loitering munition with an antipersonnel or anti-armor warhead. It can be launched from either the All-Up Round (AUR) packaging/carry tube from the ground or a multi-pack vehicle-mounted launcher. They are controlled via a Ground Control Station (GCS) tablet. Current surrogates for this are Switchblade 300/600 systems.

Quadruped (Robotic Dog) — a teleoperated ground ISR robot deployed ahead of dismounted formations to recon dead space to confirm or deny enemy presence in likely or suspected areas.

Throwbot — a hand-thrown or UAS-dropped rolling, electrically powered, teleoperated ISR robot.

Dismounted Unit Soldier Transport (DUST) — an electrically powered (battery) wheeled dismounted mobility system that allows one to two Soldiers to move up to 500 pounds of equipment, supplies, or casualties over rough terrain and within buildings. The current surrogate for DUST is the Silent Tactical Energy Enhanced Dismount (STEED).

Efforts to Date

In September 2023, A Company (EXFOR), 1st Battalion, 29th Infantry Regiment, was selected by the Maneuver Center of Excellence (MCoE) to stand up the Army's first HMI RAS platoon as part of modernizing Infantry and Armor formations for large-scale combat operations (LSCO). For the past 10 months, the RAS platoon located at Fort Moore, GA, has worked with AFC, U.S. Army Training and Doctrine Command (TRADOC), and FORSCOM entities to validate robotic employment concepts using a combination of live, virtual, and constructive training exercises. The EXFOR most recently demonstrated RAS platoon capabilities to Army senior leaders during Project Convergence Capstone 4 (PC-C4) at the National Training Center (NTC) by integrating with both 1st Squadron, 4th Cavalry Regiment (Fort Riley, KS) and 2nd Battalion, 508th Parachute Infantry Regiment (PIR) (Fort Liberty, NC) to conduct situational training exercises (STXs) and the Army's first HMI-enabled battalion-level combined arms live fire. Before PC-C4, the EXFOR conducted multiple STXs at both the company and platoon level with the RAS platoon during the Army Expeditionary Warrior Experiment (AEWE) 2024 at Fort Moore, where the company conducted prototype-assessment experimentation with FORSCOM, British, German, and Dutch units to provide critical feedback on developing technologies to AFC and industry partners. **The following sections describe how the EXFOR organized, trained, and now fights the RAS platoon and the challenges that HMI commanders may face in the future.**

Soldiers assigned to the 1st Battalion, 29th Infantry Regiment take part in a human-machine integration experiment using the Ghost Robotic Dog during Project Convergence - Capstone 4 on 17 March 2024. (Photo by SPC Samarion Hicks)

How the EXFOR RAS Platoon Was Organized

While still experimental, the 18 personnel resourced for the HMI-Infantry (HMI-I) platoon by the EXFOR were all 11-series military occupational series (MOS) Infantry Soldiers and leaders. The RAS platoon's current organization (structure and equipment) was based on the Soldiers and leaders available to man the platoon and the air/ground systems available from industry and the U.S. Army Combat Capabilities Developmental Command (DEVCOM). This combination is the minimal viable structure and manning that is thought to be operationally effective. The RAS platoon's base structure consists of a platoon headquarters (with air/ground RAS) and two RAS squads (with air/ground RAS). During live experimentation, A/1-29 EXFOR task organized the original platoon structure into air and ground sections, each led separately but collaboratively by the RAS platoon leader and platoon sergeant (see Figure 1). The individual air and ground sections operated primarily as a cohesive platoon, but they could still be broken into smaller elements

