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REPORT



## FUTURE FORCE CAPABILITIES 2024

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# Exploding Demand

## Arms Manufacturers Catching Up with World's Insatiable Need for 155mm Rounds

BY JOSH LUCKENBAUGH AND STEW MAGNUSON

**P**ARIS — It's the shell everybody seems to want. Since the war began in Ukraine the demand for the relatively low-tech 155mm ammunition

has skyrocketed, with the nation firing as many as 8,000 rounds per day, according to some published estimates.

From Asia to Europe to the United States, arms manufacturers are building new facilities to boost the capacity to produce the shell, not only to supply Ukraine but also to replenish domestic stocks.

But the captains of the defense industry wonder how long the demand will last and if they risk overbuilding production capacity.

In the United States, the Army is looking to significantly ramp up 155mm production, with a stated goal of producing 100,000 rounds per month by 2025. As of February, the Army was “manufacturing 30,000 155mm rounds per month, doubling its previous output of 14,000 rounds prior to the conflict,” according to a service release.

Doug Bush, assistant secretary of the Army for acquisition, logistics and tech-

nology, said the Army is now “on a path” to producing 70,000 to 80,000 rounds per month by the end of 2024 or early 2025.

“That will do a couple things: it will allow us to support Ukraine more fully, it will also allow us to restock ourselves and also restock our allies, all of whom have now recognized the need for a deeper well of munitions on the shelf but also more production capacity,” he said during a roundtable discussion hosted by the Center for Strategic and International Studies.

When the war in Ukraine began, the Army “had precisely the amount of 155 we were supposed to have based on the [Defense] Department’s policies, plans and assignments,” he said.

However, in a scenario like the one the United States finds itself in presently “where we are supporting allies in large-scale conflicts while maintaining weapons for ourselves, I think that requirements process does need to be relooked,” Bush said.

One solution is maintaining larger stockpiles, but that is expensive and “even artillery shells do age out over time and become less reliable,” he said. The “more efficient” fix is “not to maintain massive peacetime stockpiles but have the ability to, when



needed, ramp up faster. That way, you get the very latest version” of a weapon, “not a big stock of older ones.”

The Army had laid the groundwork in 2018 and 2019 for its current ramp-up through “renewed investment” in the government-owned factories “that do a lot of the conventional munitions work,” he said.

“It was very fortuitous that we had the plan on the shelf — so when Ukraine happened, we already had a plan we could execute to dramatically expand and modernize the Army’s organic industrial base that helps produce most of our conventional munitions such as artillery shells,” he said.

Along with ramping up production at its existing facilities, the Army is also investing in new manufacturing processes and technologies such as robotics, Bush said.

“If you could maintain a factory of robotics that [doesn’t] need as many people and the robots could be maintained at a relatively lower cost, there’s your surge capacity,” he said. “And also you get better quality and [robots] don’t take breaks. There are many advantages to just using modern manufacturing techniques.”

In May, the Army’s Joint Program Executive Office for Armaments and Ammunition hosted an opening ceremony for the Universal Artillery Projectile Lines facility in Mesquite, Texas, which will produce metal parts for 155mm shells.

The \$576 million facility will be operated by General Dynamics Ordnance and Tactical Systems. A company official who spoke on the condition of background said General Dynamics “worked closely with the Army to figure out what the [service’s] desires were and incorporate as much new technology as possible into a new facility.”

One example is the significant amount of automation throughout the facility.

“If you think about things like forklifts and hand trucks to move material from one operation cell to another, we don’t have that here,” the official said. “It’s a lot of conveyors, [and] anytime we do have to move batches of things it’s done by [automated guided vehicles], which are essentially little Roombas that go and pick up the pallets and move them to the next operation, and all that’s done through [light detection

and ranging] programming and the sensors onboard those machines.”

The new facility also features flow-forming technology, which is new for 155mm production, the official said.

“Generally what we do is press a billet through a forge and create a big cup, and then there’s a lot of machining operations after that to get it into its final form,” the official said. “With flow forming, we do that same upfront pressing, but then it goes into a machine where rollers are used to kind of iron it out,” which reduces variation from part to part and round to round.

In addition to the advanced manufacturing processes, the facility also has what an Army release described as “digital data capture ability.”

The General Dynamics official said “a lot of the equipment in this facility comes with significant sensing on it,” which allows operators to col-

lect data ranging from “the number of parts that are flowing through” to “how much load is being applied” in the press to “how much lubricant is on a tool [to] measurements for inspections that are done automatically.”

“That data is collected ... and then that makes it more traceable from part to part so if we do have an issue down the line, [it] gives us better insight into when it was made, where it was made [and] what operation could have created a problem,” the official said.

The facility will ultimately have three production lines that can each produce 10,000 metal parts per month, the official said. The first production line will be up and running this fall, with the next two to follow in 2025.

In addition to the typical 155mm high explosive rounds, the facility also “offers the flexibility to manufacture a

variety of projectile metal parts ranging in calibers from 60mm to 155mm,” a General Dynamics release stated.

The Army will assume ownership of the capital equipment, subsequently leasing it back to General Dynamics Ordnance and Tactical Systems through a government-furnished materiel agreement, the Army statement said.

Undersecretary of Defense for Acquisition and Sustainment Dr. William LaPlante told reporters the facility has “been set up such that if you really wanted to reconfigure the line to” build more advanced munitions such as Excalibur 155mm precision-guided rounds for example, “it could be done.”

A General Dynamics spokesperson said in an email the Universal Artillery Projectile Lines facility “is designed to accommodate production of the 155mm M1128 round,



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Increasing range is currently “the biggest driver of demand,” the General Dynamics official said.

“In Ukraine what we’re seeing is standoff is important. For the U.S. Army, our customer, that’s important as well,” the official said. “You want to be able to reach out and touch the enemy before they can reach out and touch you.”

LaPlante said that for the Army’s 100,000 155mm rounds per month by 2025 goal, those munitions will primarily consist of the typical high explosive shells.

“I don’t see the 100,000 being heterogeneous, I see it being homogeneous,” he said. “Because one

of the things we're trying to push with NATO and others is we're calling it not just interoperability but interchangeability, that if you take a munition from one country" and fire it from another country's weapon that "they can work together. And so that's where we're trying to go."

Along with domestic industry partners such as General Dynamics, the Army is looking to international companies to help with 155mm production.

Norway-based aerospace and defense company Nammo is in talks with the Army to open a second U.S. plant to manufacture 155mm munitions, the company's president and CEO Morten Brandtzaeg said at the Eurosatory trade show in Paris in June.

Nammo already operates a plant producing 155mm ammunition in Mesa, Arizona. Brandt-

self-propelled howitzer, a 30 percent increase over existing shells. South Korea's Defense Acquisition Program Administration recently greenlighted their mass production, Yonhap News Agency reported in February.

Dan Darling, vice president of market insights with Forecast International, said on the other side of the world "the Europeans are unquestionably surging. They have put money aside for" 155mm ammunition production, he said in an interview. But they have to open new production lines, which "is not an overnight thing," he added.

German defense giant Rheinmetall is "a little ahead of the curve, but I would say probably at about now, the United States is producing more than Europe," Darling said.

Gaspard Schnitzler, head of the defense industry program at the French Institute for International and

Strategic Affairs think tank, said before the beginning of the Ukraine war, Europe was able to manufacture about one million 155mm artillery shells, but by 2026, it should be able to produce 2 million.

The EU Commission has also come up with numerous initiatives, creating incentives on both the demand and the supply side to give the defense

industry more visibility, he said while moderating a panel on the European ammunition industry at Eurosatory.

Another indication of the rising demand was Rheinmetall in June signing the largest order in the company's history: an 8.5 billion euro deal with the German government to replenish its 155mm stocks and supply Ukraine with the shells with deliveries to start in 2025, a company statement said.

In February, it broke ground on a new 155mm-focused factory in Unterlues in the Lower Saxony region.

Armin Papperger, the company's CEO and chairman of the executive board, said the order will ensure that the new factory will not overbuild production capacity.

Rheinmetall also acquired Expal Systems in Madrid, Spain, in August 2023.

Brandtzaeg said: "The ramp-up of ammunition in Europe is a very critical issue in this time ... there are two demand drivers for this. One is to support Ukraine and the other one is to increase the war stock among allies in Europe."

Potential roadblocks include supply chain shortages, he added.

"You cannot just produce more steel, we need the energetic material as well," he said.

And along with the raw materials that make the shell explode is the machinery needed to manufacture them, he said.

"It's the whole supply chain of ammunition that is being hit. Building more capacity is one of the challenges that we have. But that needs equipment. And we need priority in order to buy that equipment and to have it delivered," he added.

Brandtzaeg said Nammo has estimated that just to supply Ukraine with enough 155mm shells will require 3.5 billion euros in investments, which is just the mechanical work that needs to be done. It doesn't include the raw materials. Replenishing the European nations' 155mm stocks would be another 3.5 billion euros. On top of that, there needs to be more investment into the supply chain for explosive chemicals.

"This is totally outside of the range of what this industry can pay for," he said.

Thierry Francou, chairman and CEO of France-based ammunition manufacturer Eurenco, said during the panel discussion that his company is investing about 25 million euros to increase capacity, but it is also running into the problem of high costs of procuring manufacturing machinery. High energy prices are also a factor, he added.

