

# ARMOR & MOBILITY

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CAPABILITIES  
INTEGRATION**

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U.S. Army Communications-  
Electronics Command (CECOM)



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Arsenal  
(RIA)



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Mine Warfare  
Division  
SMWDC

- Army Mod Enterprise ■ Future Vertical Lift
- Command Posts ■ Cyber Defense
- Ground Vehicle Autonomy ■ Countering IED

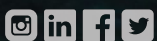


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## REWIRING THE PATH FROM DISCOVERY TO CAPABILITY

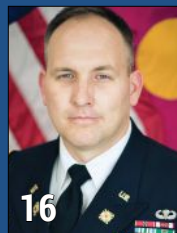
U.S. Army Futures Command is driving the transformation of scientific discoveries and concepts into fielded warfighter capabilities.

By Dr. Shawn M. Walsh

## Features



**COMMANDER'S CORNER**  
**ADVANCING ALL-DOMAIN COMMS AGILITY**  
**MG Mitchell L. Kilgo**  
Commander  
U.S. Army Communications-Electronics Command (CECOM)



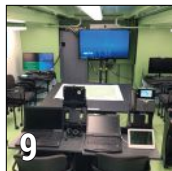
**LEADERSHIP PERSPECTIVE**  
**FORGING FUTURE WEAPONS MATERIAL EVOLUTION**  
**COL Martin Hendrix**  
Commander  
U.S. Army Rock Island Arsenal (RIA)

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**Cover:** Spc. Chris Triplett, right, a combat engineer, and Army Sgt. Reko Dent, squad leader and combat engineer, both from Bravo Company, 150th Brigade Engineer Battalion, 155th Armored Brigade Combat Team, radio back to headquarters during a dismounted patrol near Fort Bliss, TX. Mississippi Army National Guard personnel underwent pre-mobilization training, facilitated by First Army Division East 177th Armored Combined Arms Training Brigade, in preparation for overseas deployment. (U.S. Army photo by Sgt. 1st Class Darron Salzer, First Army Division East)



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The Army's Command Post Integrated Infrastructure program, or CPI2, tackles command posts mobility, scalability and survivability challenges.

By COL Rodney Bilbrew



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By Jerry Harper



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By Dr. David Gorsich

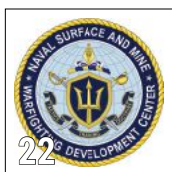


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Interview by Christian Sheehy



### ENGAGING THE GLOBAL C-IED FIGHT

The North Atlantic Treaty Organization (NATO) Countering-Improvised Explosive Devices Centre of Excellence (C-IED COE) is at the forefront of U.S. and allied global defense.

By COL Stephen Kavanaugh

# ARMOR & MOBILITY

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## INSIGHTS

The March/April 2020 issue of *Armor & Mobility* spotlights efforts by the U.S. Army's new Futures Command to advance Modernization Enterprise initiatives across the spectrum of combat readiness, ultimately key to the success of future All-Domain operability. As greater emphasis is put on integration and synchronization of capabilities and their functionality, a transformation across DoD is addressing the need for truer Joint partnering in taming a complexity of threats to U.S. security not seen before in military history.

As technology drives capability, so too is the early discovery of what is possible in the realm of future battlespace advantage. Work being done by the Army's Combat Capabilities Development Center (CCDC), Warren MI, in coordination with U.S. Army Futures Command (AFC), Austin, TX, to highlight the notion of Minimum Viable Product (MVP) scientific research. The idea that the combination of materials in simpler application can produce equal or greater results to complete systems level function is driving possibilities for future Army/Joint DoD combat development. The use of analytics as a means for experimentation to estimate hypothesized operational effects of new capability ideas early in the maturation cycle is providing a means to refine and redirect science execution to ensure maximum advantage for the warfighter. AFC Commanding General John Murray tells A&M that AFC is "...working with the entire Army Modernization Enterprise to ensure top priorities are met using Soldier touchpoints, advanced manufacturing, and continuous feedback."

From capabilities development to real-world combat application, A&M had the good fortune to hear from MG Mitchell Kilgo, Commander, U.S. Army Communications-Electronics Command (CECOM), Aberdeen, MD, on the latest challenges CECOM is addressing in support of the Army's C5ISR mission, including the latest "C" which stands for "Cyber". In this vein, we dovetail into efforts over at Program Executive Office-C3T and Cyberspace Situational Understanding (SU), a concept that leverages common operational picture, or COP, data collection and fusion to enable field commanders to make more-informed decisions in Multi-Domain Operations. As much as a clear COP is critical to battlespace command and control, so is Command Post Integrated Infrastructure (CPI2) when it comes to the mobility, scalability, and survivability of expeditionary combat mission systems.

Behind the success of every combat mission is the weapons equipment that gives it punch. The folks over at U.S. Army Rock Island Arsenal (RIA) know this quite well, and A&M was privy to what RIA Commander Martin Hendrix had to say on the latest that Advanced Manufacturing (AM) is doing to put next-generation capability in the hands of the nation's warfighters. On the aerial side of national defense, work being done by the Air and Missile Defense (AMD) and Future Vertical Lift (FVL) Cross Functional Teams (CFTs) to prepare the nation for the demands of future homeland and theater missile attack and combat maneuver is ever apparent.

Your comments and suggestions are welcome. Thank you for the continued readership!

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## REWIRING THE PATH FROM DISCOVERY TO CAPABILITY

U.S. Army Futures Command is driving the transformation of scientific discoveries and concepts into fielded warfighter capabilities. Diverse teaming, a sharp focus on Army-relevant problems, and adopting a Minimum Viable Product (MVP) approach, provides new tools for battlefield success.

By Dr. Shawn M. Walsh, CCDC Army Research Laboratory, Dr. Jean M. Vettel, Futures & Concepts Center, and Mr. Mathew M. Correa, CCDC Soldier Center



CCDC Army Research Laboratory's AJ Roberts (left) demonstrates a "minimum viable product" or "MVP" to Sgt. 1st Class Joiah Stewart and Sgt. 1st Class Roderick Trotter. The MVP uses a new hydrogen-generating alloy which, when added to any grade of water, is able to power devices (e.g., a lantern) without batteries. (Dave McNally, CCDC ARL)

Scientific discovery often begins with curiosity. As curiosity gives way to understanding and insight, the question shifts to how one might beneficially exploit these new and potentially game-changing discoveries. Preparing the Army to win in Multi-Domain Operations, or MDO, demands an ability to rapidly identify, prioritize and resource the "right" science and technology, or S&T for the warfighter. This is no easy task given the ever-accelerating global emergence of new research and S&T advances. The Army Futures Command (AFC) identifies which new scientific discoveries could enable a competitive advantage for future warfighters. As such, AFC serves as a "catalyst" that drives discovery across the Army


Modernization Enterprise (AME). Discovery alone, however, is not sufficient. Delivery of new capabilities that fully exploit the potential of new scientific discoveries is equally important.

The AME consists of a rich pool of expertise and capability from universities, industries of varying size and scope, other Army and government agencies, and public and private organizations. How does the Army best tap into the AME's innovation ecosystem and inspire new concepts and capability development? The answer is early teaming and a much sharper focus on Army modernization priorities. This includes clearly defining and analyzing the Army problem with the same rigor used in developing potential solutions





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and capabilities. Established less than two years ago, the AFC's key tenet - unity of effort - is already evident in its ability to focus diverse AME teams on prioritized Army needs and gaps.

Organizations within AFC are creating new and earlier opportunities to rapidly transform discoveries into competitive advantages for the warfighter. This includes interactive innovation workshops and a collaborative Army-wide effort to fundamentally rewire and synchronize the linkage of new discoveries and technological advances with concepts and requirements.

## UNITING INNOVATION AND WARFIGHTERS EARLY AND OFTEN

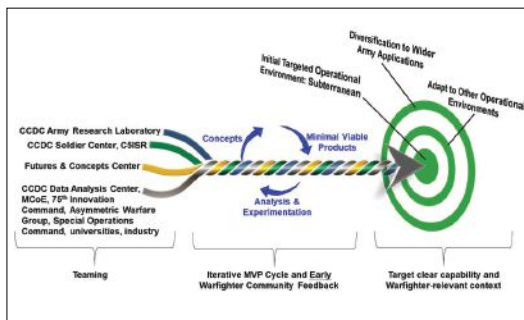
In November 2019, the U.S. Army Combat Capabilities Development Command's Soldier Center (CCDC SC) designed an interactive event that united many elements of the AME. This included members from the CCDC Army Research Laboratory (CCDC ARL), the 75th Innovation Command, the Asymmetric Warfare Group, and universities, industry and other public/private organizations. The University of Massachusetts at Lowell hosted the event at its Innovation Hub, located in the historic textile mill area of Lowell, MA. Although the event was focused on wearable sensor technologies for the future warfighter, its underlying approach is pioneering and broadly applicable. The event deliberately engaged participants from the AME to discuss both the warfighter problem space as well as potential solutions. Too often, the focus of such ideation workshops is on the latter. Experienced Soldiers provided the event participants with first-hand accounts of actual challenges and opportunities in using new technologies and capabilities in unique operating environments (figure 1).

The wearable sensors event exhibited three key elements that are essential to achieving AFC's "unity of effort" to deliver the right solutions at the right time to the warfighter. As illustrated in figure 2, these elements include early and diverse teaming on both the problem and the solution space; the use of notional Minimum Viable Products, or MVPs, to get immediate and experienced feedback from the warfighter community; and defining an initial target of opportunity where discoveries and technologies could have an immediate and significant impact (e.g., a subterranean operating environment).

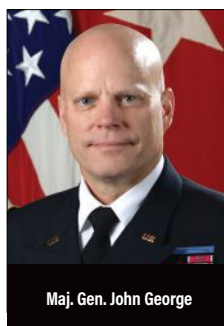
"We shaped this event around the tenets of AFC's five lines of effort (discovery, delivery, people, engagement and momentum)" said Mr. Douglas Tamilio, Director of CCDC Soldier expertise.



**Figure 1.** CCDC Soldier Center 1st Sgt. Sean Caruso was one of several warfighters who shared insights, experiences and challenges in adopting new technologies and capabilities at the CCDC Soldier Center's wearable sensors innovation event held at The University of Massachusetts at Lowell's Innovation Hub, November 2019. (CCDC Soldier Center)



**Figure 2.** Soldier wearable sensors event demonstrated the value of diverse teaming, warfighter feedback and a focus on unique challenges in a relevant operating environment. (U.S. Army image)



Center. "The event, which was held at a facility that was designed to inspire innovation, focused on platoon organic wearable sensors in an MDO 2028 operational environment. Representatives from across the AME (DoD, industry and academia) convened to look past the horizon and generate concepts that are relevant to achieving overmatch in an MDO operational environment. In partnership with some of the National Manufacturing Initiatives, the Advanced Functional Fibers of America (AFFOA), and NextFLEX, we are in the process of resourcing and transforming these ideas into prototypes for Soldier feedback. Additionally, we are in the planning stages for similar events in calendar year 2020."

Finite resources and a nearly endless array of emerging technologies to choose from emphasize why AFC is embracing "best of breed" approaches to identify, prioritize and deliver decisive combat power and capability. Innovation events that unite members of the AME and the warfighter community are an essential first step. Fundamentally rewiring the means by which promising technologies and concepts from these events are transformed into validated requirements and capabilities is equally important.