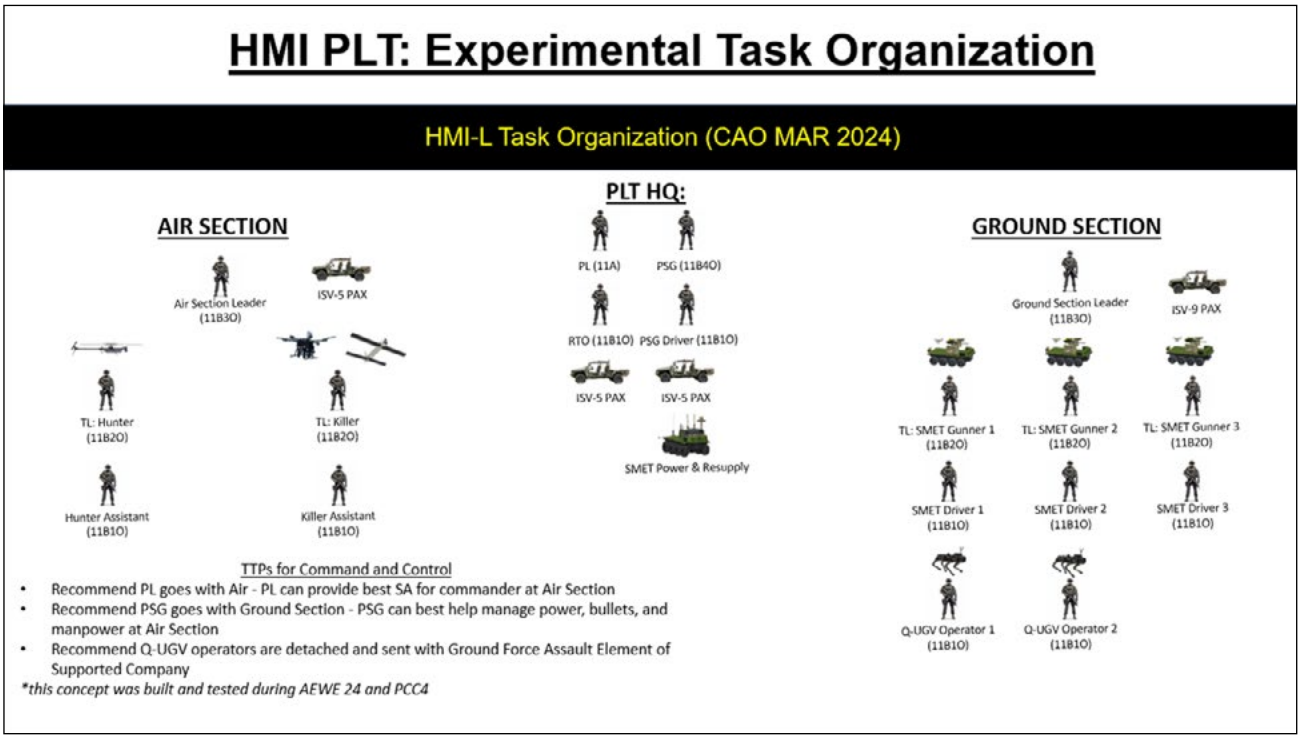


Figure 1 — RAS Platoon Experimental Task Organization

to support the commander's specific tactical requirements, such as aerial reconnaissance, geo-mapping of urban terrain, ground direct fires, or aerial fires. The platoon is equipped with Infantry Squad Vehicles (ISVs) for mobility; payload-enabled S-METs, ORIGINs, quadrupeds; and an array of aerial systems such as SRRs, MRRs, and loitering munitions.

The RAS platoon headquarters controls the employment of both the HMI air and ground sections per guidance from the battalion or company commander, depending on the directed support relationship. The headquarters element comprises a platoon leader, a platoon sergeant, a radio-telephone operator (RTO) (who also serves as the platoon leader's driver), and a driver for the platoon sergeant. The platoon leader and platoon sergeant each have their own ISV to allow these key leaders to exercise tactical control at different points of friction on the battlefield.

The air section conducts aerial reconnaissance, provides additional aerial fires, and conducts battle damage assessments (BDAs). Led by a staff sergeant (SSG), the air section comprises a hunter and a killer team. The hunter team is currently equipped with one MRR, and the killer team is armed with an armed drone and LASSO. The HaRK armed drone is capable of dropping up to four drop/glide munitions at a time, which is equivalent to an 81mm mortar, while the LASSO can be launched, loiter, then fly directly at an enemy target and explode. The entire air section includes five personnel, and all personnel and equipment will fit into one five-passenger ISV.

Similarly, the RAS ground section is also led by a SSG and conducts ground maneuvers ahead of Soldiers to gain and maintain direct fire first contact with the enemy out of contact with Soldier-manned squads and platoons. The RAS ground section contains three teams. Two of the teams are identical, consisting of an ORIGIN team leader (who also serves as the ORIGIN gunner), an ORIGIN operator, and a quadruped operator. The third team includes an ORIGIN team leader and ORIGIN operator but no quadruped operator. Typically, the EXFOR would employ each ORIGIN with a CROWS system (mounting either an M2A1 .50 caliber or M240B machine gun). Quadrupeds were non-lethal and, during experimentation with the EXFOR, were only used for reconnaissance and clearing urban spaces. The section leader also has two SRRs that the quadruped operators can employ to clear dead space for ORIGINs when the quadrupeds are not in use. The entire ground section comprises nine personnel with one ISV for mobility.