Dominique Guillet, general manager for KNDS Ammo France, along with the other two European industry executives, questioned what happens when the world's insatiable demand for 155mm rounds comes to an end.

His company has a goal to triple its 155mm artillery shell production.

"We are fully mobilized to ramp up but we need to think about the future after the next two years. It's OK now, but what happens from 2027 to 2030?" he asked.

Brandtzaeg said governments must share some of the risk industry is taking on "when we are building this massive capacity." **ND**




zaeg said Nammo is prepared to open a new 155mm plant near its Mesa location or in Florida.

"The [United States] has a very distinct and concrete plan for increasing capacity not only for the 155 but also for all the raw materials needed," he said.

Another source of the ammunition is South Korea, which has large stockpiles of 155mm shells that adhere to NATO standards. Its laws prohibit it from supplying weapons to nations at war, but it can get around the law by replenishing stocks of countries not at war who are sending their own shells to Ukraine.

Ammunition manufacturer Poongsan recently finished development of a new long-range 155mm shell designed with a range of some 60 kilometers when used with the nation's Kg



A breached mined wire obstacle explodes during a combined arms live fire exercise.

# Blast Off

## New Legislation, Indian Head Tech Hub Boosts Energetics Industry

BY JOSH LUCKENBAUGH

**A**bout 30 miles south of Washington, D.C., on the Maryland side of the Potomac River sits the town of Indian Head. With a population of around 4,000, the community is by no means a bustling metropolis.

However, Indian Head and the surrounding area have become a hub for companies dealing in energetic materials: the chemicals used in explosives, propellants and pyrotechnics.

The energetics industry received a major boost from several provisions contained in the fiscal year 2024 National Defense Authorization Act, which was passed in December 2023 but funding for which was not appropriated until March.

These provisions are “the most significant related to energetics that we’ve seen in many, many years,” said Will Durant, president and COO of the Energetics Technology Center, which is headquartered in Indian Head.

“It’s an exceptional array [of provisions] just to ensure that the energetic materials themselves are considered, and not just that end item commodity that we may buy — the missile or the munition or the long-range

weapon,” Durant said in an interview. The energetic materials are “the lethal element of the system, right? If you don’t have the material itself, you can’t shoot it, and it doesn’t go boom at the other end.”

The United States has lagged behind China in its development of advanced energetic materials, and “if there is an engagement in the South China Sea ... then we need to make sure” U.S. weapons have the necessary range and lethality for that conflict, he said. “Advancements at the material level” are essential because they “can affect an array of munitions” across the Joint Force.

One of the energetics-related provisions in the 2024 NDAA called for the Defense Department to stop procuring chemical materials for munitions from China, Russia, Iran and North Korea no later than Sept. 30, 2028.

“Energetic materials are manufactured with inert ... precursor chemicals that over the past many years, we may have offshored that capability to produce it,” Durant said. “So, if we’re dependent on a potential adversary in the future for a precursor chemical that we use in a qualified energetic material formulation to create that

lethal effect on their warfighter ... they’re not going to sell it to us, right?”

“The limitation is really kind of a risk management to ensure that we have that capability on friendly shores to get that munition manufactured, built and deployed, if necessary,” he said.

In January, the Naval Surface Warfare Center Indian Head Division, the National Armaments Consortium and the American Center for Manufacturing and Innovation’s federal unit announced the signing of a Cooperative Research and Development Agreement to develop the necessary manufacturing techniques and technologies “to support domestic production of the next generation of critical chemicals and energetic materials,” a consortium release stated.

“The collaborative effort will help meet the growing need for additional baseline, precursor chemicals and energetic materials for ordnance production within the United States and establish a stronger, more resilient supply chain for the DoD,” the release said.

The Naval Surface Warfare Center Indian Head Division is home to the Navy’s Energetics Manufacturing Technology Center, and the recent increase of interest and investment in energetic materials has led to “a very significant influx of ... industry partners coming to the area,” Durant said.

The Energetics Technology Center was among the first businesses to relocate there to be closer to the Navy base, moving from its previous headquarters in Waldorf, Maryland, in 2017. “It’s really a developing ecosystem, especially sort of rallying around the investment that the Navy’s making into its arsenal,” Durant said.

Kelly Robertson-Slagle, director of economic development for Charles County, Maryland, said the recent influx of companies in the Indian Head area made it “pretty clear to us that we really needed to ... brand that side of the county as kind of our technology corridor.”

There are now more than 130 businesses within the energetics, technology and research-and-development sectors operating in what has become known as the Western Charles County Technology Corridor, an area of 7.67 square miles that includes the town of Indian Head, according to Charles County Economic Development’s website.

The county is collaborating with



what Robertson-Slagle called its “resource partners” — which include the Naval Surface Warfare Center, the Energetics Technology Center, the College of Southern Maryland, the town of Indian Head, the county’s Military Alliance Council and the U.S. Bomb Technician Association — to promote the area as the place to be “if you want to be a part of this kind of energetics renaissance that’s going on.”

With its military, academic and industry partners, the county is working to identify “land that would be available and appropriate for development to be able to promote to new contractors, partners, organizations that are a part of” the energetics community, she said. “Not only have we identified land, we are looking at updating zoning to allow more flexibility for the increase in development,” she added.

As the county makes plans for the future of its new tech corridor, it wants to ensure its partners within the defense community are involved “at the ground floor” so that any new infrastructure is “built toward what the future workforce is looking for,” she said.

“We want” energetics companies “to come here and be able to grow and thrive ... with their employment base,” and that means making sure the workforce knows “what’s available to them for their families, what’s in their community, how [they can] get involved,” she said. “We’ve seen time and time again that if you don’t have some of those wraparound and supportive services, you don’t always get your highly technical workforce to stay. ... It’s very competitive, so we recognize that and we’re really looking at those supportive services holistically.”

One example of something companies new to the area can take advantage of is the College of Southern Maryland’s Velocity Center, a 13,000-square-foot facility where “our defense partners” can “meet outside of the gate” of the Navy base “for more collaborative conversations,” Robertson-Slagle said.

The Velocity Center features a “variety of conference and meeting spaces, shared flexspace workspaces and a makerspace” that can “host community, Navy or professional development events,” such as tech transfer classes in which Navy scientists can collaborate with local students, a Maryland Department of Planning fact sheet stated.

Durant said having some type of “organizing body” to foster increased coordination and collaboration across the energetics enterprise has been a pressing need for years, and the hope is that the establishment of a Joint Energetics Transition Office — another 2024 NDAA provision — fills that gap.

“That office hopefully will coordinate across the enterprise right now — whether it be the industry leaders, the defense labs or the acquisition community — to make sure everybody’s speaking that same language,” he said.

In peacetime, “weapons and munitions and energetic materials are in that minimum sustaining rate ... so we’re hoping that as we have a future conflict that we’re not caught off guard with capabilities that an adversary may have,” he continued. “So, it’s how do we maintain the existing materials and capabilities that we have and continue to look [to] the future with this transition office to get that greater capability to the warfighter that we may need?”

Durant was encouraged that the office will have leadership appointed by both the undersecretary of defense for acquisition and sustainment and the undersecretary of defense for research and engineering “because energetics cuts across” both organizations.

As more research and development is done on advanced energetic materials, the Joint Energetics Transition Office will be “positioned to ensure that the acquisition community is made aware of those advancements and help make that connection to traverse that valley of death where it makes the most sense for a weapons system advancement,” he said.

Robertson-Slagle could not comment on whether there have been conversations with the Defense Department to place the office in or near Indian Head, but said Charles County would certainly “welcome to have it here.”

“I tell folks all the time, ... what better strategic location?” she said. Indian Head is within driving distance of the Pentagon and “right around the corner [from] the decision-makers. ... This is where you make it, so why not?”

“We’re the closest arsenal. We’re the closest DoD manufacturing facil-

ity that does this kind of work. So to me, it’s a no-brainer,” she said.

A Defense Department spokesperson said in an email the office of the undersecretary of defense of acquisition and sustainment and the office of the undersecretary of defense for research and engineering are “moving forward on the establishment of the Joint Energetics Transition Office” but could not provide additional details as of press time.

“The department recognizes the critical importance of ensuring a strong and reliable supply chain, along with robust investment in research, development and production that supports the energetic materials and propellants our forces require,” the spokesperson said.

As the Defense Department lays the groundwork for this new office, Durant said he’s “very optimistic” the recent momentum in energetics will continue, “based on what we’ve seen over the past couple years of the awareness of the material itself but also by necessity of what’s happening in Ukraine.”

“The amount that we’re ramping up production just for the material that goes into” 155mm artillery shells “seems to be a sustainable investment that’s being made to ensure that we have that capability,” he said. In the next five to 10 years, the department and Congress will have to make some “difficult decisions” regarding which types of materials, systems and weapons “to make limited budget invest-



Aerial view of the Naval Surface Warfare Center Indian Head Division

ments” in, but the focus on energetics “should and ... will continue because that is the lethal effect of our force.”

“The research-and-engineering and defense labs and industry will respond when given that demand signal” from the government, “and I think that this trend is just going to continue over the next five to 10 years,” he said. **ND**

# Ammo Increase

## 6.5 Creedmoor Round Expands in SOF Applications **BY SCOTT R. GOURLEY**

In addition to U.S. Special Operations Command's development efforts to optimize the lethality of traditional sniper calibers like the .300 Winchester Magnum or newer .300 and .338 Norma Magnum designs, command developers have exhibited a growing embrace of the 6.5 mm Creedmoor round.