## FROM DISCOVERY TO REQUIRED CAPABILITY

A new warfighter capability is not based purely on a new technological advance; rather, a new capability relies on a well-developed concept and a holistic balance of tactics, techniques and procedures that fully exploit advances made possible from new technologies. More generally this is known as Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy, or "DOTMLPF-P" capability. Synchronizing the interaction of concepts, requirements, and emerging S&T is paramount to delivering complete and competitive solutions to the warfighter.

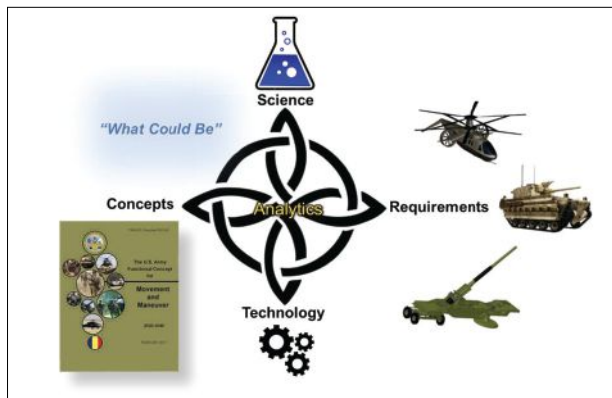
As depicted in figure 3, the Army has two primary communities of experts with a shared mission to architect the Army's future: operational experts in the Army concepts and requirements community who identify required capabilities to overcome a projected adversary and technical experts in the Army S&T community who execute use-inspired research to provide disruptive warfighter capabilities. Historically, these experts were housed in two different 4-star commands. A core design in AFC's organizational structure was to fundamentally unite this expertise, creating the Futures and Concepts Center with operational expertise and the CCDC with technical



In March 2019, Task Force Ignite (TFI) was formed to instantiate processes, events and outcomes to realize this AFC vision. Ignite has iterated on the design of science-concept collaboration workshops to formalize new partnering opportunities between the Futures and Concepts Center (FCC) and CCDC. The workshops structure early and interactive discussions to integrate the operational expertise of FCC concept writers with the scientific expertise of CCDC researchers. These workshops collaboratively identify capabilities for the deep future that integrate capability needs with the art of the possible based in scientific discoveries and art of the probable based in technological advancements.

"Discovering, developing, and fielding future Army capabilities requires the concepts and S&T communities to be in total sync," said Maj. Gen. John George, CCDC commanding general, "and that has been reinforced since I transitioned from my role at FCC to leading the team at CCDC."

The "Celtic Knot" in figure 3 highlights the new holistic,



**Figure 3.** AFC's Futures and Concepts Center and the U.S. Army Combat Capabilities Development Command created new mechanisms that unite the concepts and requirements community and S&T community much earlier. This iterative synchronization maximizes warfighter impact of emerging S&T from the Army laboratories and centers as well as the larger Army Modernization Enterprise. (U.S. Army image)

analytically-driven framework that creates interactions among each element to ensure that concepts shape and refine use-inspired research, and executing S&T programs ground and devise new required capabilities in the concepts.

A recent TFI collaboration workshop supported the ongoing revision of the U.S. Army Functional Concept for Movement and Maneuver to integrate fully with Multi Domain Operations, or MDO. For the first time, a functional concept S&T appendix is being co-authored by technical and operational experts sitting in the same room debating the best path for the Army's future force. The

collaboration workshops produce co-authored text for the S&T appendix of the concept. The appendix now clearly codifies how executing research in CCDC will overcome technical challenges that prevent realization of the required capabilities. This integration of science and concept is a critical need to accelerate the delivery of innovative capability to the warfighter.

In addition to the science-concept collaboration workshops, TFI has designed FCC-CCDC events that enable data-driven

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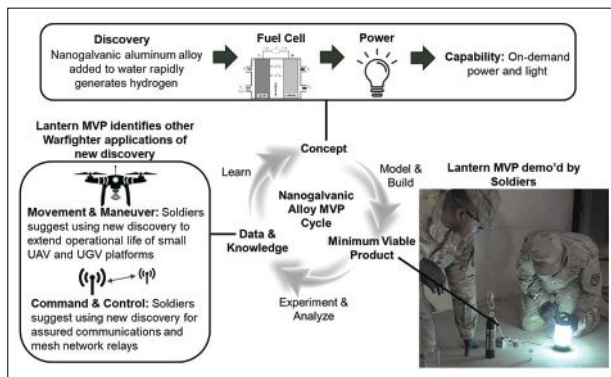
decisions about the future fight. Specifically, Ignite collaboratively expanded the future study program in FCC to develop a concept of operations for scientific research earlier in maturity (Technology Readiness Level (TRL) <6). The most recent focused excursion concept of operations examined deep reinforcement learning, a subset of artificial intelligence, with the potential to enable mission command and facilitate MDO. Attendees decomposed operational implementations discovered during wargaming, analyzed capability enablers, revectorized scientific hypotheses and defined key attributes and metrics that can be used in future experimentation to quantify the operational advantage of hypothesized scientific outcomes. These analytics provide a means for experimentation in the FCC future study program to estimate hypothesized operational effects of new capability ideas early in the maturation cycle, providing a means to refine and redirect the science execution to ensure maximum advantage for the warfighter.

Maj. Gen. George emphasized that “CCDC scientists and engineers provide invaluable technical expertise to FCC, ensuring our future warfighting concepts and requirements are informed by not only realistic assessments of our adversaries’ capabilities, but also scientifically-based projections of technological advancements in 2035 and beyond. Task Force Ignite is a critical step toward establishing even stronger working relationships between FCC and CCDC.”

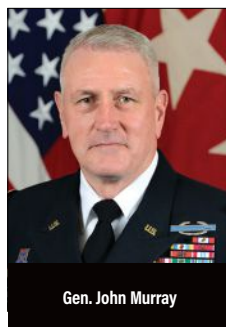
## MVP DISRUPTION OF MOBILITY AND COMMS

The path from discovery to delivery of a new capability is not always obvious, nor is it necessarily linear -- especially for disruptive technological advances. The TFI and MVP frameworks are attractive because they create a very early and iterative methodology for connecting new discoveries to required capabilities. Figure 4 is an actual work-in-progress exemplar of AFC embracing the MVP framework. CCDC ARL discovered and developed a new aluminum alloy that can rapidly and safely generate hydrogen when it reacts with water. The MVP approach made it possible to demonstrate the discovery in a context that would be relevant and intuitive to a Soldier -- the ability to use the hydrogen-generating alloy to generate electricity to power a lantern for subterranean illumination.

Early exposure of warfighters and other key Army decision-makers and stakeholders to a new MVP can initiate the validation and maturation of promising new S&T discoveries and accelerate the Army’s ability to develop “complete” warfighter solutions. The MVP cycle also allows identification of new and disruptive potential uses for the nanogalvanic alloy. For example, after experimenting with the MVP, the Soldiers in Figure 4 suggested the technology could extend the operational life of both vital communication devices and UAVs.



**Figure 4.** The MVP approach provided a rapid and effective way to link a newly discovered hydrogen-generating metal alloy to a warfighter relevant need: illumination in a logistically-denied subterranean environment. Feedback from experienced Soldiers identified other warfighter-relevant applications for the new discovery. (U.S. Army image)



new ways of thinking about important problems and opportunities,” said Dr. Patrick J. Baker, Director of CCDC ARL. “This is bringing changes to how we operationalize science to get timely useful solutions to our Soldiers.”

Collectively, the efforts across AFC – to include the use of MVPs, a collaborative approach to early synchronizing of concepts, requirements, and S&T, and new workshops to directly connect warfighters to emerging sources of innovation from the AME gives AFC new tools to win in MDO and beyond.

## PROMOTING JOINT SUCCESS

AFC from its inception has been committed to strategically driving and empowering the AME to produce the right capabilities at the right time for the future warfighter. As noted by AFC command leadership, “winning matters...but winning together matters more.” This emphasis on collaboration is evident in AFC’s CCDC ARL, CCDC Soldier Center, and the Futures and Concepts Center efforts to develop entirely new and earlier linkages between the Army S&T community and

the concepts and requirements community. The use of MVPs and the ability to synchronize S&T advances with required capabilities accelerates the transformation of new discoveries into competitive advantages for our warfighters.

“Ultimately, everything AFC does must be focused on the end user, our Soldiers,” said Gen. John M. Murray, Commanding General of Army Futures Command. “From the very beginning we’ve been working with ASA(ALT), the other commands and the entire Army Modernization Enterprise to ensure our top priorities are customer centered results, delivered at an accelerated pace. We’re doing this with Soldier touchpoints, advanced manufacturing and continuous feedback to make sure our entire team delivers what our Soldiers need to win wars.” ■

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## ENHANCING BRIGADE-LEVEL EXPEDITIONARY READINESS

The Command Post Integrated Infrastructure program, or CPI2, stood up as Product Manager CPI2 under the Program Executive Office Command, Control and Communications Tactical (PEO-C3T) in January 2018, tackles Army command posts mobility, scalability and survivability challenges.

By COL Rodney Bilbrew, PM, CPI2



One of the platforms into which CPI2 is integrating is the M1087 expandable van shelter (above). A vast amount of C5ISR equipment including network communications, mission command hardware and software, power systems, radios, servers and computers will enable commanders to conduct mobile and survivable mission command operations. (PEO C3T)

As the Product Manager (PdM) for Army's Command Post Integrated Infrastructure program, or CPI2, it is my job to ensure we're listening to what warfighters need and are delivering the right capabilities to enable robust and expeditionary command post operations. Two years since the program's inception, Soldier feedback from experimental units is continuing to shape modernization across the service and is influencing mobile command post design efforts while an all-hands-on-deck effort across numerous stakeholders ensures we remain on track.

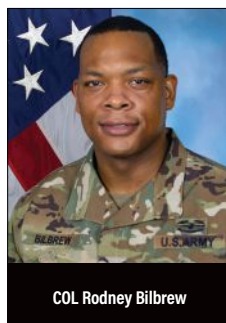
### INCREMENTAL DEVELOPMENT

The Army is executing CPI2 in two increments. Increment 1, or Inc. 1, involves multiple phases of prototyping, integration and follow-on formal design for brigade combat team (BCT) command post designs. The

design approach is taking a government-driven solution, developed through a functional support agreement with the Army's Combat Capabilities Development Command C5ISR (Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance and Reconnaissance) Center, and putting it up against an industry solution to deliver a best-of-breed final solution.

PdM CPI2 has conducted Developmental Operations, or DevOps, with the 2nd Stryker Brigade Combat Team, 2nd Infantry Division (2/2 ID) and the 3rd Brigade Combat Team, 101st Airborne Division (Air Assault) over the last 10 months as part of this first increment. Additional DevOps engagements with the 4th Infantry Division will inform a mobile command group solution to provide capability for commanders away from headquarters.

Each design incorporates a significant amount of C5ISR equipment, including network communications,



mission command hardware and software, power systems, radios, antennas, servers and computers, and heating and cooling units. Each component has complex interfaces, cabling, security requirements and power needs that must be taken into consideration. The number and types of vehicles – including modifications to the standard Family of Medium Tactical Vehicles (FMTV), Humvees, an ultra-light all-terrain combat vehicle and an ISO shelter – that will be components of the command post are also part of the experimentation and design process.