How the RAS Platoon Trained

The EXFOR trained the RAS platoon utilizing a crawl, walk, run method. The crawl phase focused on exposing Soldiers to the HMI equipment and allowing them to touch and operate the equipment with the assistance of vendor field service representatives (FSRs) and DEVCOM trainers. Soldiers achieved proficiency with the suite of all RAS equipment in a week, while complete mastery of the systems, including troubleshooting procedures, occurred in roughly two weeks. During the walk phase, the EXFOR utilized tactical exercises without troops (TEWTs) to work on the synchronization of assets and to develop an understanding of how RAS capabilities change tempo and the scheme of maneuver decisions. In the run phase, the EXFOR conducted platoon and company STX against a free-thinking and unrestricted opposing force (OPFOR). The culmination of this run phase

occurred during PC-C4 experimentation when the RAS platoon was under operational control (OPCON) of 1-4 CAV and 2-508 PIR against NTC's OPFOR (11th Armored Cavalry Regiment "Blackhorse").

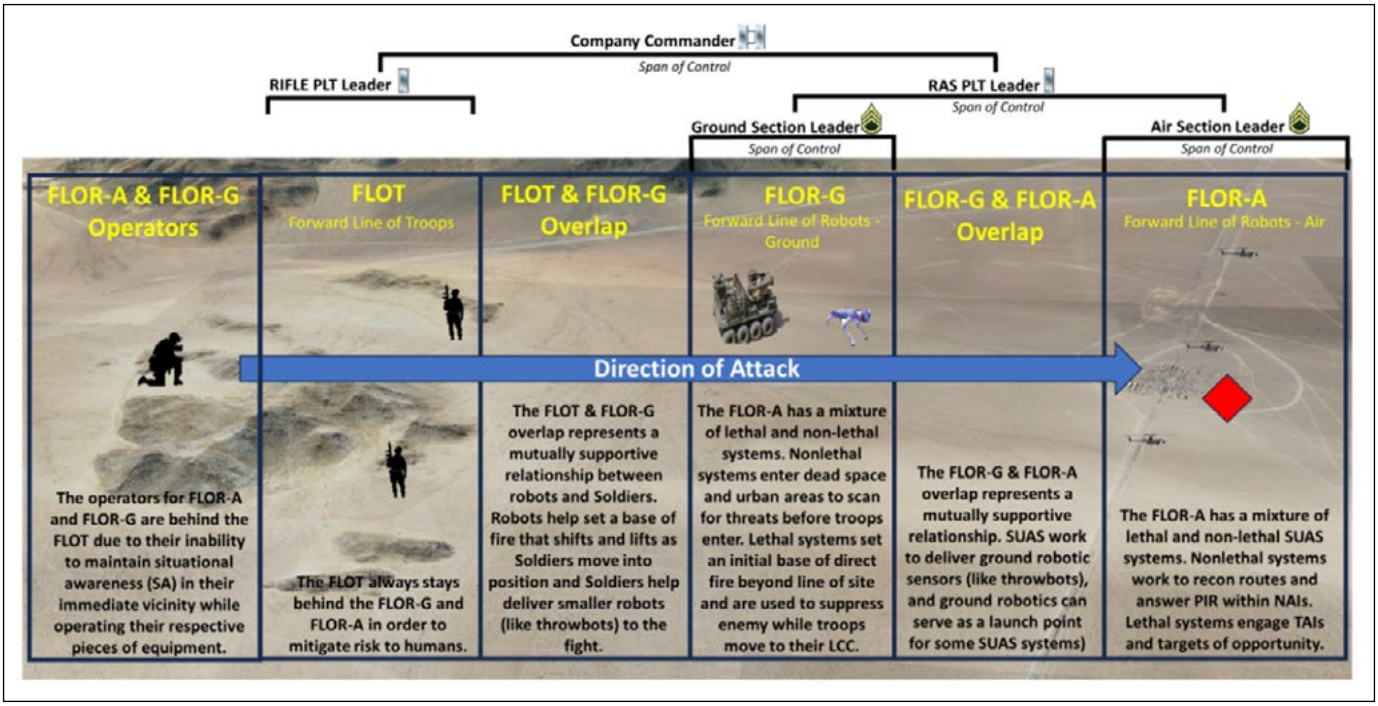
How the RAS Platoon Can Fight

The proposed RAS platoon is organized to serve as a specialty platoon in an IBCT infantry battalion and equipped to enable infantry maneuver companies with a robotic capability as an entire platoon element or split into two elements with near-similar capabilities. The RAS platoon fights as a cohesive unit, leveraging the simultaneous employment of air and ground robotic capabilities to support the commander's decision-making and achieve the desired effects that support the close fight. While less optimal, ground and air elements can be individually cross-attached to subordinate units to support tactical maneuver. When the RAS platoon fights as a cohesive element, its platoon leader is responsible for the placement, movement, and deployment locations of all RAS assets. The platoon leader's focus centers on controlling the overlap of air and ground activity synchronized within the battalion/company's scheme of maneuver. Proper synchronization of this overlap is crucial to maintain tempo and concentration during the offense and security, concentration, and disruption on the defense.