Introduced to the sport and target shooting market by Hornady around 2007, it wasn't too long before the 6.5 CM began to draw attention from the military community. While the "big Army" has been refining its 6.8 mm Next Generation Squad Weapons, Special Operations Forces appear to be increasing their focus on the 6.5 CM as the best way to take advantage of advances in ammunition and weapons technology to improve intermediate range sniper lethality, reliability and performance — when suppressed — at distances from 50 to 1,500 meters.

References to the 6.5 CM started to appear in public briefings in the 2015 to 2017 timeframe. During the 2017 Special Operations Forces Industry Conference, the Special Operations Command program manager for ammunition and weapons highlighted the continuation of "6.5 mm ammo development" to support a subsequent intermediate caliber sniper rifle/carbine fielding.

Another line in the program manager's portfolio overview reflected a 6.5 mm assault machine gun development leading to an intermediate caliber assault machine gun fielding.

Finally, a list of weapon business opportunities in the same briefing identified interest in both a 6.5 mm sniper support rifle and a 6.5 mm assault machine gun.

Just over a year later, the command's June 2018 request for information for International Special Operations Forces Range Day to be held the following January identified the 6.5 CM as a continuing technology area of interest, with identified topics including: a 6.5 CM lightweight assault machine gun — belt-fed and less

than 14 pounds; suppressor options for 6.5 CM; precision ammunition for 6.5 CM; and a 6.5 CM mid-range gas gun, described as a semi-automatic, magazine-fed, sniper support rifle with a length of 20 to 22 inches.

Those investigations contributed to some early program applications of the 6.5 CM.

One of the first applications appeared in October 2019, with Naval Surface Warfare Center Crane Division announcing a technology improvement award for the M110 series Semi-Automatic Sniper System, or SASS, from Knight's Armament Co. Under the modification of an existing contract, the company upgraded the upper receiver for the SASS, converting it from the original 7.62 mm design to 6.5 CM and designating it as M110A2.

Additionally, Special Operations Command's briefings during this period began to highlight expanded 6.5 CM weapon and ammunition programs. As examples, the briefing by the program manager for Special Operations Forces lethality at the May 2019 Special Operations Forces Industry Conference included fiscal year 2019 technical evaluation and planned fiscal year 2020 combat evaluation of a new 6.5 CM mid-range gas gun.

With weapon platform programs taking shape, the command also seemed to expand its focus on ammunition.

Evidence of this could be found in the publicly announced focus themes for the 2022 range day in April. A request for information highlighted interest in alternate material cartridge cases for small arms — primarily in 6.5 mm Creedmoor and .338 Norma Magnum, signature on target projectiles and high velocity cartridges.

Additionally, event planners expressed interest in 6.5 CM high velocity assault cartridges "with projectiles that will defeat current barriers at designated ranges," adding cartridges shall have angular dispersion of less than 1.0 minute of angle at 100 meters — a spread of just over 1 inch at 100 meters — with a muzzle veloc-

ity of more than 2,850 feet per second when fired from a 14.5 inch barrel and a muzzle velocity standard deviation of less than 13 feet per second.

One year later, in its request for information prior to the 2023 range day, planners highlighted continuing interest in both 6.5 CM ammunition and weapon developments. Identified performance standards remained consistent from the previous year.

In terms of weapons, the request for information identified interest in rifle and machine gun suppressors in several calibers, including 6.5 CM, with prioritized emphasis on reducing ground disturbance, flash and sound.

September 2023 also marked another program milestone for the 6.5 CM in special operations applications with the award of the "Mid-Range Gas Gun – Sniper" program to Geissele Automatics, which displayed the MRGG-S, designated Mk1 Modo, at the SHOT Show in Las Vegas, Nevada, in January.

"It's a 6.5 Creedmoor with a barrel swap to caliber .308 [7.62 mm],"



explained Benjamin Gould, a company program representative. "It shoots a 140 grain bullet. We're getting ready to go into production, although fielding is up to the military."

He described the design as featuring "a 20-inch cold hammer forged chrome-lined barrel with our proprietary phased array gas system that features multiple gas ports fired in sequence, making it a much softer shooting rifle so operators can watch bullet impacts instead of having to get kicked off target by recoil.

"It's fully ambidextrous so they can control the entire gun one-handed," he continued. "They can press the dust cover to lock the bolt open and then use the bolt release behind it. It also has an ambidextrous mag release."

It has a reinforced upper receiver and a delayed bolt carrier system that also helps with the recoil management, he said.

“We’re seeing half to quarter minute of angle accuracy. And with the very long-life, chrome-lined barrel we’re seeing excess of 6,000 rounds plus in 6.5 Creedmoor,” he said.

“Our suppressor was adopted with the gun,” he continued. “It’s a removable flow-through suppressor design. It’s our own design with some mirage dampening capabilities with insulated double-wall. So, you can fire an entire magazine through it, and it’s still cold to the touch. That really helps with the mirage in precision shooting.”

The Mk1 Modo design also incorporates an integrated “Arca Rail” for stabilized mounts, with Gould observing, “a lot of the military have gone to that for accessories because you can basically put the bipod wherever you want. You can put shooting bags on it, or you can clamp it to a tripod for a fixed position.”

The command’s increasing embrace of the 6.5 CM also comes with ammunition implications.

In selecting or refining a caliber

programs like the M110A2 SASS conversion or Mk1 Modo MRGG-S.

For example, a slightly redacted Special Operations Command justification and approval announcement, dated October 2022, identified the need to purchase additional “6.5 mm Match” ammunition with the 140 grain open tip bullet from Black Hills Ammunition to complete qualification testing and operational testing of the MRGG-S as well as fielding and new equipment training for the M110A2 “without changing the ammunition source and inducing additional variables.”

But what about the needs for larger numbers of unique ammunition types required by various special operations programs? One answer involves the SOCOM Unique Munitions Requirements program, which is an acquisition vehicle designed to streamline the command’s procurement of specialized or unique items. The process started just over two years ago with interested companies invited to provide information on things like capabilities and production capacity, said Emil Praslick, business development director for Capstone Precision Group, which is part of the Nammo group.

“From those responses, they picked approximately one dozen companies — with Capstone being one of those entities — to whom they provided a list of all possible munition types that they might ask for,” he said. The first request for proposals that they put out under the program

seven stations slowly draw out the copper that will jacket the lead to create the requisite 140 grain Berger bullet. Berger is part of Capstone.

“There are two parts to every bullet, the copper jacket and the lead core,” Thelen explained. “That’s pretty basic on most bullet manufacturing. What we do is hold our tolerances tighter than we think anyone else does.”

The bullets coming off the machine represent the first of four elements in a loaded round of M1200 ammunition. Additional elements are the cartridge cases, which are made at Lapua — another Capstone company — in Finland and were “on the boat over” in late January, Thelen said. Then there is the powder, from ADI Australia and the primer, which was changed by the customer in January 2024 from the planned Federal Number 34 military primer to the Federal 210M commercial primer. Thelen added that a final step in cartridge production involves “just a small amount of waterproofing” on the primer.

Looking toward the future of the M1200, Praslick speculated, “I see a time in the near future where there are going to be alternate specifications written for Vihtavuori propellants. That’s the powder company that Nammo has over in Finland. They make a lot of powder there, and it’s some of the best powder in the world. [Sport shooting enthusiasts] use it. It’s in wide use at the Lapua factory over in Finland and we are using it in our Berger match ammunition.”

Praslick’s belief regarding a possible propellant change is supported by a market survey announcement released in early November, seeking to identify “potential competitive sources of supply for propellants used in precision small caliber ammunition.”

The announcement cited interest from the Army Contracting Command — New Jersey, on behalf of the Office of the Project

Manager for Maneuver Ammunition Systems, in “industry commercial product information regarding the U.S. government need for 300,000 pounds of propellant per year” to “be used in calibers 6.5 mm Creedmoor up to and inclusive of .338 Norma Magnum” identifying specific interest in “temperature-stable propellants with low muzzle velocity variation and low ammunition dispersion.” **ND**



from the sport shooting community, Special Operations Forces would traditionally have to go back to that community for supporting ammunition. Since the Lake City Army Ammunition Plant doesn’t make the 6.5 mm Creedmoor, the command went out to private vendors. Black Hills Ammunition in Rapid City, South Dakota, is now manufacturing cartridges to meet the needs of

was for the newly designated M1200 6.5 mm Special Ball Long Range, which was awarded to Capstone.

Capstone officials said the award covers approximately three million rounds of M1200.

Walking through the Capstone production facility in Mesa, Arizona, Dan Thelen, president of Capstone Precision Group, pointed to bullet manufacturing machinery, in which

# VIEWPOINT

## Pentagon's Industrial Expansion Plans Face Long-Term Questions

BY ROBERT KAVETSKY

**D**uring World War II, the U.S. government faced the unprecedented challenge of rapidly scaling up production to support the war effort.

One of its most notable initiatives was the 1942 establishment of the War Production Board, charged with overseeing the conversion of peacetime industries to meet wartime needs. The board had the daunting task of coordinating production across countless sectors, from aircraft manufacturing to munitions and chemicals.

An example of its efforts was the production of synthetic rubber. Before the war, the United States had been heavily reliant on natural rubber from Southeast Asia. However, Japanese advances in the Pacific cut off those crucial sources and threatened to cripple the allied war machine.