Increment 2, or Inc. 2, kicked off recently following approval of the CPI2 Capability Development Document, or CDD, from the Army Requirements Oversight Committee. The CDD specifies operational requirements for the program, and follow-on CDDs will incorporate additional threat assessments and capabilities based on emerging requirements. Industry will have opportunities in Inc. 2 across a wide range of CPI2 program areas including addressing electromagnetic spectrum reduction, onboard vehicle power, alternative mobile CP platforms, tentage, communications system integration and more.

### EXPANSIVE OPERATIONAL INFLUENCE

CPI2 is a far-reaching effort across multiple program offices, the platform and network integration communities, and the modernization enterprise at large. PdM CPI2 is leading the integration across these stakeholders to take both existing and emerging command post solutions and incorporate them into mobile, scalable and survivable designs that enable commanders in all phases of operations.

In December 2019, a design workshop with the 2nd Stryker Brigade Combat Team, 2nd Infantry Division at Joint Base Lewis-McChord, Washington provided an opportunity for CPI2 users to share direct input on a formation appropriate design for the program's initial industry solution. The workshop designated time with each staff section to determine what equipment is needed to be fully operational and to understand space allocations for unit personnel. Unit staff sections came well prepared to discuss what they need and how they operate which, in turn, enables us to provide a significantly improved command post design solution for their mission set.

The team recently led an initial prototype design review between the Inc. 1 vendor, PM Mission Command's technical management and business management divisions, the Network Cross-Functional Team, C5ISR Center's Command, Power & Integration Directorate and unit personnel. The intent of the design review was for the program office to review conceptual designs for command post system integration, power and cooling solutions, and human factors considerations to include seating layouts. During the Initial Prototype Design Review (IPDR), the vendor used existing government-furnished equipment vehicles and shelters to generate mock-ups of their conceptual designs and presented proposals for survivability-related technology insertion.

Following this design review the program is taking a closer look at the current Army inventory of environmental control unit and power generation products to determine if power and environmental needs can be met with products already fielded versus needing commercial-off-the-shelf systems. PdM CPI2 continues to work with internal and external stakeholders to fully examine the conceptual designs and provide the vendor with a decision in order to proceed to the next design phase.

### INTEGRATION MOVING FORWARD

These interactions are critical to the program's path forward as they facilitate dialogue between the program office responsible for making sure requirements are met, the vendor or government developers in charge of the actual command post designs, and the users themselves who will take this capability into the field. Design workshops and prototype design reviews will continue regularly throughout the program to drive collaboration and deliver process and capability improvement through an iterative process.

Within the next year, the Army will start to see this radically mobilized command post design in action. The final prototype design review is scheduled for mid- to late-April, after which the fabrication and integration phase will begin. Follow-on limited user tests will evaluate the designs this fall and initial fielding to select BCTs is slated for early FY21. ■



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## ADVANCING ALL-DOMAIN COMMS AGILITY

*Major General Mitchell L. Kilgo assumed duties as the 16th Commander of the U.S. Army Communications-Electronics Command (CECOM) and Senior Commander of Aberdeen Proving Ground on June 20, 2019.*

*As the commanding general for a 9,000-person, two-star global command and the senior commander of a 28,000-person military base, General Kilgo serves as the U.S. Army's command, control, communications, computers, cyber, intelligence, surveillance, and reconnaissance (C5ISR) materiel integrator. He is responsible for enabling the U.S. Army's warfighting readiness by providing sustainable global C5ISR support.*

*Raised in Newport News, Virginia, General Kilgo entered active duty in January 1988 after graduating from Virginia Union University with a Bachelor of Science degree in Mathematics and Natural Sciences. He also holds a Master of Science degree in Systems Technology, (Joint Command, Control, and Communications) from the Naval Postgraduate School and a Master of Science Degree in National Security Strategy from the National War College.*

*During his 31 years as an Army officer, General Kilgo served in a variety of command and staff positions, including Deputy G6 and Executive Officer, 122nd Signal Battalion, 2nd Infantry Division; G6 for U.S. Army Japan, Camp Zama, Japan; Deputy CIO/J6 Multi-National Force – Iraq; Chief Spectrum and IED-Defeat Branches, The Joint Staff, J6; Executive Officer to the Commanding General, U.S. Africa Command; and U.S. Forces Command G6.*

*His most recent assignment was as the J6 for the United States Central Command (CENTCOM) where he oversaw the implementation and management of the global communications and computer networks for the Central Region.*

*General Kilgo commanded at every operational level from company to Theater Signal Command with significant assignments as the Commander, Support Company, 111th Signal Battalion, Site-R; Commander 2nd Signal Brigade, Wiesbaden, Germany; and the Commanding General of the 5th Theater Signal Command, Wiesbaden, Germany.*



### MG Mitchell L. Kilgo

Commander, U.S. Army Communications-Electronics Command (CECOM)  
Senior Commander, Aberdeen Proving Ground

cyber, intelligence, surveillance and reconnaissance (C5ISR); research and development; test and evaluation; chemical and biological defense; and public health sciences.

CECOM is part of the C5ISR community at APG, which also includes the Combat Capabilities Development Command (CCDC) C5ISR Center and the Network Cross-Functional Team (both part of Army Futures Command); Program Executive Office Command, Control, and Communications-Tactical (PEO C3T); and Program Executive Office Intelligence, Electronic Warfare, and Sensors. Your astute readers might recognize there's a new "C" for cyber in our acronym. That reflects how security has become really foundational to everything our community does, at every stage of the technology life cycle.

Within the C5ISR community, CECOM maintains hardware and software systems for the sustainment tail after they are fielded, which can account for up to 70% of a program's life cycle cost. We also sustain Army Enterprise Resource Planning systems (ERPs), which house business data. Sustainment is critical, because even the most advanced platform can be vulnerable or even non-mission-capable

*A&M spoke recently with MG Mitchell Kilgo, Commander, U.S. Army Communications-Electronics Command (CECOM), Aberdeen Proving Ground, MD, regarding initiatives CECOM is working to enhance Army/ Joint DoD comms field readiness in the next decade and beyond.*

**A&M: Tell us about your role as CECOM commander and the command mission.**

**MG Kilgo:** My position is unique in that I serve as both commanding general of CECOM and senior commander of Aberdeen Proving Ground (APG), Maryland. APG is a major technology center for the Army, with more than 21,000 employees and more than 90 tenant organizations working mostly in command, control, communications, computers,

if it's missing a critical part or security update. That puts mission success and Soldiers' lives in jeopardy. It's advantageous for us to be co-located with other C5ISR organizations at APG, because it helps us plan together for the long-term sustainment of systems early in the acquisition process.

**A&M: From an accountability perspective, talk about some of CECOM's focus areas in addressing Army Materiel Command (AMC) goals.**

**MG Kilgo:** The return to great power competition and strategic deterrence has forced us to rethink the "business as usual" mentality that guided much of our last two decades at war. For my boss, AMC Commander GEN Gus Perna, the name of the game is the Strategic Support Area (SSA). The SSA is AMC's area of responsibility within multi-domain operations (MDO), the Army's new operating concept that looks at the battlespace as a single combined entity across land, air, sea, space and cyberspace. Simply defined, the SSA is where combat power is generated, projected forward and sustained in MDO. The SSA concept has become central to everything AMC does, and because CECOM is a major subordinate command to AMC, the same holds true for us.

Relative to SSA, we have several lines of effort. Supply availability is a big one: ensuring our Soldiers have the right part at the right place at the right time. When GEN Perna took command of AMC in 2016, he ordered CECOM to pursue 100% supply availability, and we took that and ran with it. We devised new ways to segment different populations of readiness-driving parts, and we're using a new projection tool to reverse engineer when we fail to hit a target. Those efforts to see ourselves are paying dividends. In fiscal year 2017, supply availability was 77%, but it rose to 84% the next year and 90% at the end of fiscal year 2019. And we're not letting off the gas.

We're also making strides in logistics information readiness, another SSA priority area. Army business data is often stovepiped across multiple ERPs, and traditionally, so are ERP support operations such as service desks. The CECOM Software Engineering Center (SEC) is responsible for sustaining those ERPs, so we established the Army Shared Services Center to centralize support teams and bring standardized tools and processes together under one roof. This is an important complement to the work AMC and Program Executive Office Enterprise Information Systems are doing to better connect ERPs to improve business users' ability to get and apply the data they need.

Industrial base readiness is a third SSA priority area, and our focus is on the Tobyhanna Army Depot, CECOM's organic industrial C5ISR repair and overhaul facility in Tobyhanna, Pennsylvania. Tobyhanna serves customers across the joint forces, and it saw its workload rise 35% in fiscal year 2019. It's kept up thanks to 500 new employees hired in fiscal year 2019 and improved sales and operations planning. Together, these efforts have led Tobyhanna to improve its Performance to Promise, a measure of its ability to deliver services on time, from 49% in fiscal year 2015 to 97% in fiscal year 2019.

Another SSA priority is strategic power projection, in which our focus has been equipping Army Prepositioned Stocks (APS) with modernized, division-size sets of C5ISR equipment. This has been especially important in the lead-up to the DEFENDER-Europe 20 exercise in the spring, the largest deployment of U.S.-based forces to Europe in more than 25 years. The exercise is intended to validate the draw, use and turn-in of configured-for-combat equipment sets from APS in Europe. In many ways, it is a test of AMC's capability and capacity to "own" the SSA and see ourselves. Our troops shouldn't spend any time working on

equipment when they arrive – they need to be able to do a quick status check and be on the front lines with their gear immediately.

**A&M: As the Army continues its transition to BCT combat level emphasis, how is CECOM keeping the focus on comms assurance to ensure mission readiness?**

**MG Kilgo:** One of our biggest current efforts is working with the Network Cross-Functional Team and PEO C3T to plan for sustainment of the future Integrated Tactical Network (ITN). The ITN is designed to be more resilient in contested and congested environments, more expeditionary and easier for Soldiers in use. PEO C3T is fielding the system in two-year capability sets beginning in 2021. Each capability set is infused with equipment procured via middle-tier acquisition (MTA) authority, which enables more rapid fielding.

However, these MTA systems have a huge variety of warranty durations, conditions and pathways for Soldiers to exchange non-functional equipment still under warranty. This is a challenge from a logistics and sustainment standpoint, so CECOM is implementing a plan known as 5-3-1 to address it. "Five" refers to the five-year warranty the Army will pursue for all new MTA equipment. "Three" refers to the year-3 decision point, at which point the Army will decide if it will sustain the equipment after the initial warranty period ends. And "one" refers to the central warranty exchange center, the Tobyhanna Army Depot and its more than 40 forward locations worldwide.

Another major focus is the ability to surge in case of a return to large-scale combat operations. For supply availability, we are partnering with Army Contracting Command, the Defense Logistics Agency and the industrial base to build better contract responsiveness and surge capacity. This includes moving to longer-term, 10-year contracts that procure from multiple supply sources. These contracts feature language for surge production and expedited delivery in case contingencies come up. At Tobyhanna, the Army is making major modernization investments – nearly \$850 million from 2009 through 2022 – which are also improving its surge capacity.