The RAS air section operates its assets at the front edge of the battlefield and establishes the forward line of robotics – air (FLOR-A) while its operators remain behind the forward line of own troops (FLOT) for protection. In the movement phase of an operation, the hunter team conducts aerial reconnaissance of routes and observes named areas of interest (NAIs). The RAS air section must be stationary to launch the aircraft but can then move freely along a route in its ISV while the hunter team controls the MRR. In the "actions on" phase of an operation, the killer team provides the battalion commander, or supported company commander, with further options on engaging enemy targets. At the same time, the hunter team continues to observe NAIs and conduct BDA. During STXs and at NTC, the air section had tremendous success destroying entire platoons and armored vehicles before Soldiers ever fired a shot. The air section's MRR and SRR UAS proved to be rugged and able to withstand relatively harsh wind conditions compared with previously fielded ISR UAS platforms.

The RAS ground section typically operates its assets behind the FLOR-A and establishes the forward line of robotics – ground (FLOR-G) in front of the FLOT in order to trade blood for steel on first contact. In the "actions on" phase, the ORIGINs were controlled by the RAS ground section leader in the same way that a weapons squad leader would control his machine guns, emphasizing controlling fire rates and ensuring continuous suppression of the objective. When not operating a quadruped, the quadruped operators employed SRR UAS within the ground section to visually clear dead space for the ORIGINs, but this would be unnecessary if the ORIGINs could move with their sensor masts and tethered drones up. When required by the mission, the quadruped operators were integrated into the lead squad of a rifle platoon tasked to enter and clear a building. Those operators moved with that squad to provide immediate information on what was behind a wall or up a set of stairs. Overall, experimentation and STXs demonstrated that the RAS ground section poses a significant dilemma for the enemy that draws direct and indirect fire away from Soldiers. However, there is still much work to be done ruggedizing, powering, and controlling these robots at range for best effect.

Figure 2 — Proposed Battle Space Management with RAS Platoon



Potential Challenges and Opportunities for Commanders with an HMI-IBCT RAS Platoon

The RAS platoon will bring unique changes and challenges both in garrison and on the battlefield. It will be critical for leaders at all levels to "buy in" to these new formations and embrace how they will increase unit effectiveness and might change the way we fight.

Personnel Selection. In garrison, the battalion and company commanders, with their command sergeants major and first sergeants, respectively, will need to ensure the right people are selected for the RAS platoon. The platoon can be MOS agnostic, but these Soldiers will directly shape and support the battalion and company fight.

Training. Commanders will have to consider different training requirements for the RAS platoon when it comes to resourcing training. Just having land will not be enough. The RAS platoon will require airspace training and multiple types of frequency allocations to train effectively with the suite of HMI equipment.

MDMP and Maneuver. Commanders, the S-3, and the RAS platoon leader will have to plan to manage the tempo and overlaps of the FLOR-A, FLOR-G, and FLOT. A second tempo challenge came with managing the overlap between the ground section and the FLOT. In this case, the EXFOR had the opposite problem with tempo: Soldiers from the lead rifle platoon would often engage too early, not allowing the ground robotic assets to absorb the first contact and setting conditions for the assaulting squads.

Spectrum Management. At all echelons (platoon through brigade), increased awareness and emphasis on radio frequency (RF) spectrum management is required to ensure the optimal employment of different radios, UAS capabilities, robots, etc., to prevent systems from jamming one another. The inclusion of RF spectrum management will be critical in the planning process.

Power Management. Power management of robotic systems is critical to ensuring they can effectively contribute to the close fight when and where the commander needs them.

Employment of Armed UAS and LASSO Systems. Army policy for the training and employment of armed UAS and LASSO at lower and lower echelons is currently being worked out. These systems are non-line of sight (NLOS) and beyond line-of-sight (BLOS) and share characteristics with both aircraft and traditional indirect fire systems (mortars and tube artillery).

Airspace Management. Commanders and staff at echelon will need to increase their awareness of managing airspace to maximize the employment of UAS and LASSO. To ensure conflict between manned and unmanned systems, three-dimensional graphic control measures with prescribed altitudes and periods of time will also be necessary.