In response, the War Production Board launched a massive synthetic rubber program, pouring resources into research and development, restructuring market incentives and price levels and pushing companies to collaborate on production. Despite initial chaos and confusion, the synthetic rubber program became a remarkable success story. By 1944, the United States was producing more synthetic rubber than the pre-war supply of natural rubber, ensuring that military vehicles and aircraft had the tires and seals necessary to keep moving.

Yet, this success came at a tremendous cost. The rush to ramp up production led to gross inefficien-



cies and waste, as the government often overstepped and misallocated resources. Factories were built in locations that later proved suboptimal, and many industries faced severe bottlenecks due to the unexpected, drastic shifts in government policy and production demands.

The experience highlighted the delicate balance between necessary government intervention in times of crisis and the risks of interference in the dynamics of a market economy.

As the Defense Department now embarks on a slew of encouraging

initiatives under the Manufacturing Capability Expansion and Investment Prioritization Directorate, it would do well to think hard about the lessons of wartime production: the importance of flexibility, the dangers of inefficiency and the need for sustained, strategic support to ensure that short-term gains translate into long-term resilience.

Over the past two years, the office kicked off several significant programs to enhance the capability, capacity and resilience of the defense industrial base. These initiatives — particularly

Defense Dept. photo



emphasized by the office's leadership — are designed to expand the marketplace, improve buying power and strengthen the influence of the Defense Department all in alignment with the National Defense Industrial Strategy released in January.

An especially important effort is the Critical Chemicals Pilot, intended to demonstrate the feasibility of domestic production of essential chemicals. Initially funded with \$5 million and augmented by an additional \$17.4 million in 2023, this pilot has reportedly attracted private capital

at an impressive 16:1 ratio, tallying up some \$80 million in private investments. The pilot has established domestic production pathways for several critical chemicals and expanded to address about 60 chemicals overall, focusing on munitions tooling and process innovations.

Another major initiative is the Munitions Campus project, which is aimed at creating a shared supply chain ecosystem from critical chemicals through munitions production. With \$50 million allocated for equipment and \$25 million for prototyping over five years, this project expects to stimulate more than \$300 million in private capital investment. The campuses in Lafayette and Bloomfield, Indiana, are advancing through land acquisition, facility planning and tenant engagement with support from partnerships with the Naval Surface Warfare Center, Crane Army Ammunition Activity and Purdue Energetics Research Center.

While these initiatives undeniably stand to improve domestic production capacity and economic security for the defense industrial base, a degree of skepticism about their long-term impact is warranted.

The substantial investments the Manufacturing Capability Expansion and Investment Prioritization Directorate made reflect a concerted strategy, yet it remains unclear whether they fully comprehend the complexities of the supply chains for critical chemicals and raw materials, especially since many producers and agencies themselves lack much visibility into the criticality of the chemicals involved in munitions production, let alone into the supply chains for them.

Additionally, the effectiveness of these investments in creating lasting improvements in U.S. munitions production hinges on sustained commitment from Congress and the Defense Department. At a time when munitions are widely acknowledged as being in critically short supply, the House Appropriations Committee Defense Subcommittee's significant marks earlier this month against the munitions provisions in the president's 2025 budget request are symptomatic of the problem.

While acknowledging the residual funding in munition accounts from the previous budget cycle, the Defense Department's history of surging and then diminishing funding for munitions underlines the need for steady resourcing to keep the pipeline flow-

ing and contractors motivated. Private investment follows an expectation of return, tempered by definable measures of risk. Without consistent demand signals and price levels, the commercial pretext for market actors to remain engaged may falter, causing the initiatives to fizzle within a few years instead of thriving.

The Munitions Campus — managed by the American Center for Manufacturing and Innovation — offers a promising approach to avoid the feast-or-famine of a distortive industrial policy by emphasizing the use of private capital and the diverse utility inherent in its campus concept. A shared supply chain ecosystem bridges critical chemicals and munitions production, aligning Defense Department and industry needs through a market-driven strategy that follows successful models in pharmaceuticals and the aerospace industry, among others.

By integrating public and private resources, the campus concept aligns with the manufacturing capability office's objectives of leveraging private capital, building regional ecosystems and fostering collaboration among government, academia and industry in a manufacturing network capable of meeting 21st century demands. It also stands a better chance of avoiding the distortions and inefficiencies that often accompany government industrial policy.

As the Defense Department tries to figure out its munitions requirements in the face of strategic challenges unseen for decades, the lessons from past examples of defense industrial policy are as pertinent as ever.

Just as the War Production Board had to balance rapid intervention with market dynamics, today's initiatives must navigate similar challenges to ensure efficiency and long-term success. The manufacturing capability office's Critical Chemicals Pilot and Munitions Campus project — alongside support from the Defense Business Accelerator and Defense Market Catalyst — underscore a strategic push to enhance the defense industrial base in ways that reflect both the potential and constraints of industrial policy in the 21st century, even as they highlight the importance of flexibility, sustained strategic support and leveraging private capital to foster innovation and resilience. **ND**

*Robert Kavetsky is CEO of the Energetics Technology Center.*

# Falling Short

## Army Not Giving Up on Extended Range Cannon Goal **BY SCOTT R. GOURLEY**

Once dubbed a “signature effort” within one of the Army’s top modernization priorities, the Extended Range Cannon Artillery system was a middle tier of acquisition rapid prototyping effort initiated in October 2018 to potentially improve lethality, range and reliability over the Army’s existing M109 series of self-propelled howitzers.

In October 2021, at the Association of the United States Army’s annual conference in Washington, D.C., then Army Chief of Staff Gen. James McConville — to prove that the service’s acquisition enterprise had turned a corner — vowed to put in the hands of soldiers 24 key technologies by the end of fiscal year 2023.

The new cannon was on that list, signaling the general’s confidence that the program was on track.

But by 2023, the program was in trouble, and not long after the Army’s self-imposed deadline, it paused the cannon’s developmental testing to address several technical flaws and later announced that it was going back to the drawing board, determining

that the artillery platform required further maturation and redesign.

So, what happened?

Lt. Col. J. Todd Mueller, ERCA product manager, told *National Defense* in an interview that even though the Army does not yet have a cannon capable of reaching extended ranges, the prototyping effort was “extremely successful.”

In short, while the new ammunition that would be used in the cannon was a success, the new 58-caliber cannon barrel did not work out.

The Army science-and-technology community is now investigating how to mature the barrel’s design in hopes of moving forward, he added.

The original impetus for the effort was to identify ways of addressing critical capability gaps within the Army’s field artillery formations. One of those gaps acknowledged that potential adversaries could deliver artillery fire at longer ranges than the Army could respond.

As a result, the initial objective focused on extending the range of current field artillery systems, “pushing the envelope on techni-

cal feasibility” and then developing requirements to inform Army senior leaders on options to address outstanding capability gaps, beginning with range extension, he said.

One method for increasing artillery range involves a longer cannon tube, accompanied by greater chamber ignition volume and longer lands and grooves inside that barrel. That tube length is traditionally expressed as a multiple of the projectile diameter. For example, the Army’s latest M109A7 self-propelled howitzers feature a 39-caliber length 155mm tube. In contrast, many global forces utilize 52-caliber length 155mm tubes, with inherent range advantages.

For ERCA, underlying science-and-technology studies contributed to a decision to apply a 58-caliber length 155mm tube, which was developed and manufactured at Watervliet Arsenal. In addition to the tube itself, other efforts focused on things like a new muzzle brake design, attached to the end of the tube, to minimize some of the significantly greater recoil effects, he said.

Much of the cannon’s development was coordinated by the Army’s Long Range Precision Fires Cross Functional Team, one of the initial eight teams that emerged from the standup of Army Futures Command in July 2018.

The cross functional team worked to unify efforts across multiple organizations, including the Combat Capabilities Development Command Armaments Center, Fires Center of

Excellence, Installation Management Command, Army Materiel Command and others.

In July 2019, BAE Systems announced its receipt of a \$45 million contract for the Extended Range Cannon Artillery “Increment 1 prototype with the purpose of increasing the range and rate of fire on current and future M109A7 self-propelled howitzers.”

Noting that the development of the cannon would be conducted in collaboration with the Armaments Center, the release stated that the prototype phase “will address capability gaps in the Army’s indirect fire systems and improve the rate and range of fire with the development of power distribution software and hardware integration solutions,” adding, “ERCA



ERCA testing at Army Yuma Proving Ground

will be integrated onto the M109A7 and will require the M109A7's current 39-caliber turret to be replaced with a 58-caliber, 30-foot long gun barrel with the objective of creating firepower double the current range."

The self-propelled ERCA was designated as the XM1299.

Mueller said: "In the early days, ERCA had two increments. Increment 1 focused on increasing the range. Increment 2 involved rate of fire. The Army subsequently made the decision to go 'all in' on range and address rate of fire down the road."

But essentially, ERCA was putting a 58-caliber cannon on an M109A7 chassis with the minimal modifications required for the chassis to accommodate that cannon, he added.

The new cannon utilized the exact same M992-series Field Artillery Ammunition Support Vehicle, also known as Carrier, Ammunition, Tracked, or CAT, as the M109A7, he said.