Finally, we are working to repair and return mission-critical C5ISR equipment to Soldiers faster than ever before. In 2018 and 2019, we established depot maintenance forward facilities in Korea, Europe and three CONUS locations. The intent is to bring depot-level repair capabilities closer to where units are stationed. We are also creating repair cycle floats for the highest-priority C5ISR systems. Repair cycle floats are pools of ready-to-issue equipment that are immediately available to units if their systems break down. This is in lieu of sending non-mission-capable systems to Tobyhanna, repairing them, and shipping the same systems back to units, a process that can take months.

**A&M: Given the Chief of Staff of the Army's No. 1 priority is people, what is CECOM doing to empower its workforce?**

**MG Kilgo:** People are the heart and soul of CECOM, which has a 99% civilian workforce. Guided by our Human Capital Strategic Plan, we're executing a number of efforts to cultivate a diverse, equipped and resilient team of professionals.

For example, our SEC is scheduled to begin sustaining 25 new systems by 2025. However, it doesn't have the skill-sets in sufficient quantity to sustain these systems, and contract support is extremely expensive. So beginning in 2019, it began a revolutionary program to retrain and cross-train employees in areas such as software



programming, database administration and cybersecurity. Selected employees undergo three to nine months of classroom instruction, followed by 60 to 120 days of on-the-job work with subject matter experts to apply what they learned. It's a vote of confidence in the nearly 100 employees who have participated so far, and we expect that figure to grow significantly.

We are also working with local educational institutions to equip young people with the 21st century skills they need for successful careers at CECOM and APG. Among other programs, our annual two-week Real-World Internships in Science and Engineering program invites nearly 40 local high school students to work in SEC and CCDC C5ISR Center labs every summer. I am also excited about our upcoming P-TECH initiative with Harford County (Maryland) Public Schools and Harford Community College. The program engages high school students to receive their diploma and associate's degree in four to six years, at no cost, and it includes an IT- and cyber-focused internship at APG.

**A&M: From a partnering perspective, how is CECOM leading Army/ Joint DoD efforts to work more closely with industry?**

**MG Kilgo:** Public-private partnerships (P3s) help sustain the industrial base by fostering cooperation and teamwork and reducing costs. One of their big advantages is that they help us build our capacity in-house while leveraging private industry support and expertise as needed. Two CECOM major subordinate commands are designated Army Centers of Industrial and Technical Excellence (CITEs): Tobyhanna Army Depot and the SEC. The CITE designation is important, because it allows organizations to enter into formal P3s.

It's most widely used at Tobyhanna Army Depot, which has 32 active partnerships and is pursuing more than 50 more. It recently entered into its biggest P3, a seven-year agreement with Lockheed Martin to repair more than 90,000 pieces of hardware for the Instrumentable-Multiple Integrated Laser Engagement System family of training devices. The system uses lasers and blank cartridges to simulate battle. Tobyhanna employees work on the devices themselves, and a Lockheed team is on-site to handle logistics like receiving, warehousing and shipping.



MG Kilgo, right, discusses a Combat Service Support Very Small Aperture Terminal with Brad Amon of the U.S. Army Information Systems Engineering Command, a CECOM subordinate command, Ft. Huachuca, AZ. (U.S. Army photo by Sean Kief)

ing, warehousing and shipping.

The SEC also recently completed its first-ever P3, a 24-month engagement with Chemring to provide software assurance and documentation support for the Husky Mounted Detection System. It uses ground-penetrating radar to protect Soldiers from IEDs.

**A&M: Anything else you'd like to add?**

**MG Kilgo:** There's a quote from GEN Perna that resonates with me: "The difference between being ready and reacting will be measured in the number of lives lost." It's a great reminder that there's no room for complacency in our business, which is all about projecting combat power. We're a profession of arms, and when our Soldiers deploy, CECOM goes right alongside them, providing critical field support and forward repair. We take the Chief and the Secretary's priorities of people, reform, readiness and modernization seriously. The men and women of CECOM inspire me every day, and it's the privilege of a lifetime to serve as their commanding general.




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## ADVANCING CYBERSPACE SITUATIONAL UNDERSTANDING

To fight and win on today's tech-driven battlefield, the Army must be able to contend and dominate in the cyberspace domain. An emergent capability known as Cyberspace Situational Understanding will allow commanders to see themselves in their cyberspace domain, see their battlespace and the threats impacting mission success, and leverage a common operational picture of collected and fused data to understand that battlespace and make informed decisions in multi-domain operations.

By Jerry Harper, Product Lead for Mission Command Cyber, PEO-C3T



CW4 Alexander Adorno from the U.S. Army Training and Doctrine Command's (TRADOC) centralized capability development integrator for Cyberspace Operations, TRADOC Capability Manager Cyber, discusses how Cyberspace SU can consolidate and enrich data from other emerging/developing capabilities such as the Command Post Computing Environment (CPCE), Electronic Warfare Planning and Management Tool (EWPMT), Distributed Common Ground System-Army (DCGS-A), Big Data Platform, and other platforms to reduce the cognitive load on commanders and staff. (U.S. Army)

Emerging technologies are driving a fundamental change in the character of war. From a cyberspace operations perspective, new and emerging technologies such as artificial intelligence and high-speed data processing are enabling smart jammers, sophisticated cyber-tools, and improved speed and accuracy in human decision making. Warfighters must also contend with an electromagnetic spectrum (EMS) that is both highly contested and congested to ensure command and control and information sharing. These threats require new tools for Soldiers to control the cyberspace domain, the EMS and the information environment.



### GREATER COMPREHENSION OF OPERABILITY

Cyberspace Situational Understanding, or Cyberspace SU, will be an application or set of applications to manage, interact with and visualize Cyber and electromagnetic activities. Cyberspace SU provides three primary capabilities. First, it allows commanders and their staff to see how events in the information environment – cyberspace attack, jamming, social media campaigns, etc. – impact their overall mission and then choose an appropriate course of action during multi-domain operations.



Second, Cyberspace SU helps warfighters to identify risks or possible impacts of the information environment. Finally, Cyberspace SU allows commanders and their staff to integrate cyber operations, electronic warfare operations, and other information warfare planning capabilities into their mission objectives and tasks, and track them through completion. These capabilities enable the commander to concurrently defend the network/information systems, identify and target cyberspace threats, manage risk, and aid in increasing operational success.

The capability will include backend analytics that leverage source and enriched data from specific tactical and strategic programs to provide analysis, forecasting, enable information prioritization and reduce the cognitive workload of warfighters.

With Cyberspace SU, tactical units are afforded the ability to view cyberspace events, associated impacts and related status quickly by correlating in time, physical and logical space; across likely threat vectors and actions; and phases of operation and mission types. Cyberspace SU tools will also ingest data and information from national, strategic and tactical sources. Analytic, visualization and correlation capabilities then transform data into useful information needed to achieve the commander's situational understanding of cyberspace. This process ultimately provides the "so what" factor needed to drive decisions in Multi-Domain Operations (MDO).

## MORE EASE IN ENEMY ASSESSMENT

Cyberspace SU maps mission systems and dependencies and assesses the impact of losing key systems on the overall mission success. It continually assesses vital military systems for vulnerabilities and indicators of compromise and alerts operators when a mission is affected. By expediting the warfighter's ability to recognize and react to cyber-threats/attacks to key mission systems, Cyberspace SU allows commanders to quickly address system issues, mitigate risks and ensure successful operations. Cyberspace SU also seeks to incorporate emerging machine learning and artificial intelligence capabilities to further aid warfighters with predictive analytics to help warfighter's disrupt adversary kill chains.

With adversaries developing capabilities like smart jamming and sophisticated offensive cyber tools, warfighters need a means to recognize when adversaries employ these tools and respond. To do so, sensor data must be rapidly ingested, correlated and understood to help warfighters recognize their adversary's avenue of attack.

The Army must also look to fuse disparate information sources to gain better insights into the information environment. One example is correlating a cyber-persona, identified by a national or joint cyberspace asset with a real person (or organization) residing in a tactical unit's AO derived from battlefield forensics performed on digital devices seized in a raid.

## MULTI-DOMAIN SUPPORT AND NETWORK 2028

All of the disparate information concerning cyberspace must be brought together to inform the commander on the best way to operate in the cyberspace domain – including its capabilities and limitations – in multi-domain operations. Cyberspace SU analyzes data and information and then presents the results with intuitive visualizations that enable commanders and staffs to take action. Correlation of these disparate data sets will provide an intuitive logic to otherwise meaningless statistics, logs and status reports.



Project Manager Mission Command invited six network defenders from the 82nd Airborne Division to take part in a Tactical Defensive Cyber Operations Infrastructure (TDI) user jury at Aberdeen Proving Ground last year. TDI, which is hosted on the Army's new Tactical Server Infrastructure v2 server stacks, enables key cyber tools including Cyberspace SU. (U.S. Army)

To further support multi-domain operations, Cyberspace SU will integrate with and converge onto the Army's Command Post Computing Environment, also known as CPCE, as an application that brings situational understanding of the cyberspace domain, EMS and information environment to the commander's common operational picture as overlays. These overlays are also customizable, allowing warfighters to depict the three-layers of cyberspace – physical, logical and cyber-persona – in conjunction with the other operational domains.

## DEVELOPMENT LOOKING AHEAD

Current Cyberspace SU efforts include integrating vendor solutions into experimental exercises such as Cyber Quest and Cyber Blitz, both which represent annual opportunities for vendors to interact with tactical, networked systems for evaluation and risk mitigation purposes. These events allow vendors to showcase innovative technologies, including both hardware and software solutions, while warfighters sit alongside the vendors' engineers to evaluate their systems and provide feedback for system improvement. This Developmental Operations, or DevOps, environment allows the program to adapt with speed and implement iterative capability enhancements through regular user engagement.

The many Cyberspace SU stakeholders are as varied as the systems and programs of record with which it will integrate. They include FORSCOM (user), Army Capability Managers (user representatives), the Army's C5ISR Center (research and development) and other program managers for Cyberspace SU: EWPM, DCGS-A, WIN-T and CPCE to name just a few.

The program office, Product Lead Mission Command Cyber, is currently working with the System of Systems Consortium on challenge-based acquisition to spur technology from the cyber exercises leading to a Cyberspace SU prototype award this spring. This approach allows the product office to deliver a demonstrated prototype to the warfighter while quickly increasing capability overtime.