Range. Currently, ground robotics are limited in their ability to operate long distances. Lessons learned from PC-C4 showed that when UAS can be used as an aerial comms extension or network relay, unmanned ground vehicles can extend their FLOR-G ranges during missions. An additional air asset dedicated to connecting the operator to the robot would be ideal within the RAS platoon.

A drop/glide munitions drone releases munitions during Project Convergence - Capstone 4. (Photo by SGT Brahim Douglas)

Who Is Involved

TRADOC, MCoE — The Army Force Modernization Proponent System (Army Regulation 5-22) establishes the MCoE commander as the maneuver force modernization proponent. The force modernization proponent is the commander with primary duties and responsibilities relative to doctrine, organization, training, materiel, leadership development, personnel, facilities, and policy (DOTMLPF-P) requirements for a particular function (e.g., maneuver). The proponent determines DOTMLPF-P requirements. It also establishes the MCoE commander as proponent for robotics in addition to previous requirements. The Chiefs of Armor/Infantry serve as branch proponents, executing training, leader development, education, and personnel responsibilities for their designated branch. The Chief of Infantry also serves as director of the Soldier Lethality Cross-Functional Team.

MCoE, 316th Cavalry Brigade and A/1-29 IN (EXFOR) — The 316th Cavalry Brigade generates leaders and lethality for the Army in order to fight as part of a combined arms team that delivers precise direct fires to win the first battle of the next war decisively. A/1-29 IN (EXFOR) is a subordinate unit and the Army's only dedicated experimentation force.

AFC, Maneuver Capabilities Development and Integration Directorate (MCDID) — MCDID determines and develops future force capabilities and future infantry, armor, and robotic requirements across DOTMLPF domains, resulting in a trained and ready maneuver force fully integrated into Army, combined, and joint operations to maintain the battlefield primacy of our Soldiers and the formations in which they fight.

MCDID, Maneuver Battle Lab (MBL) — MBL conducts combined arms, cross-domain maneuver experiments in live, virtual, constructive, and gaming environments. Integrated within the centers of excellence, joint services, and multinational partners, MBL uses live prototyping, force-on-force experiments, modeling, and simulation capabilities to support Soldier and small unit modernization efforts. It recommends DOTMLPF-P solutions supporting force development, brigade combat team (BCT) modernization, future force concepts, and current operational needs from the BCT through the Soldier level. MBL's objectives are to mitigate risk to the force, help focus science and technology efforts, quantify value with validated underpinnings, and shape investment strategies to align resources to solutions of the highest operational value.

MCDID, Army Capabilities Managers IBCT, Armored BCT, and Stryker BCT (ACM) — The ACMs integrate and synchronize requirements across the dimensions of DOTMLPF-P for all maneuver brigades, both active component and National Guard, to ensure success on the battlefield. The ACMs are the voice of the warfighters who advocate and advise Army senior leaders as the "user representative."

MCDID Robotic Requirements Division (RRD) — RRD, in coordination with key stakeholders, enables the Army to deliver robotics that enable our Army to fight, win, and dominate in a multidomain environment by 2030.

Conclusion and Way Ahead

"The one thing we've really got to offload on the machines is risk. Shame on us if we make first contact [in combat] with a human again. The technology absolutely exists for us to make sure that we don't trade blood for first contact. Let's trade robots for that."[2] An HMI formation described in this article begins to achieve that effect. Utilizing prototype capabilities based on the latest technologies that industry can offer, the AFC-TRADOC-FORSCOM triad of experimentation has established a firm base from which we, as an Army, can leverage new capabilities and begin to change the way we fight. We are informing a larger modernization effort that stretches from the present "Transformation in Contact" effort directed by the Chief of Staff of the Army through the conceptual Army 2030 to the future Army 2040. For HMI, the Army Rapid Capabilities and Critical Technologies Office (RCCTO) will, in the near future, provide two operational prototype HMI sets of equipment to two FORSCOM units for tactics, techniques, and procedures development and lessons learned to inform future requirements.

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> ***— GEN James Rainey[2]***

Notes

[1] GEN James Rainey, "Rainey: Army Needs Industry's Help to Transform," Association of the U.S. Army, 27 March, 2024, https://www.ausa.org/news/rainey-army-needs-industrys-help-transform.

[2] GEN James Rainey, "Rainey: Service Needs Help Designing Army of 2040," Association of the U.S. Army, 18 August 2023, https://www.ausa.org/news/rainey-service-needs-help-designing-army-2040.

A robotics and autonomous systems platoon sergeant assembles the Ghost-X UAS during Project Convergence Capstone 4. (Photo by SSG LaShic Patterson)

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