"It was the same resupply vehicle," he said. "Again, we prioritized going after range. Had we fielded the [XM]1299, we likely would have looked at modifications or opportunities to introduce automation on the resupply side. But for the sake of the rapid prototyping effort, we were using the CAT."

In December 2019, the Army began live fire testing with an ERCA prototype at Yuma Proving Ground, expanding aspects of the test envelope over the next three years. It was the lessons learned during these events that caused the Army to recognize the need for a different approach, Mueller said.

"When it became clear that 'the 58 cal' — specifically based on maturity — was not going to meet the Army's schedule to address the capability gap, that's when we started looking at other paths," he said.

In late 2022, the Army was going through some of its critical test events with well-defined and formal exit criteria, when it encountered technical challenges on the firing point, and that forced it to go back and analyze the root causes to determine what had to be fixed, he said.

"And once we understood that, we were able to estimate the cost and schedule it was going to take to do those [fixes], and we realized that we were out of alignment with the Army schedules," he added.

Asked to elaborate on those technical challenges, he offered, "We

learned a lot about the durability of the system. We're operating at pressures and temperatures higher than we have in the past. It's important to note that if you look around the globe today, 52-caliber [tube length] systems are pretty much the norm around the world. And we went well beyond that, to 58 caliber. And the temperatures and pressures required to achieve ranges caused some challenges on the tube wear side of things.



**ERCA during an autoloader speed demonstration**

Simply, we were wearing out tubes quicker than expected. ... Ultimately, it was just maturity of the system."

Noting that the middle tier of acquisition rapid prototyping effort initiated in October 2018 was constrained by a five-year timeline, he added, "We used the full five years and culminated in October of 2023."

Mueller said rapid prototyping is just one type of acquisition authority. Under middle-tier acquisition, there are several roads to take at the end of the five years.

There could be a determination to further iterate on prototyping. It can transition to a "major capability acquisition" pathway, which entails going straight to production.

"Or you could determine that you've learned enough that the Army is going to go a different route and be done with it," he said.

"Essentially, when we got to the end of the runway, the determination was made that the ERCA system required further maturation and redesign before being considered as a suitable candidate to transition into the major capability acquisition pathway," he added.

While the tube proved problematic, there was success with the ammunition to helping close the range capability gap. The program worked with the project manager for combat ammunition systems — part of the Joint Program Executive Office for Armaments and Ammunition — to improve the shell's range, he said.

"The development of new ammunition — including propellants, projectiles, precision fuses — all focused on achieving range of 70 kilometers or more. We extended the Excalibur capability by investing in and testing upgrades to make it compatible with the higher pressures and velocities that come with the longer cannon tube. And we demonstrated 70-kilometer precision target defeat with Excalibur on multiple occasions," he said.

Both cannon and ammunition lessons learned were also incorporated into the Army's recent "Tactical Fires Study," with its participants summarizing that the XM1299 was included in that effort and that the requirement for such a platform was "revalidated" in two potential theaters of conflict.

Mueller summarized that ERCA "was extremely successful in terms of what the rapid prototyping efforts set out to do. Again, if you go back to the two primary objectives of the rapid prototyping — to push the envelope on technical feasibility and informing requirements — we did both of those really well. And in terms of residual capability that rapid prototyping efforts always seek to provide, on the ammo side, we have numerous examples of residual capability.

"The other thing that's important for folks to know when they look at a chunk of money and time that was invested in something that's not going to sit in motor pools in the next year or two, is that we're still leveraging investments made across numerous efforts within the Army," he continued. "I can't go into all of them, but in terms of both technology development and even hardware, there are other Army programs that are still benefiting from the investment made in ERCA."

Meanwhile, the ERCA prototypes are sitting in storage while the science-and-technology community looks at possible maturation and redesign of a future 58-caliber system, he said.

The next steps involve a performance demonstration in 2024, followed by a competitive evaluation in late 2025 to identify the ideal platform solution, he added.

"Moving forward, we will continue 'innovating at the round,'" Mueller concluded. "As the 58-caliber technology matures, we will concentrate on identifying a mature and available platform solution that complements our ammunition and achieves the necessary ranges," he said. **ND**



# Interoperability, Training Vital to Counter-UAS Operations

BY ALLYSON PARK

**W**ASHINGTON, D.C. — The ongoing war in Ukraine has showcased the importance of uncrewed aerial systems on the modern battlefield, and improving interoperability and training processes are vital to counter-UAS operations, Defense Department officials said Aug. 7.

What are the most critical missing capabilities in the counter-UAS world right now? Rachael Plumley, chief of maritime counter-unmanned systems at European Command, said it's not one system or capability, it's interoperability.

"It's the only way that we're going to be successful at any of this, without being hyper fixated on an acoustic sensor or a jammer or the new cool thing, is to be able to layer our defenses with our host nation partners," Plumley said at a fireside chat at National Defense Industrial Association's Emerging Technologies for Defense Conference and Exhibition. "We have to have different types of capabilities to layer on top of each other, and those capabilities have to be interoperable."

Interoperability isn't only about the services having the ability to plug into each other's system. On a deeper level, the services must be able to share radar and sensor data both with each other and with allies and partners

so that there can be a more robust, wider-reaching and improved common operating picture, she said.

One of the other "biggest unknown concerns" in the counter-UAS sector is training for operators, Plumley said.

"I've consistently said when it comes to industry, please bear in mind that the end user of the majority of your systems are somewhere around ... 19 to 22-year-olds," she said. "And if I do not have the means to be able to instruct them on how to use the system, you can give me the most robust capability there is," but it will ultimately be "absolutely wasted technology."

Plumley argued that industry works too hard and the government spends far too much money for the end capability to be too complicated for operators to use effectively.

"And then honestly, ultimately the system gets blamed, saying that it's not functioning properly, it's not a good capability, but in my opinion and what I've personally seen as evaluating the training, especially for the Air Force, the most likely result is that the operator was not effectively trained to begin with," she said. "So, I think those are very big things to consider, the releasability of any training material that you offer and things of that concern."

Brent Ingraham, deputy assistant secretary of defense for platform and weapon portfolio management,

said that in addition to training operators effectively and ensuring new capabilities are relatively user-friendly, the military is working to improve mission-effective training.

"Hopefully, for our industry side, you start to see us testing to a point where it's really mission-driven, [and] at the end of the day it leads to contracts and orders, production capacity increases so that we can truly get to a sustainable production here for counter-UAS, and so [that's] the one area that I feel like we don't have a good stable production base [for] yet," Ingraham said.

The operational effectiveness of a capability or system does not necessarily equate to mission effectiveness, and in order to fully prepare warfighters to utilize those new capabilities, their training must reflect that, Plumley said.

"As an example, there's a location right now that we've marked to do mission-effective testing against where we're going to go out there and have a threat assessment done, determine what the actual threat to that location is and then test our systems that are in place against that determined threat," she said. "To the purpose of predicting the most likely attack route and things of that nature, if there's some way that can be done prior to those systems getting there, I think we all might learn a lot more." **ND**



# Counter-Drone ‘Secret Sauce’ Refined in Ukraine

BY STEW MAGNUSON

**P**ARIS — In August 2023, the International Fund for Ukraine ordered several counter-drone systems developed by Norway’s Kongsberg Defense and Aerospace.

The CORTEX Typhon Systems were delivered two to three months ago and the company has used the real-world opportunity to “refine” how the system works to shoot down what has become a deadly weapon used by both Ukraine and Russia during the more than two years of war, John Carlsson, director of business development for the company’s U.S. division, said June 18 in an interview at the Eurosatory trade show in Paris.

CORTEX consists of a remotely operated .50 caliber machine gun, a radar provided by Teledyne FLIR, a communication system and the CORTEX Integrated Combat Solution, or what Carlsson called the system’s “secret sauce.”

The open digital architecture is what allows the company to integrate all the subsystems and shoot down drones with relatively small caliber bullets, he

said.

“We’re doing counter-UAS capabilities in excess of 1,000 meters — and they’re very small class [drones] — and we are able to engage them with a .50 caliber machine gun, effectively,” he said.

While Kongsberg has not disclosed how many of the systems were sent to Ukraine — at the customer’s request — the system can be used with several vehicles, all outfitted with the system. If a drone is spotted, the information is shared among all the nodes. Then a commander can decide which one is most capable of engaging the target. The remote weapon station automatically tracks the drone and cues up the weapon until a “human in the loop” decides to fire, he said.

Or they could one day choose to use a different kind of weapon, when they become integrated into the system, Carlsson said.

Now that Kongsberg has used the opportunity to refine the Integrated Combat Solution’s software, it is looking at integrating other weapons that could destroy an incoming drone. It is looking

into adding a BAE Systems Advanced Precision Kill Weapon, which can travel as far as 5,000 meters, he said.

“The commander could make that decision — ‘Maybe I’ll use this one,’” he said. It could also be configured to have a drone act as a spotter and cue up the weapons to shoot down another drone, he said.

If a commander doesn’t want to give his position away or that of another vehicle, the data can be sent seamlessly to one of the other vehicles, he said. If one of the nodes is attacked, the Integrated Combat Solution will still function in the other vehicles.

“It gives you the ability to streamline the kill chain,” he said.

Another option the Integrated Battle System can provide is mounting the remote weapon system on a robotic vehicle, he said.

Speaking as a former Marine Corps infantry officer, Carlsson said this “could change the whole dynamic of the battlefield.”

“It feasibly could change the doctrine in how we fight,” he added.