A total of 40 whitepapers submissions from industry have been evaluated leading to several invitations to the final acquisition challenge to validate capability on the current Tactical Server Infrastructure, leading to a prototype contract award in late-March. The vision is to partner with a CPCE unit to incorporate feedback from the user as we build a capability we can field within 18 months. ■

## FORGING FUTURE WEAPONS MATERIAL EVOLUTION

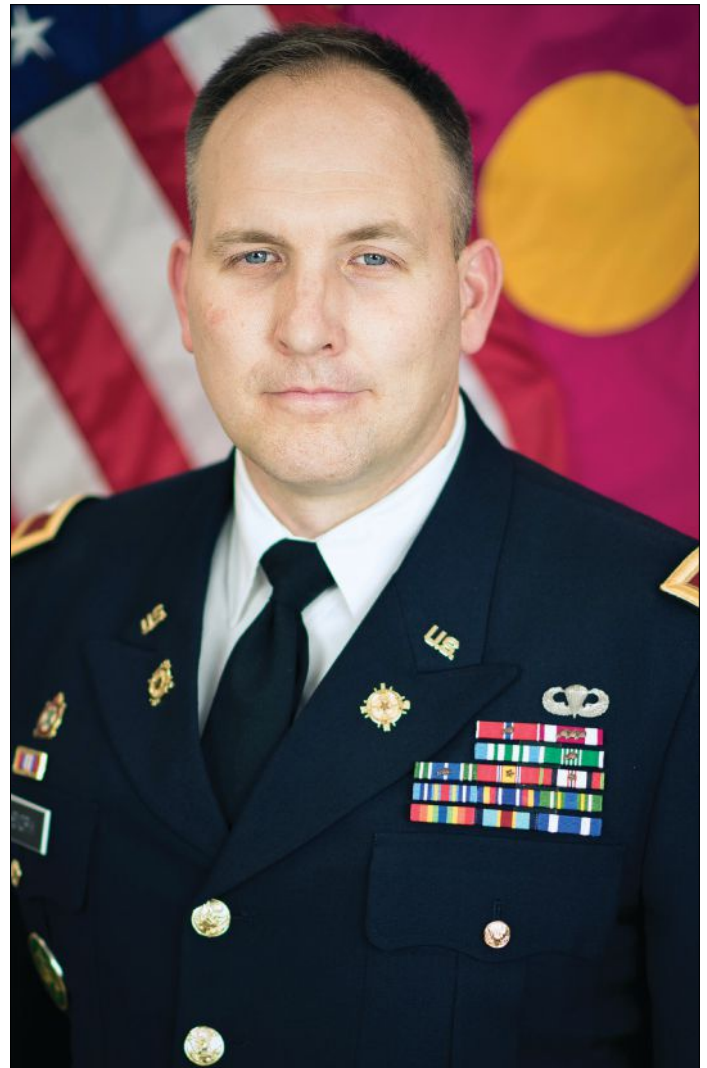
*Colonel Martin James “Jimmy” Hendrix III serves as the 50th commander of the Rock Island Arsenal Joint Manufacturing and Technology Center (RIA-JMTC), a position he has held since May 29, 2019. As Commanding Officer, Colonel Hendrix oversees operations of a multi-purpose and vertically integrated metal manufacturer in the Department of Defense, applying the unique technical expertise and equipment to manufacture products high in quality and sustainability.*

*Colonel Hendrix completed the Reserve Officer Training Course at Appalachian State University and was given a Regular Army commission as a 2LT in the Ordnance Corps on the 11th of August 1996.*

*Since his commissioning, he has performed unit leadership duties ranging from platoon leader to battalion commander. In addition to leading Army formations, he has served in various positions as a staff officer, an instructor, an aide de camp, and an executive officer.*

*His prior units of assignment include: the 227th Maintenance Battalion, 264th Corps Support Battalion, 498th Combat Sustainment Support Battalion, 3d Armored Cavalry Regiment, U.S. Army Logistics Management College, U.S. Army Ordnance School, 3rd Sustainment Command (Expeditionary), 19th Sustainment Command (Expeditionary), 1st Sustainment Command (Theater), 8th U.S. Army, United States Forces Korea, Combined Forces Command, Korea, and the Army Staff.*

*His most recent assignments include Battalion Commander of the Army Field Support Battalion – Bragg, the Chief of the Personnel Development Office, U.S. Army Ordnance School, and the Assistant Chief of Staff for Support Operations, 3rd ESC. COL Hendrix has served overseas in Afghanistan, Iraq, and the Republic of Korea. His stateside assignments include duty at Fort Bragg, Fort Lee, and Fort Carson as well as at the Pentagon.*



### COL Martin Hendrix

Commander  
U.S. Army Rock Island Arsenal  
(RIA)

*A&M had the opportunity to speak with COL Martin Hendrix, Commander, U.S. Army Rock Island Arsenal (RIA), IL, regarding focus areas of RIA's Joint Manufacturing Center in promoting combat weapons material readiness of tomorrow.*

**A&M: The Rock Island Arsenal – Joint Manufacturing and Technology Center, or RIA-JMTC, is one-of-a kind in the Department of Defense because all the manufacturing capabilities and processes under one roof. What are some of those capabilities?**

**COL Hendrix:** RIA-JMTC's capability set is unlike any other due to all of the capabilities we have located under "one roof." We are home to one of the few foundries and forges in the DoD. That gives us the capability to melt raw metal and cast it into near net shape parts or forge extremely strong metal components. We have more than 1,000

machines that give us the ability to turn, mill, grind, saw, drill, laser cut, water jet, and hone in order to create parts ranging from small springs to several thousand-pound armor kits.

We can weld, heat treat, plate, and paint significant volumes of material. We also have in-house rapid prototyping, engineering and laboratory services, non-destructive testing and pliable materials fabrication.

On top of all of our traditional manufacturing competencies, in 2019, we opened the Army's Advanced Manufacturing Center of Excellence which has provided us the ability to 3D print both polymer and metal parts.

**A&M: The Army designated RIA-JMTC as the Advanced and Additive Manufacturing Center of Excellence. How are you using this advancing technology to meet the needs of the Army and other customers?**

**COL Hendrix:** RIA-JMTC was designated as the Center of Excellence



in the spring of 2018 and reached initial operating capability the following spring. It is projected to reach full operating capability in 2021.

Advanced manufacturing (AM) is the combination of any new, innovative technology with traditional manufacturing to improve products or processes. Examples include additive manufacturing (e.g. 3D printing), robotics, artificial intelligence and composite materials. This is a modernization of our infrastructure, training, processes and skillsets to support next-generation capabilities. Modernization of the Army's Organic Industrial Base must keep pace with the modernization of the Army's equipment. The OIB must have the upgraded facilities and machinery necessary to manufacture, retool and maintain the next-generation of technology and equipment.

RIA-JMTC is leveraging the full potential of advanced manufacturing to enable modernization and readiness objectives. Obsolete parts, diminishing sources of supply and sustained global operations challenge Army readiness.

#### Advanced manufacturing enables:

- Increased system performance through lighter and stronger materials.
- Decreased design limitations imposed by traditional methods. Design for performance, not manufacturability.
- Production of complex components as one piece, reducing failure points and increasing reliability.

- Reduced development time by rapidly producing prototypes and quickly transitioning them to production.
- Rapidly scaled production to field greater quantities of systems faster.
- Collaboration with innovative vendors on cutting edge technologies.
- Transformed industrial operations to increase efficiencies on the factory floor.
- Strengthened the commercial industrial base to compete against the threat of near peer adversaries.
- Reduced risk of obsolete parts and diminishing sources of supply.

Currently, the CoE is developing a variety of methods to meet the needs of RIA-JMTC's customers. Internally, this technology is being used to create tooling and fixtures to assist in conventional manufacturing techniques, which assists in making subtractive manufacturing more efficient. RIA-JMTC is also conducting prototyping to design parts for testing which are lighter or more intricate than conventional manufacturing can produce. This includes using additive manufacturing to create molds with a printed part. Printed parts are already being shipped to the field to support the supply chain. These are hard-to-source parts but are still tested to ensure they are safe, suitable, and effective before incorporation into the system.

Another initiative with AM is to develop the digital thread. This thread will be the repository for Warfighters in the field to fabricate a

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Prototype parts are 3D printed in the new Advanced and Additive Manufacturing Center of Excellence to trouble shoot the machines at Rock Island Arsenal - Joint Manufacturing and Technology Center, Rock Island Arsenal, IL. (U.S. Army photo by Debralee Best/RIA-JMTC)

part when needed. The challenge Army agencies are working through is ensuring this system is secure as well as building the repository as parts are tested and approved to be manufactured through additive means.

**A&M: As a critical installation for the management and supply of the Army/Joint DoD weaponry, How Does RIA-JMTC help maintain DoD readiness?**

**COL Hendrix:** Everything we produce at the JMTC is directly tied to either maintaining readiness of current DoD systems or helping develop new Joint Force capabilities.

While private industry will ultimately always be a larger provider of readiness for DoD, the private sector is ultimately driven by profit. This creates many situations where parts for aging systems become impossible to find in the private sector because they have become unprofitable to produce.

JMTC has the ability to both manufacture from technical data packages and reverse engineer parts in order to support the readiness supply chain when no other organization can or will. We are also leveraging our new AM capability to print parts for readiness. 3D printing is a perfect capability for rapidly producing small quantities of hard to find components.

RIA-JMTC continues to adapt manufacturing processes to include emerging technologies that contribute to stock availability and readiness for the Warfighter.

**A&M: In terms of manufacturing, how is RIA-JMTC working to meet DoD force goals at or below cost requirements?**

**COL Hendrix:** The single best way a manufacturing organization can improve schedule delivery and quality while driving down costs is by executing a Continuous Process Improvement (CPI) program that is based on Lean Manufacturing (LM) tools. LM is a method of process improvement that empowers both leaders and the workforce to make radical change and solve the problems that are standing in the way of high performance. Lean is not about small incremental changes. Lean organizations are constantly looking for ways to make huge improvements. Lean consultants, which are often referred to as "Sensei" train organizations to look for ways to get rid of "half the

bad" or to "double the good". RIA-JMTC has a great history of success employing Lean, however our CPI program had atrophied over the last decade.

Over the last six months, the RIA-JMTC team has rededicated the organization to continuous process improvement through Lean. We have employed a Lean private consulting team and we have grown our own CPI team back to a level that will allow us to aggressively increase the pace of rapid improvement events. We have created an organizational transformation plan and have established our Ambulance line as our 1st model values stream. This foundational work will be used to spread Lean tools and thinking throughout the organization, ultimately making us better and more cost effective.

**A&M: From a partnering perspective, talk about any notable relationships RIA-JMTC has/is cultivating with industry and other entities?**

**COL Hendrix:** Creating partnerships is a great way to leverage strengths and spread institutional knowledge across organizations. RIA-JMTC has great partnerships with other Army and DoD organizations as well as with private industry and academia.

JMTC has long partnered with the Watervliet Arsenal in the manufacturing of towed artillery systems. WVA's cannon tube production pairs perfectly with our own artillery system and component manufacturing. We also have longstanding partnerships with Combat Capabilities Development Command's Engineering Support Activities (formerly Defense Engineering Centers). Their ability to find engineering solutions to military problems and pass those solutions to RIA-JMTC for manufacturing is a recipe for great success in providing both readiness and modernization to the force.

Partnering with private industry is a great way to help DoD arsenals and depots stay relevant. Private industry often leads the way in leveraging new technology and is typically more nimble in supply chain management due to the need for government agency adherence to the Federal Acquisition Regulation. We are currently partnered with AM General to produce the M997A3 HMMWV Ambulance. RIA-JMTC manufactures the ambulance enclosure with AM General provided materials and mounts them on the HMMWV. This partnership allows us to take full advantage of their supply chain.

We are leveraging partnerships to help us move the ball in additive manufacturing. We currently have a RIA-JMTC employee attending and internship with Honeywell. There our Engineering Tech is learning industry leading, AM manufacturing techniques.

RIA-JMTC is also involved with the local community and academia. We have long partnered with Western Illinois University in the creation and sustainment of the Quad City Manufacturing Lab (QCML), which is located here at RIA-JMTC. QCML has been developing AM techniques and training students on this technology for more than decade. Prior to our own AM Center of Excellence, we have utilized them to help with manufacturing solutions and create tooling for our machines that could not be accomplished through traditional manufacturing efforts.

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# INTELLIGENT AUTONOMOUS GROUND MOBILITY

Recognizing the need for autonomous ground systems to operate in the unknowns of a mission, the U.S. Army is making investments in ground vehicle mobility modeling and simulation (M&S) to improve and prepare for future off-road operations. Army engineers and scientists are working diligently and purposefully to shape future operational capabilities and, as a ground force, remain ready and resilient.

By Dr. David Gorsich, CCDC GVSC and Michael Letherwood, Alion Science & Technology



A depiction of ground combat vehicles operating in unknown terrain. Army Ground Vehicle Systems Center (GVSC), Warren, MI, is working with NATO to mitigate future chances for platform immobilization leading to catastrophic mission failure. (U.S. Army)

As the Army looks to the future, there is an opportunity for the ground vehicle community to help shape the unique role of land forces in achieving national security objectives. As intelligence, surveillance, target acquisition, and reconnaissance capabilities are rapidly developing, assured mobility becomes even more important. In 2016, Chief of Staff of the United States Army Gen. Mark A. Milley stated that "On the future battlefield, if you stay in one place longer than two or three hours, you will be dead. With enemy drones and sensors continuously on the hunt for targets, there won't even be time for four hours of unbroken sleep." The Army's future force must be able and ready to be called upon for a variety of missions so it must be ready to apply land power/ground forces toward achieving strategic outcomes across the full range of military operations. Development and deployment of autonomous weapons systems generally point to several military advantages such as acting as a force multiplier, and, more importantly, may require fewer warfighters for a given mission. As depicted in figure 1, when vehicles become immobilized, troops are put at risk and the mission is jeopardized.



Figure 1. Vehicles getting immobilized by terrain conditions

Unlike commercial autonomous systems, the military must operate in unknown and unstructured environments where roads may not exist but the supplies must reach the front lines. On the battlefield, mobility is the key to survivability and it's crucial for commanders to know which vehicle to deploy on what terrain. Commanders need to have the ability to assess their own and opposing forces vehicle mobility in the area of operations, which will increase confidence in mission planning and reduce the risk of mission failures due to compromised vehicles. The U.S. Army's Combat Capabilities Development Command (CCDC) Ground Vehicle Systems Center (GVSC) strategy provides an overarching framework to develop, integrate and sustain advanced manned and autonomy-enabled ground system capabilities for the current and future force.

## ADVANCING AUTONOMY

For ground autonomous mobility, GVSC has shown the potential superior mobility of autonomous ground vehicles over tele-operated vehicles and is implementing a roadmap towards assessing autonomous mobility through M&S. GVSC is developing an understanding of how to leverage autonomy and autonomous systems - understanding not only the technological value of these new capabilities, but also how the off-road mobility has a huge impact on successful autonomous operation

and mission completion. Autonomous systems and autonomy-enabled manned ground platforms are enabling capabilities that provide force multiplication (figure 2) to warfighting functions.



Figure 2. Utilizing autonomous systems as force multipliers (unmanned smaller vehicles)

Mobility is regarded as a vital component of autonomy. These capabilities are major objectives of GVSC's research and development programs as it continues to collaborate with its partners to integrate technologies and develop advanced capabilities that improve warfighter effectiveness and efficiency. The emergence of intelligent ground vehicles and their dependence upon quantitative analysis of mobility has infused terrain vehicle systems M&S with a new relevance and broader scope than ever before. Mobility metrics and analysis for robotics and vehicle intelligence (VI) is a very active and prolific research area and is an essential element of M&S from two application perspectives: 1) inclusion of robotics and VI in mobility metrics and assessments for operational planning, acquisition, and design; 2) embedding M&S models and metrics into robots and VI algorithms because they are standards for mobility assessment and decision making.

## EVOLVING ANALYTICAL M&S MOBILITY CAPABILITIES

The objective is to generate models and data products for predicting vehicle performance that can be used to plan and execute desired mission scenarios over specified regions. Beyond operational use, these capabilities can be used for autonomous vehicle development as well as the acquisition process. The current mobility assessment methodology is called the NATO Reference Mobility Model (NRMM) and is a simulation tool aimed at predicting the capability of a vehicle to move over specified terrains. It's empirically based and developed using decades-old data and technology, but it is also broadly understood to be theoretically limited and difficult to adapt to contemporary vehicle design technologies and to implement within modern vehicle dynamic simulations. "The current model is outdated, it's old, but it's still useful for current systems that are different nowadays" according to GVSC's Chief Scientist, Dr. David Gorsich. "Our vehicles have stability control systems, tire pressure systems, etc. and all those systems make a difference in your off-road mobility, and we really do need to update M&S capabilities and standards to be able to predict those types of things. Also, high performance computers and simulation have come a long way since the 70s that allows the implementation of complex soil mechanics where the physics of the soil and the interaction of vehicle and soil are being considered (figure 3). There's a lot that can be done if we understand the variability in the soil and the terrain when predicting mobility."



Figure 3. Simulation of Tracked Vehicles in Soft Soil Terrains

Dr. Gorsich further added, "The NATO reference mobility model is so important, from an acquisition perspective, that when we buy systems we need to understand

how good they are from a mobility perspective. But also in operation, we need to understand how well a vehicle can go from point A to point B and can it carry out this operation with this vehicle or a set of vehicles." To address the problem, GVSC researchers and engineers partnered with a NATO Research Task Group (RTG), which consisted of 70 members from 15 nations, to develop a Next Generation NATO Reference Mobility Model (NG-NRMM). NG-NRMM is defined to be any M&S capability that predicts land and amphibious vehicle mobility through coordinated interoperation of Geographic Information Systems (GIS) software and multibody, physics-based vehicle dynamics M&S software. NG-NRMM is a new capability that lacks extensive experience and maturity and its' development involves rapidly evolving technologies and scope. The physics of vehicle-terrain interaction is better understood today due to the advancement of M&S capabilities. As depicted in figure 4, the goal is to place the physics-based mobility software at the center of the geospatial terrain data and soil maps so that mobility performance metrics such as a Go/No-Go map (which will be explained later) can be derived. This mobility metric can be used in the acquisition process and in operational planning as is done today using NRMM.

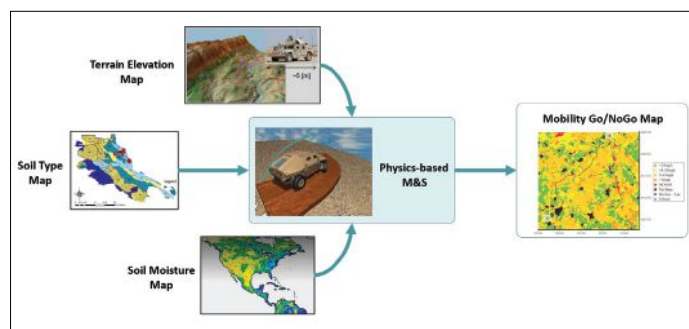


Figure 4. NG-NRMM Terramechanics Modeling

The M&S software must be capable of utilizing terramechanics to properly assess vehicle-terrain soft soil interactions, incorporate capabilities to portray autonomous control systems, and include uncertainty quantification (UQ) to enable probabilistic M&S. Terramechanics modelling is focused on vehicle terrain interaction that accounts for soft soil (i.e. deformable soil) effects on mobility. NG-NRMM has the potential to significantly reduce procurement risks enabling alternative solutions to be considered and will also provide operational decision makers with a tool for assessing their own and opposing vehicle mobility in the area of operations, which will increase confidence in mission planning and reduce the risk of mission failures due to compromised vehicles. "This research could prove relevant when it comes to the change in the character of warfare, the kinds of operations that NATO member states have been part of, as well as due to technology developments," said Marta Kepe, a Rand think tank analyst specializing in defense, security, and infrastructure. A myriad of other complexities complicate the movement of military land platforms across Europe, including "the conditions of transport infrastructure; multinational, cross-border and national level-movement coordination, including between military users of infrastructure and the civilian managers; and national legal requirements," Kepe added. The vision is to reach a point where nearly all virtual prototyping and operational effectiveness can be determined up front leading to rapid fielding of technology with a clear understanding of the operational capability of the technology. NATO Secretary General Jens Stoltenberg,



Dr. David Gorsich



in speaking before the alliance's Parliamentary Assembly on May 28, 2019 said NATO's security "does not just depend on the forces we have deployed, but it also very much depends on our ability to move forces to reinforce quickly if needed." The goal of M&S investments is to minimize the need to build physical prototypes, and to fill the gaps in our mobility M&S capabilities especially for autonomous operations.

## NG-NRMM SOFTWARE

For effective autonomous navigation, NG-NRMM software tools must be capable of predicting a real vehicle's mobility results on any given terrain map to support operational analysis and mission planning purposes, to include selecting the optimum vehicle path on a terrain map based on the mission requirements. It must also be capable of replicating the existing NRMM output products which includes: Go/NoGo trafficability and Speed-Made-Good (SPG) maps as well as speed limiting reason codes and single-pass/multi-pass results. The output results are in two categories – Go areas and NoGo areas. Go/NoGo maps identify areas where the modelled vehicle can and cannot go. The Go areas are usually portrayed as "green" areas on the map, while NoGo areas are normally portrayed as either "red" or "black" (as seen in figure 5).

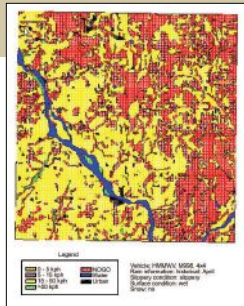


Figure 5. Go/NoGo Map

NG-NRMM also must generate a list of "reason codes" that provide further insight into the causes behind a vehicle's immobilization. These additional insights can shape route planning, choice of a vehicle for a selected mission, and inform vehicle acquisition / modernization decisions. Example reason codes include: inability to negotiate / overcome obstacles; inability

to negotiate vegetation; and inability to overcome soft soil / slope resistances. Lastly, NG-NRMM must be capable of predicting maximum safe speed for each terrain unit. SPG maps enable users to quickly and easily determine the best areas to conduct operations. Other newly desired output metric capabilities also included generating results for vehicle stability/handling, urban manoeuvrability, path modeling, fuel consumption/range estimation, and rut depths.

NG-NRMM is intended to expand the basis of the legacy NRMM to define innovative M&S mobility capability that develops, such as autonomous navigation, and facilitates interoperability with current and evolving M&S capabilities. Figure 6 depicts the flow of data through the NG-NRMM analysis process.

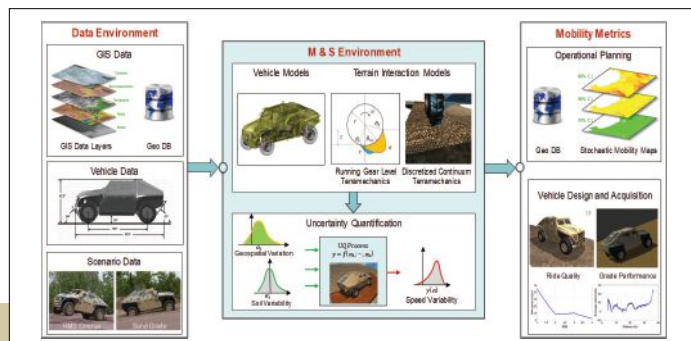


Figure 6. NG-NRMM Software Architecture

First, GIS data is collected and aggregated into a file geodatabase using standard GIS tools and processes. In order to achieve this, the NG-NRMM imports and aggregates remotely-sensed GIS data and generates terrains that can be analyzed in the NG-NRMM vehicle / terramechanical analysis software. The data in the file geodatabase are processed to generate the terrain properties needed by the multibody, physics-based vehicle dynamic M&S software. Capturing the accurate soil mechanical properties such as internal friction and cohesion are critical to evaluating soft soils and for vehicle terrain interaction and this is possible with physics based terramechanics modeling. The multibody dynamic vehicle M&S software executes vehicle runs using the terrain files and generates results for each terrain unit. NG-NRMM compliant software preserves the spatial orientation of the data by linking the results to the original terrain file. Using GIS software, the data can now be visualized to produce spatially-oriented, map products. GIS data is critical to building the required terrains needed to support coalition mission planning and operational effectiveness analyses required for autonomous operations.