The United Kingdom created the International Fund for Ukraine and spent \$71 million on the undisclosed number of systems. The Norwegian government donated the remote weapon stations and the vehicles to carry them. **ND**

CORTEX Typhon System mounted on a Dingo vehicle



Norwegian Armed Forces photo



# Land Mass

## Development of Swarming Tech for Ground Robots Lagging **BY SEAN CARBERRY**

**A**nts, hyenas, velociraptors — all creatures that operate in cooperative, intelligent ground swarms to create dilemmas for prey and adversaries. And that's what the U.S. military is seeking to do using ground robots, but fielding attritable, autonomous systems on the ground is proving far more complicated than in other domains.

"The terrain gets a vote," Byron Boots, co-founder and CEO of Overland AI and director of the University of Washington Robot Learning Laboratory, said in an interview.

"That may mean things like dirt roads or gravel roads or like a main supply route, but it also means completely cross-country, across fields, through forests, through snow, mud, inclement weather, dense vegetation, all of those sorts of things," he said.

That's largely why ground autonomy is so far behind the maturity and deployment of air or maritime autonomy. And that's why the U.S. military, labs and private companies are still tinkering with autonomy stacks that can perform waypoint navigation at defense-relevant speeds, let alone more complex operations like swarming.

Overland is one of the vendors working on the Defense Advanced Research Projects Agency's Robotic Autonomy in Complex Environments with Resiliency program to

develop new autonomy algorithms. The company is also working with the Defense Innovation Unit on the Ground Vehicle Autonomous Pathways program and the Army's Robotic Combat Vehicle autonomy stack.

Boots said the company's goal is to perfect an agnostic autonomy algorithm that can adjust to the dynamics of any vehicle and the sensors on board.

For the DARPA program, Overland is integrating its OverDrive autonomy stack onto 3,000-pound Polaris RZR and 24,000-pound tracked Textron M5s, he said. "So, the same autonomy stack can control a range of different types of vehicles and use a range of different types of sensors."

"Up until this point, there has been a lot of focus on just that point-to-point navigation, and the reason is because it's ... a basis for these other capabilities, and fast point-to-point off-road navigation really hasn't been demonstrated until recently," he said.

Company videos show an ATV buzzing through off-road terrain at "operationally relevant" speeds up to 35 mph guided by OverDrive, which can operate in GPS-denied environments.

"I think we've made a huge amount of progress on it, and so I think now is a great time to start to kind of think about, 'OK, now that we have this, what are the more complex things that we can do with it?'" he said.

However, the complexity of operations performed by driverless ground vehicles needs to come without increasing the complexity for users. Robots will need to "earn their place on the team," he said.

"The key thing, in my view, is really ensuring that robots do what you expect them to do, and that they're easy for the end user to use," he said. "There's a lot of work [that] goes into making a system ... [so] that it behaves as expected, that it goes where you want it to go and does so reliably, and that it is very easy to task the robot to do it."

That means continuing to mature the technology while demonstrating the capabilities and earning the trust of warfighters, he said.

An Army robotics expert spoke with *National Defense* on the condition that they not be quoted and said much of current ground autonomy capability is still in science-and-technology phases of development as vendors and labs continue to grapple with the multivariable equations of size, weight, power, sensor capabilities, speed, terrain and cost.

However, technology is outpacing doctrine and concepts of operations, the expert said, adding that the Army is still thinking about ground robotics largely in terms of teleoperation rather than full autonomy and complex interaction.

The Army needs to open the aperture and explore the use of ground robots for deception, denial and disruption — simply creating chaos on the battlefield to confuse an adversary, the expert said.

That could involve sending groups of robots out to blow up bridges or create potholes or attack tanks as the Ukrainians have demonstrated.

Aside from imagination, another limiting factor for ground robots is communications. Teleoperated robots need comms links back to operators. But more sophisticated autonomous robots will at least need local comms with each other to share sensor data and swarm, the expert said. That could be undermined by an adversary's electronic warfare capabilities and limit the ability of swarms to spread out.

Right now, the intelligence of ground robots is quite limited, the expert said. For example, if one robot approaches a ditch and swerves, how does it communicate that to the others, and how do they process that information? Do they recognize that it was a local phenomenon and keep moving, or do they slow down to process the anomalous behavior of the other robot?

And the more complex the hardware and software, the more expensive the platform becomes, which butts heads with the Defense Department's goal of achieving attritable mass on the battlefield through programs like the Replicator initiative, noted Boots.

"If you have a small, attritable platform, it has to meet a certain price point," he said. "I would guess that also means that you have some restriction in terms of sensors and compute and communication, and you have to be thinking about, 'OK, how do I actually want to use this platform? How expensive or cheap does it need to be? How does that affect the capabilities of the platform?'"

"I think it's clearly in the future. I think the question will just be, what are the tradeoffs? How are they expected to be used? How will they integrate with U.S. doctrine?" he said.

Stephen Houghton, co-founder and CEO of startup Swarmbotics AI, which is developing two variations of swarming-capable UGVs, said those questions need to be answered sooner rather than later.

"What I worry about is that we wait until the balloon goes up to start testing these things at scale," he said. "And what's critically important is that we pull the human-machine teaming for-

ward. So, maybe you have an imperfect solution, but you start working [doctrine, organization, training, material, leadership] considerations early so that you can identify some of those issues, because the devil is going to be in the detail from how do you maintain these, how do you run the operations? How do these things get recharged? How do you swap out payloads?"

"Those are underestimated complications that if we wait and try to deliver this whenever the balloon has gone up, we are late," he said.

Swarmbotics is developing two models of Attritable, Networked, Tactical Swarm, or ANTS, robotic ground vehicles. The HaulAnt is a commercial-off-the-shelf, hybrid-electric, 600-pound ATV that can be manned, teleoperated or fully autonomous. The FireAnt is a 50-pound, custom-built UGV designed for surveillance, perimeter security, chemical, biological, radiological and nuclear detection as well as kinetic uses.

They run on the company's AntsNet command-and-control software, which is designed to be hardware agnostic and facilitate heterogeneous swarms, Houghton said.

With the focus on the software and command and control, the goal is to use commercial hardware as much as possible, he said.

"Now, that's not always possible. We do have to do some customization, some integration, and that is really driven by price," he said. "It's driven by what's available out on the market. So, we've been able to find a really cool base platform for a hybrid-electric ATV platform. But on the [FireAnt], there wasn't anything out there, and so we had to actually build that one fully custom."

One of the major constraints for U.S. drone makers is China's near monopoly on inexpensive, commercial drones. There is a limited, trusted supply chain for some of the sensitive microelectronics, which makes it difficult for companies like Swarmbotics to drive down the cost of robots, Houghton said.

"We understand the tradeoffs where this may not have a reasonable U.S.-source part, but we've identified it. We know it. We're looking for it, and when it comes available, we'll make that switch over," Houghton said. "That said, we're extremely careful about things like components that have embedded systems or firmware that

we need to be careful [about] from a software perspective, and so those are much more important to potentially spend the extra dollars to ... make sure that there is better cybersecurity."

In the meantime, the company is focused on maturing swarming technology, he said.

"We're working with prototype swarms, so multi-agents on the ground side, and starting to get a larger array of plays that we can use," he said. "Imagine being able to tell the robots to do like, 'Hey, I want you all to go to the right, or I want you to go to the left, or split or surround something.' And so, there's a lot of interesting things that we're doing on the software side now that we've got this prototype swarm fleet."

"The more you can automate what is happening, the less you have to oversee it, and that allows you more time to engage in the places where the human can add the most value," he continued.

That requires designing the user interface to provide the right context, he said.

"And then in the future, you can start to talk about swarm situational awareness, where you're able to more quickly decode what's going on based off of perceptions of multiple robots that are engaged in the situation," he said.

For all the possibilities, there is still a long way to go, cautioned the Army expert. Power supply and charging will remain a constraint, and warfighters need to have realistic expectations about what UGVs



A Polaris RZR operating with Overland's autonomy software

can accomplish in the near term.

Placing mines and serving as unattended ground sensors are realistic tasks for the robots today, the expert said. Warfighters might want them to be tigers, bears and pumas that own the battlespace, but it is more likely UGVs will function like mosquitoes, crickets and crabs — persist, move and get in the way. **ND**

# Starlink Lets Operators Control Ground Robots at Long Distances

BY STEW MAGNUSON

**P**ARIS — Estonia's Milrem Robotics has married a Starlink satellite communications system to one of its most popular military robot models, allowing operators to control the vehicles "from thousands of kilometers away," a company executive said.



The 3,500-pound tracked THeMIS unmanned ground vehicle is being used by 17 militaries, including Ukraine, for logistics and casualty evacuations.

"When they move forward to collect casualties, it is always full of ammunition, food, water and medical supplies ... you never want to have an empty UGV operate in the battlespace. You always want to be delivering something," the company's chief sales officer Patrick Shepherd said at Milrem's booth at the Eurosatory trade show.

Milrem and Netherlands-based AEC Skyline integrated Starlink satellite communications so operators can safely control them from beyond line of sight, he said. Joining the two systems was not the hard part — it was

figuring out the latency issue as there is always some brief lag in time when doing communications via space, he added.

"The way we are able to handle that is our autonomy kit is able to make decisions without human intervention," he said. Space links also reduce the radio frequency signature, making it harder to detect than "over the air," he said.

Ukraine initially had 15 THeMIS robots but is now down to 13, he said. He echoed other vendors at the conference who had equipment in Ukraine: the feedback it is gaining from the real-world operations is proving invaluable.

"We have a direct line of contact with our users in Ukraine, and we're getting day-to-day updates on how we should change and upgrade our designs to make them more useful, including the software," he said.

The company recently announced it is building a new facility next to its headquarters in Tallinn, Estonia, which will allow it to manufacture 500 THeMIS units yearly. **ND**

# Marines Order Small, Tactical Robots

BY KARA THOMPSON

**A**RLINGTON, Virginia — The Marine Corps has ordered hundreds of new Micro Tactical Ground Robot systems that can perform a variety of missions for the service.

The robots — manufactured by Israel-based Roboteam — are lightweight, portable platforms designed to be used indoors and outdoors for tactical missions including explosive ordnance disposal, special operations and other missions. They weigh about

16 pounds, are teleoperated and come with a remote controller, keeping the user out of potentially harmful situations.

Matan Shirvi, the company's CEO, said the robots — previously sold to the Air Force — were "modified" to fit the Marine Corps' needs.

The models the Marine Corps will receive are the fourth and newest edition and have improved communications links as well as updated cameras, Shirvi said in an interview. The control unit can also operate several

robots simultaneously, Shirvi said.

"We believe that the soldiers have to be as far as they can from dangerous, dangerous locations," Shirvi said. "This is what we are doing. We're giving the soldier the buffer that he needs in order for him not to get hurt."

The robots are designed to be easy to use and operators can get up to speed with an initial three-hour training, Shirvi said, although additional training is needed for more advanced skills.

The Marine Corps' initial purchase order was for more than 130 robots, which is part of a larger order totaling \$30 million that includes spare parts and maintenance. Roboteam will deliver a total of approximately 200 systems to the service, a company press release stated. Roboteam has already sent the first batch of robots to the Marine Corps and plans to complete delivery by early 2025.

In the future, Roboteam hopes the robots will continue to augment humans in military operations and other perilous locations like mines and nuclear power plants, Shirvi said.

"Any area that makes human life dangerous to live, I believe that robots will replace [humans,] and they should replace" them, he said. **ND**



Milrem Robotics image; Misha Kominsky photo



## Army Already Looking for Next Version of Robotic Mule **BY STEW MAGNUSON**

**C** HARLOTTE, North Carolina — The Army took delivery of its new robotic mule — known as the Small Multi-purpose Equipment Transport, or S-MET — in late 2022. Less than 18 months later, it has started the process of developing a second increment, officials announced at a recent industry conference.

The S-MET is an eight-wheeled tele-operated robot built by General Dynamics Land Systems and is primarily designed to lighten the load of soldiers in rough terrain by carrying up to 2,500 pounds of gear.

It can also be used for medical evacuation, to mount weapon systems or sensors and can export power to recharge the myriad electronic devices troops carry in the

field.

Kyle Bruner, Army Force Projection project manager, said: “[It] is not what that platform brings in terms of just load carrying capability, but all the things that can be integrated onto it. It can only be limited by the imagination.”

General Dynamics is in the final year of delivering the S-MET increment 1, which was based on an off-the-shelf robot the company had developed.

The Army is developing requirements for the next version. For starters, it wants an open standards architecture for increment 2 to make it easier to “plug and play” sensors and weapon systems, Bruner said at the National Defense Industrial Association’s Tactical Wheeled Vehicles conference in Charlotte, North

Carolina.

The service particularly wants to add counter-small drone systems to the robot, he added.

It will also be looking for more autonomy, more exportable power and enough extra energy to operate the counter-UAS systems, he said.

“A lot of the work that is going on is ... to look at what things can be added on and do experimentation, and we’ll eventually work that into the program,” he said.

The day after Bruner spoke, Anduril Industries announced it would lead a team to compete for the S-MET increment 2, with South Korea’s Hanwha Defense USA providing its Arion platform and Forterra proving its AutoDrive autonomous software and other components. **ND**

# Data Normalization, Distribution Key to CJADC2

The Defense Department's Combined Joint All-Domain Command and Control concept envisions a future where data is pulled from a multitude of sensors operated by different services and partners across all domains and then passed along to the correct "shooter" to execute a particular mission.

But to make all that data usable, the Pentagon will need a C-3PO-esque translator that can speak the language of each service's or partner's systems, Army officials said.

Col. Matt Skaggs, director of tactical applications and architecture at Army Futures Command, said each service has its own system to ingest data that has "its own data model — its own language." And when "we try to make the boxes talk to each other," there is often a data normalization problem where the data is not compatible with each system in the link.

The Defense Department is working to create a "single ingest point" where "all of that data is normal-



AI and machine learning will "help us not leave 75 percent of the data on the cutting room floor," he added. "If I could get my soldiers to process 25 percent of our sensor [intake], we're doing good. We're moving away from that place."

Col. Mike Kaloostian, director of transportation and network security for Army Futures Command, said that to avoid creating a single point of failure through these data normalization systems, "distributed networks are going to be super important."

"We should be thinking about heterogeneous networks that we are going to be tying in through different control planes of different echelons," Kaloostian said. "What we don't want is just one network for every echelon."

Operators can't always "reach back to a data point — we need to figure out how to also share data locally in case we are cut off," he continued. "Total distribution is the key to the future of having the ability to be able to push down to the lowest level — truly the tactical edge — and to share data at the tactical edge."

Returning to the smartphone analogy, Skaggs compared the ability to operate at the tactical edge with an iPhone in airplane mode that still works despite not being connected to the cellular network.

Maj. Gen. Jeth Rey, director of the Army's Network Cross-Functional Team, said the military recognizes it has a "data management problem, and we believe we're at the cusp of data convergence so that we can create these regional nodes where our data is stored so that they can get [the data] normalized in a way that we can point to that data and then use that data" to construct a common operating picture.

The military must also ensure its networks are robust enough to handle the strain of a high-intensity conflict against a peer adversary, Kaloostian said. "What we really are striving to do is to ensure that we have an intelligent, fully autonomous network in the future" that is "threat-informed, it understands what the threats are, it understands the entire [electromagnetic] spectrum, and we can operate in that spectrum the way that we are able to do so based on

an enemy's capabilities," he said.

During the recent capstone event, the services proved "that we have resilient [data] transport," Rey said. "So, we know that part is starting to be proved out. The second part is we have to be cloud-enabled" and understand "where our data is going to be stored so we can point to that data."

The biggest challenge with storing data in a cloud environment is doing so in a zero trust architecture where all networks and traffic are treated as potential threats, he said. Zero trust will allow the services to "secure the data layer with attribute-based access control."

While previous access management modernization efforts within the Defense Department have fallen short, "the technology now exists for us to think about [zero trust] in a reliable manner," Kaloostian said.

Rey said, "We now understand how ... zero trust operates: the user authenticates with the device, to the application, the application to the actual network and then to the actual data itself. We understand that now, and we believe that we have a path to get there."

The Defense Department is currently in the "experimentation phase" of developing data normalization systems and is working with companies to figure out the specifications and application programming interface standards "that industry can write to," Skaggs said. Kaloostian added that it is "not just an Army thing to solve ... because we're going to fight as a Joint Force."

Rey said the military is getting close to solving its data management problem — maybe by 2025 or 2026, he said.

"We're getting a lot closer to understanding that now we need these data repositories [so] that we can actually curate our data," he said. The military is learning through exercises like PCC4 that "a lot of cloud-enabled instances may not be the answer, but having this data repository around our regions may be an answer."

"We have to still kind of flush that out right now," he said. "So, I think we're getting a lot closer. We learned a lot here at [Project Convergence], and I think it's helping us understand where we are." **ND**



ized so it can be read by all of our applications," Skaggs said during an interview at the Army-led Project Convergence Capstone 4, or PCC4, in March. "If everybody's looking at that same layer of data, the different applications can have equal access to it for different functionalities."

Skaggs compared it to how different cell phones, such as Android smartphones or Apple iPhones, "all talk a different language" but can ingest the same data and communicate with one another.

Normalizing the data will also allow the military to bring in artificial intelligence and machine learning tools to analyze the data faster than is humanly possible, he said.



# Networked Warfare

Army's Project Convergence Goes on the Offensive

BY SEAN CARBERRY

**C**AMP PENDLETON, California — Inside a hulking white tent in an expeditionary command base next to the

Pacific Ocean, projectors render a large map on the floor representing the Pacific theater. U.S. and allied bases, ships and aircraft are spread across the battlespace, as are enemy ships, aircraft and installations.

The mission objective: use sensors and weapons deployed in all domains to detect and defeat air threats and missiles and take out enemy maritime, air and land targets.

This scenario played out multiple times over several days at phase one of the Army-led Project Convergence Capstone 4, or PCC4. The experimentation at Camp Pendleton in California was designed to test and stress the capabilities of the U.S. military services and allies from the United Kingdom, Australia and New Zealand to connect their disparate systems and share threat and mission execution data at machine speed.

Lt. Gen. Richard Coffman, dep-

uty commander of Army Futures Command, said during a media roundtable that PCC4 built on the Project Convergence 2022 model that included the Joint Force along with partners and allies.

“At that point, we began producing a number of enemy systems to prove technology,” he said. “With the concept that you prove the tech, then you scale, and you continue to prove the tech and scale again.