Once the prototype software was developed, the RTG conducted a virtual demonstration which was an "end to end software demo" that demonstrated how NG-NRMM adopted new technologies, modelling techniques, and computational tools to enable physics-based simulation of any vehicle design, in complex environments and scenarios. The team also conducted a set of verification and validation (V&V) field exercises, using both a tracked and wheeled vehicles, to evaluate the state of the art terramechanical models.

## LOOKING AHEAD

Even as full autonomy remains the eventual goal, essential to the reliable operation of autonomous vehicles in the field to successfully carry out a mission is the ability to predict its mobility performance and risk over a specified region. Such predictive capability is needed to effectively monitor and guide autonomous vehicles to keep the vehicle safe while meeting mission constraints (e.g., no-go areas) and maximizing performance metrics (e.g., time, speed, fuel consumption). The viable use of autonomous vehicles depends on the development of predictive models and data products that can guide the vehicle safely and effectively in the field. The future of analytical soft soil mobility analysis clearly rests with NG-NRMM as it holds the promise of allowing manufacturers, planners, and users the ability to model virtually any platform, over any soil and terrain type. NG-NRMM is vital to the Army's mission as it will add new capabilities in the design, modeling, and simulation of a broad class of vehicles, with the potential to reduce costs and improve performance. Future intelligent autonomous mobility may involve many different classes and sizes of vehicles such as wheeled/tracked vehicles, small robots, legged robots, humanoid robots, and other emerging technologies traversing a variety of environments that may include on-road, urban, off-road, and building interiors. NG-NRMM could yield a new paradigm for ground vehicle mobility with the possibility to model complex vehicle maneuvers in high fidelity. The mobility performance metric maps generated using this technology are key requisites for consideration of military missions which could succeed or fail depending on how accurately the performance maps are generated. ■

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## COUNTERING MARITIME THREAT EVOLUTION

*CAPT Chris Merwin assumed duties as the Director of the Mine Warfare Division at the Surface and Mine Warfighting Development Center and the Vice Commander, Navy Mine Warfare Battle Staff in October 2016. CAPT Merwin is qualified as an EOD Officer, a Master EOD Technician, a Naval Parachutist, and a mixed-gas diving and salvage officer. He has a master's degree in National Security and Strategic Studies from the Naval War College.*

*Originally from Florida, CAPT Merwin graduated from the University of South Carolina and received his commission through the Naval ROTC program in 1991. After completing initial Surface Warfare and Diving and Salvage training he served at sea aboard the USS BEAUFORT (ATS-2) and at Mobile Diving and Salvage Unit ONE before attending Explosive Ordnance Disposal (EOD) School.*

*Upon designation as an EOD Officer he was assigned to EOD Mobile Unit (EODMU) SIX as an Officer in Charge of a Mine Countermeasures (MCM) detachment where he deployed to conduct underwater mine countermeasures in the Arabian Gulf. He was Operations Officer at EODMU TWO and Executive Officer at EODMU FIVE, where in 2006 he deployed to Iraq as the Officer in Charge of the Combined Explosive Exploitation (CEXC) Cell for Task Force Troy. In 2009 he took command of EODMU TWELVE and deployed the unit to Iraq as the Joint Counter-IED Task Force for U.S. Division North in support of the Third Infantry Division. In 2014 he was assigned as the Deputy Commander at EOD Group ONE where he deployed as the Initial Operational Capability Commander of the Navy Expeditionary Forces Command Pacific and Commander Task Force 75 prior to assuming command of EOD Group ONE. As Commodore he was the EOD community lead for Mine Countermeasures and was instrumental in the development of Expeditionary MCM.*



### CAPT Christopher Merwin

Director Mine Warfare Division  
Naval Surface and Mine Warfighting  
Development Center

Vice Commander, Navy Mine Warfare Battle Staff

*A&M had the opportunity to speak with CAPT Chris Merwin, SMWDC Mine Warfare (MIW) Division Director, regarding some focus areas for the Navy's current and forward-looking objectives for mine warfare readiness in combatting present and future maritime threats.*

**A&M: What operational support does SMWDC MIW Battle Staff provide when a Fleet command requests MIW subject matter experts (SMEs)?**

**CAPT Merwin:** The Naval Surface and Mine Warfighting Development Center (SMWDC) Mine Warfare (MIW) Division provides support to all numbered fleet commanders. The SMWDC Commander, as the globally deployable Mine Warfare Commander (MIWC), assumes combined task-force commander (CTF) duties in theater when required, to include CTF-37 Operational Control (OPCON) to Commander, U.S. Third Fleet (C3F); CTF-37 OPCON remains constantly activated. The SMWDC MIW Division director is dual-hatted, and also serves as Vice Commander of the MIW Battle Staff.

The MIW Division provides full Battle Staff support to major global theater exercises, and smaller Battle Staff cells to multiple exercises in all

theaters of operation to support both live exercises and table-top exercise events. Major global theater exercises include but are not limited to, Commander U.S. Third Fleet (C3F) Rim of the Pacific (RIMPAC), Commander, U.S. Seventh Fleet (C7F) Korea Combined Command Post Training (CCPT), Commander, U.S. Sixth Fleet (C6F) Baltic Operations (BALTOPS), Maritime Homeland Defense Vigilant Shield, and Commander, U.S. Fifth Fleet (C5F) International Maritime Exercise (IMX).

MIW Division attends Concept Development Conferences (CDCs), Initial Planning Conferences (IPCs), Main Planning Conferences (MPCs) and Final Planning Conferences (FPCs) for multiple MIW exercises supporting all numbered fleet commanders. In this capacity they assist with MIW scenarios development, including red and white cell support; inject development; gaming support; intelligence; and force construct.

**A&M: With the convening of the inaugural MIW WTI class this past summer, can you provide some information about the program?**

**CAPT Merwin:** In general, Warfare Tactics Instructors (WTIs) are dedicated to increasing the lethality and tactical proficiency of the Surface Force



across all domains, and enabling Surface Warriors to fight and win the high-end fight. Top-talented junior Surface Warfare Officers apply for the WTI program, and once selected become WTI-candidates, receive training, and become expert warfighting tacticians in one of four Surface Warfare areas. After completing the requisite WTI course of instruction, they become qualified patch-wearing WTIs.

The MIW WTI program consists of a 30-week syllabus, with the majority of training (21 weeks) conducted at the NATO Naval Mine Warfare School in Belgium. MIW WTI candidates complete additional training in San Diego and Norfolk to become acquainted with Aviation and Underwater Mine Countermeasures (AMCM and UCM) capabilities.

Qualified MIW WTIs will integrate and learn alongside SMWDC's AMW Division in Little Creek to understand the linkages in planning and execution with amphibious operations. MIW WTIs may be assigned to positions in Belgium, Norfolk, San Diego, or Mayport.

## A&M: What is the MIREM program?

**CAPT Merwin:** MIREM is the Mine Warfare Readiness and Effectiveness Measuring (MIREM) program. The MIREM program collects data and conducts analysis to assess the readiness and effectiveness of in-service MIW systems, sensors, personnel, command & control structures, and tactics. It then provides decision makers access to data and analysis to weigh decisions on proposed improvements to existing systems or development of new systems.

MIREM data and analysis further informs evaluation of next gen-

eration systems of emerging technology in support of the MIW mission. Planners and model builders use this real-world data to produce realistic performance characteristics in simulations.

The Commander, Surface Warfare Development Group initiated MIREM in 1995, (OPNAV) N85 Expeditionary Warfare, chartered MIREM in September 1996. Today, OPNAV N95, director of Expeditionary Warfare, provides oversight of CNO staff responsibilities pertaining to amphibious lift, mine warfare, naval fire support, and other missions essential to Expeditionary Warfare, and leads the planning, programming and budgeting for acquisition, operational readiness, and modernization of the Navy's broad portfolio of Expeditionary Warfare capabilities.

The Navy conducted 36 MIREM events across nine distinct locations between 1996 and 2009. The program was suspended in 2009 due to ineffective leveraging of feedback to facilitate fleet improvements.

Established in 2015, SMWDC MIW Division assumed MIW leadership and subject matter expert roles during the deactivation of Commander, Mine Warfare Command (COMINEWARCOM). Senior Navy leadership in 2017 re-established the readiness and assessment program for MIW, and restored the program in 2018. MIREM event 18-1, conducted on the East Coast, was an Aviation Mine Counter Measure (AMCM) Sea Wall Sweep assessment and was the only event conducted in Fiscal Year 2018. The feedback and lessons learned were documented and shared with the AMCM community. The results recommended changes to the current Naval Air Training and Operating Procedures Standardization (NATOPS) program procedures and sweep tactics.

Fiscal Year 2019 saw the execution of one MIREM event. Event 19-1



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## ■ MINE WARFARE INCREASING LETHALITY AND TACTICAL PROFICIENCY

conducted an evaluation of SQQ-32 Mine Hunting Sound Navigation and Ranging (SONAR) Through-the-Sensor software on a Surface Mine Countermeasure (SMCM) platform in the C5F operating area in conjunction with CTF-52 staff. The results validated that the use of software maximizes sonar performance and were documented and shared with Mine Countermeasure Squadron (MCMRON) Five and MCMRON 3 staffs.

In Fiscal Year 2020, two events are planned for execution. Event 20-1 is a C7F Intelligence Preparation of the Environment (IPOE) assessment in the Korean Theater, planned for spring 2020. Event 20-2 is a near surface system and tactics assessment planned for early summer 2020 in the C6F theater that will assess Airborne Laser Mine Detection System (ALMDS) from an MH-60S Seahawk platform, and a Mark (MK) 18 Mod 2 Undersea Unmanned Vehicle (UUV) with an integrated Autonomous Topographic Large Area Survey (ATLAS) SONAR.

### A&M: What are the primary objectives of the MIREM program?

**CAPT Merwin:** The MIREM program seeks to quantify and recommend Doctrine, Organization, Training, Material, Leadership and Education, and Personnel and Facilities (DOTMLPF) improvements. MIREM involves current program assessments, weapons proficiency assessment, development and validation of MIW tactics, and techniques and procedures (TTP). Additionally, MIREM drives Concept of Operations (CONOPS) and Tactical Memo (TACMEMO) review and improvements, assessing viability of emerging technology, next generation concepts, and future naval capabilities.