“This year, we have increased the threat envelope to 10 times what we did last” time, he continued, adding that two multi-domain task forces participated, with Army Pacific representing the headquarters. “And the entire Joint Force and with our U.K. and Australian teammates and allies, we’re able to effectively move data for the first time in an Indo-Pacific scenario at a magnitude never seen before.”

Project Convergence is the Army’s program of record to develop capabilities for the Defense Department’s Combined Joint All-Domain Command and Control effort. The

overarching goal is to develop connectivity so that any sensor can provide threat information that feeds a command center that can then task the “best shooter” to target the threat.

Col. Matt Rauscher, director of the fires capability development and integration directorate at Fort Sill, Oklahoma, told reporters that integrating offensive and defensive fires was a central element of the experiment.

“The integration of those will increase the effectiveness of both capabilities by sharing data at machine speed across the Army, our joint partners and our allies, enabling a joint coalition force to more effectively fight the fight,” he said.

“When we talk offensive and defensive integration ... imagine an enemy threat. They fire a volley of missiles ... at a target,” he said. “We pick up that launch location. As our sensors are also tracking those targets inbound, we are passing that data through a pathway over to the [joint task force] commander, who then can make a decision to offensively strike that location or sense that location or do



Soldiers work inside a command cell at Camp Pendleton, California, as part of Project Convergence Capstone 4.

some kind of effect on that location.

“So, before it would be a launch, we would engage those targets, and then we would send aircraft to go SCUD hunting,” he said. “We’re past that. Now, it’s launch, then we’re launching to kill the launcher, and then we’re killing the arrows as they’re inbound.”

The transition to integrated fires is a recognition of the U.S. military’s limited magazine depth and the need to take out an enemy’s offensive capability rather than defend against a potential adversary’s larger supply of missiles, officers said.

Project Convergence 2022 experimented with the Joint Track Manager Capability bridge — developed by the Missile Defense Agency — which provided “the ability to share data across the services,” a new capability at the time, Rauscher said.

“Over the past 18 months, the work that MDA has done on the bridge has brought us the ability not only to pass data but composite data and share that data holistically across the services, and in some cases we’re able to share that data with our allies,” he said.

Another new element of PCC4 was the integration with the Defense Department’s Global Information Dominance Experiment 9.2 led by the Chief Digital and Artificial Intelligence Office, which is responsible for the data integration layer of CJADC2.

Alex Miller, senior science and technology advisor to the chief of staff of the Army, told a small group of reporters that GIDE 9.2 and PCC4 phase one were essentially the same event.

“Their objective at GIDE is how do you rapidly field digital workflows and CJADC2 capabilities?” he said. “And our objective for PCC4 is how

do you bring that joint task force and [combatant command]-level architecture down to something that is below the joint task force — so at your component level, at your service level, all the way down to the warfighter or system level?

“And what we’ve been able to demonstrate ... is how do you take nontraditional sensors and pair them with traditional shooters? How do you sort of hide in plain sight in the spectrum?” he said.

Connecting everything was no small task, he said.

“What we saw, frankly, was we could force the technical architecture together, we could do that,” he said. “The soldiers and sailors and airmen out here, they are magicians. They made it work, and they’re amazing.

“But we spent a lot of time standing up a network,” he continued. “We spent a lot of time getting architectures to work together. And because we focused so much on that, we invested a lot of calories and time just getting us to that.”

Much of that had to do with the different standards and languages or grammars the services — and allies — use in their communications and messaging systems, he said.

Maj. Gen. Jeth Ray, the Network Cross-Functional Team director, “did something that was really awesome,” Miller continued. “He forbade anyone from saying the network was broken. And what he really did was he told people, ‘You have to identify the problem and then work to identify the root cause.’”

That meant saying things like: “This part failed because the cross-domain dropped the message, or it was an ill-formed request, or this

segment of the network actually failed for these reasons,” he said.

There was one network failure that highlighted the importance of real-world testing, he said.

“There’s some wildlife out here, and the wildlife apparently got hungry one morning and decided that one of the network cables looked really delicious,” he said. “So, there are some unique effects that we saw from being live, not being at home, not being in a lab that you could only really get in the field.”

Once the network team got things connected, participants shifted over “to something that is actually quite amazing for us ... when service components started talking about workflows and they started talking about, ‘Hey, here’s what I actually have to do with this data. Here’s what I actually want to achieve. Here’s the actual end result,’ rather than, ‘Oh, I just want this box to talk to that box,’” he said.

From there, scale and speed increased, “and the time between every event went way down, from what used to take hours to something that is now taking seconds in terms of being able to move a piece of data ... from where it originated to who has to do what with it,” he said.

Miller said that since the first Project Convergence capstone, the speed of moving data from a sensor to an effector has increased by two orders of magnitude.

“We did see things that took minutes of very human-centric processing go down to seconds because the workflows were entirely automated,” he said.

Some of it was making sure not to overclassify data. Some of it involved automating data entry and transfer tasks, eliminating what the military refers to as “chair swivel” — manually moving data from one system to another.

That’s where some of the GIDE systems came into play, he said.

“And then instead of going from digital to a PowerPoint slide and then ... make it another digital dashboard, another PowerPoint slide, we just left everything in the data, we lived in the data, and we fought in the data.”

With the completion of phase one, PCC4 shifted to the National Training Center at Fort Irwin, California, for phase two, which was Army-centric experimentation focused on ground autonomy.

Reflecting on phase one, Gen.



James Rainey, head of Army Futures Command, said the experiments validated assumptions that came out of Project Convergence 2022.

“What we’ve been able to figure out over the last 18 months or so is the power of software,” he said in an interview. “So now, you don’t have to standardize everything. What you need to do is be able to connect the systems — cross-domain solutions we call them — and the ability to automate that.”

“And that was one of the big breakthroughs of this experiment,” he said, adding that some of the solutions will be imported into the force now. That’s what the Army now refers to as C2 Fix — making current systems work together for today’s fight — whereas C2 Next is about the future

generation of command and control.

“There’s a clear realization that the future is about moving to data central-ity, algorithmic warfare, whatever term you prefer,” he said, referring to the C2 Next effort. “So, when we start thinking about the next set of things we buy ... we need to connect them by design and acquire them that way, so we don’t have to have a connection problem.”

In addition to solving connection problems, PCC4 phase one also tested smaller form factors for network technology to reduce electronic signatures and lighten the load for expeditionary forces, Miller said.

“We showed that we could virtualize a lot of the current stack that we’ve been making units lug around for several years,” he said. “And in

the virtualization, we can make it smaller. ... Again, it doesn’t mean that we’ve solved the data problem. What it does show is for the near term ... we can take 700 or 800 pounds of gear and put it into a 50-pound box.”

That will help units that have to fight today, and it will help inform the development of C2 Next, he said.

“The goal is, what is the actual data architecture? What are the actual data workflows?” he said. “And don’t worry about the boxology, don’t worry about the kit. How do you actually make those tools effective?”

“So, I am pretty excited to see some of the experimentation that’s happening there, which will inform” C2 Next, he said. “It doesn’t fix the problem, but it will inform the future.” **ND**

## Demo Satellites to Facilitate Pentagon’s CJADC2 Goals

BY JOSH LUCKENBAUGH

**COLORADO SPRINGS** — Lockheed Martin recently launched a pair of small satellites the company hopes will showcase how space can enable the Defense Department’s Combined Joint All-Domain Command and Control concept.

CJADC2, as it is called, envisions sensors and weapon systems across every domain connected via an artificial intelligence-enabled network to ensure the right data gets to the right shooter or effector.

Launched March 4, Lockheed Martin’s self-funded Pony Express 2 mission is “really all about Combined Joint All-Domain Command and Control,” said Jeff Schrader, vice president for global situational awareness in the company’s space division.

The two satellites are meant to demonstrate three mission areas: autonomous, collaborative data collection; tactical, over-the-horizon communications; and on-edge processing, Schrader said during a Lockheed Martin media briefing.

With these satellites, the company is looking to perform demonstrations with the U.S. government and international partners, he added.

One possible demo — which Schrader said would require governmental approval — would involve a radio frequency collector such as an

F-35 fighter aircraft pushing data up to one of the Pony Express satellites, the spacecraft combining its collection with that of the F-35 and then sending that information to the Aegis Combat System on a Navy ship.

“Right now, we don’t know if all these [systems] connect, but we can connect them with our Pony Express 2” satellites, he said. “That’s one of the demos we’re looking at” to show how systems across multiple domains — air, space and sea — can work collaboratively.

Along with demonstrating CJADC2 capabilities, Pony Express 2 is also meant to showcase the potential of

artificial intelligence and machine learning tools in space, Schrader said.

The satellites feature a software program called HiveStar, which Schrader described as a “bid-auction” style technology.

“Think about two satellites flying — one of them might be closer to the collection site, one of them may be farther away,” he said. With HiveStar, the satellite closer to the collection site can autonomously “say, ‘Hey, I can do this easier than you can,’” reducing the need for operator input.

Using AI, “these two satellites can fly within a couple of kilometers” of each other, he added. “Think of Pony Express and the horses riding together very quickly, these things are flying in formation with each other in orbit right now. ... This was done on our money, on a small budget, but we believe is bringing a significant amount of capability.” **ND**



Rendering of Lockheed Martin's Pony Express 2 satellites