### A&M: Who are the key MIREM participants? What is their role?

**CAPT Merwin:** Office of the Chief of Naval Operations (OPNAV N95) Expeditionary Warfare is the Resource Sponsor. Other participants include SMWDC MIW Division as the Executive Agent, Program Executive Office Unmanned and Small Combatants (PEO USC) and Program Management Systems (PMS) 495 Mine Warfare Systems as the Financial Manager.

Naval Surface Warfare Center (NSWC) Panama City Detachment manages data collection and leads data analysis. Fleet organizations across the MIW continuum – (names of Fleet organizations) are involved in planning and execution of MIREM events.

### A&M: What is the way ahead for the MIREM program?

**CAPT Merwin:** In Fiscal Year 2021, the funding line shifts from PMS 495 to the Fleet with three events planned for execution. SMWDC will become the Funding Manager, and will award a new Resource Efficiency Management (REM) contract to support data collection and analysis efforts. The goal is to finalize 5-year execution plans to get ahead of the planning, and to conduct a Concept Development Conference for Fiscal Year 2021 in February 2020.

Ultimately, the goal is to provide a formalized readiness and assessment program to improve Fleet tactics and inform system and sensor performance. This will further enable development, refinement and validation of current tactics, techniques, and procedures.

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# PROJECTING LONG-RANGE POWER AND PAYLOAD



An Air Launched Effects launches from a UH-60 Blackhawk over Yakima Training Center, Wash., during Joint Modernization Command's Joint Warfighting Assessment 2019. The Science and Technology demonstration was a partnership between the Future Vertical Lift Cross-Functional Team and the Aircraft Development Directorate. (Photo by CCDC AvMC)

*A&M had the chance to speak with the Future Vertical Lift Cross Functional Team (FVL CFT), U.S. Army Futures Command, regarding current and forward-looking goals and focus areas for the future of Army helicopter capability.*

**A&M: Provide brief background on Army requirements and current evolution on the first of five Capability Sets for FVL.**

**FVL CFT:** Army Aviation leaders several years ago wisely invested in the Joint Multi-Role Technology Demonstration Program to develop leap ahead vertical lift technologies. The JMR-TD efforts have successfully demonstrated significant capabilities culminating in FY19 with two flying tech-demonstrators; Bell V-280 Valor and Sikorsky/Boeing SB-1 Defiant. Both have received an extension to fly in FY20 with Valor reaching speeds of ~300 ktas and Defiant ~130 ktas. The knowledge learned from these technical demonstrators have informed requirements for FVL platforms allowing for accelerated development of Army Aviation's next generation of future vertical lift aircraft.

**A&M: From a medium-size assault/utility perspective, how will FVL provide greater offensive and transport capabilities for rapid zone entry/exit?**

**FVL CFT:** Future Long Range Assault Aircraft (FLRAA) is the next generation Lift, Assault, and medical evacuation (MEDEVAC) aircraft that integrates new technology, materials, and designs that increase speed, range and payload. The FLRAA (CS3) is intended to replace the UH-60. FLRAA will see increased speeds of more than twice the current fleet and endurance of up to three times the distances we're capable of today. These increased capabilities will allow FVL to maintain vertical

lift dominance over peer and near peer adversaries in all phases of Multi-Domain Operations (MDO) and for FLRAA specifically in the exploitation phase.

**A&M: From a long range advanced aircraft perspective, how does FVL design offer greater capability in increased endurance reconnaissance?**

**FVL CFT:** Future Attack Reconnaissance Aircraft (FARA) harnesses the technological design advancements in vertical lift bringing increased lethality, speed, agility, and survivability against our near-peer threats. As the aerial reconnaissance gap replacement, FARA will find, fix, and finish the enemy's defensive systems through a robust family of aerial vehicles comprised of the FVL ecosystem. Armed with advanced long range precision munitions and air launched effects, FARA will be fine-tuned for reconnaissance, surveillance, and target acquisition as an integral part of a Joint All-Domain force.

**A&M: What are some current milestones (recently achieved/coming) for FVL going forward?**

**FVL CFT:** Following a series highly successful experimentations/demonstrations firing Long Range Precision Munitions (LRPM) going 9 for 9 on Spike missile shots from a maneuvering AH64 at MDO relative altitudes of ~100' AGL clearing terrain as high as 1600' to hit targets at MDO relative distances as long as 32km day, night, and moving targets an Army Directed Requirement was developed to provide Spike as an interim Long Range Precision Munition (LRPM) capability to the force in FY23. Follow on LRPM developmental work begins in FY20 for a more permanent solution.



In August 2019, the Future Vertical Lift Cross-Functional Team and Aircraft Development Directorate-Fort Eustis conducted a Long-Range Precision Munition during an experimentation in Yuma Proving Ground, Ariz. (Photo by FVL CFT PAO)



A Long-Range Precision Munition fired from an AH-64E Apache Helicopter successfully destroyed its target during a 2019 experimentation in Yuma Proving Ground, Ariz. (Photo by FVL CFT PAO)

FLRAA Competitive Demonstration and Risk Reduction efforts for FY20 to reduce risk and inform the refinement of requirements and acquisition approach prior to the program of record scheduled to begin in FY22. The U.S. Army solicited for the Future Long Range Assault Aircraft (FLRAA) Competitive Demonstration and Risk Reduction (CD&RR) via the Aviation and Missile Technology Consortium (AMTC) Other Transaction Authority (OTA). The CD&RR phase one is for delivery of an initial conceptual design to include all substantiating technical documentation to support the design, requirements decompositions, trade studies, and requirements

feasibility with contract award anticipated by April 2020.

FARA Competitive Prototype efforts are underway with five industry partners submitting engineering designs for the future scout helicopter again under an OTA that will see two selected to continue on and build prototypes beginning in FY20 with a fly-off scheduled for FY23. These prototypes will provide the Army with critical data to determine the requirements for FARA and deliver capabilities to soldiers sooner rather than later. As senior leaders have recently commented, we're going to "fly it before we buy it."

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# SOLDIER-LEVEL SITUATIONAL AWARENESS

By Cale Teeter-Gregg, goTenna, Inc.

Individual attention to providing each soldier with the tools, skills, weapons, and technologies necessary to succeed has made America's military the most effective and capable in the world. Unfortunately, this granular focus on every single soldier doesn't extend to situational awareness. That's because our military doesn't really have the ability today to see exactly where every single soldier is located.

Why does the world's most advanced fighting force lack this level of insight and awareness?

## UNIT LEVEL AWARENESS, NOT SOLDIER

Today's military-grade radios are incredibly adept at delivering connectivity, advanced communications capabilities, and situational awareness for the military. But they're large, difficult to use, – and often, extremely expensive. Ultimately, not every soldier can bear having a giant radio or a full satellite terminal on their back. And the military can't afford to give them all one. So, with logistics and cost control in mind, the military has elected to predominantly distribute these radios to team leaders. But that prevents command from having a truly accurate, individual soldier level of awareness of the battlefield.



Cale Teeter-Gregg

Here are some examples of the kinds of trouble that can be caused:

**Dropping Ordinance** – many maritime and land skirmishes receive air support. If the situational awareness of the leaders calling for air support and the aircraft providing it is at the unit level or brigade level, there's a better chance that not all individual soldiers are safe from friendly fire.

**Airborne Infantry** – when warfighters jump out of planes, there's a good chance that they'll wind up somewhat scattered on the ground. If there is only one radio for an entire unit, it could be difficult to find and recover all airborne troops in a timely fashion.

**Injured Soldiers** – as teams are leaving a target area, they may find that people are missing, forcing them to go back into the target area and re-engage the enemy. This exposes the rest of the team to danger to look for the missing soldier. But what if another team found the injured and carried them out? With greater situational awareness, they'd know where each soldier was and could potentially avoid re-engaging the enemy needlessly.

## ONE SOLDIER, ONE NODE

There is a solution that can give military leaders a better, more granular level of detail in their situational awareness: goTenna Pro. goTenna Pro's advanced mobile mesh networking solutions are significantly less expensive (less than 10 percent of the price of larger, military-grade radios) and extremely small. This means that they can be deployed to each and every individual dismounted soldier.

When utilized, the mesh node connects with a warfighter's end user device either via a physical USB tether connection or low-output Bluetooth. It requires no existing infrastructure or network hardware be implemented or installed. All location and messaging data is then displayed in compatible mobile apps like ATAK, delivering soldier-level situational awareness. Since each mesh node effectively accepts and then rebroadcasts the signal to other nodes, by simply attaching a node to any number of military platforms – such as weather balloons or unmanned aerial vehicles (UAVs) – coverage can extend to a wide geographic area.

With goTenna Pro's mobile mesh networking solution, there is no reason for only brigade-level or unit-level situational awareness when transparency can be enabled down to the individual warfighter.



Soldier carrying a goTenna Pro advanced mobile mesh networking solution. (goTenna, Inc)

## MODERNIZING FOR RAPID INTEGRATION AND SYNCHRONIZATION

*Colonel John S. Brewer is a native of Laurel, Mississippi. He received a Bachelor of Science degree in Agriculture from Mississippi State University in 1994 and a Master of Science degree in Management from Troy State University in 2004.*

*COL Brewer began his military career in the Mississippi Army National Guard in 1990 as a Cannon Crewmember in Alpha Battery, 4/114th Field Artillery. Upon receiving his commission as a Second Lieutenant from the Mississippi Military Academy in 1992, he served as Fire Direction Officer and Forward Observer in Bravo and Charlie Batteries, 4/114th FA. The battalion was reorganized as the 1-204th Air Defense Artillery in 1994 and he served in various duty positions including Platoon Leader, Battery Executive Officer, Battery Commander, Battalion S1, and Battalion S2.*

*COL Brewer joined the Active Guard and Reserve Program in 2000 as the Training Officer for the 1-204th ADA. Upon his promotion to Major, he was assigned to the 168th Engineer Brigade as Brigade S1. He deployed with the 168th to Afghanistan in 2009 in support of Operation Enduring Freedom as Brigade S4. Upon redeployment, he returned to the 1-204th ADA as Battalion Executive Officer and full-time Administrative Officer. He deployed with the 1-204th ADA to Iraq in 2011 in support of Operation New Dawn as Battalion S3. He was next assigned to the Recruiting and Retention Battalion serving as S3 and Deputy Commander. After serving briefly as the G1 Operations Officer for Joint Force Headquarters, Mississippi, he was promoted to Lieutenant Colonel and assigned to 66th Troop Command where he served as S1 and full-time Chief of Staff. COL Brewer's last duty assignment with the Mississippi Army National Guard was as Battalion Commander, 1-204th ADA. He currently serves as Chief of Staff for the Air and Missile Defense Cross Functional Team, Army Futures Command.*

*COL Brewer's military education includes the Field Artillery Officer Basic Course, Air Defense Artillery Officer Advance Course, Engineer Captain's Career Course, Military Intelligence Officer Transition Course, Human Resource Officer Course, Support Operations Officer Course, Combined Arms and Services Staff School, and Command and General Staff College.*

*COL Brewer's awards and decorations include the Bronze Star Medal with one oak leaf cluster, Meritorious Service Medal with two oak leaf clusters, Army Commendation Medal with two oak leaf clusters, Army Achievement Medal with two oak leaf clusters, Afghanistan Campaign Medal and Iraq Campaign Medal both with campaign stars, Mississippi Magnolia Medal with one oak leaf cluster, Combat Action Badge, and the Basic Strength Maintenance Badge as well as numerous other awards and decorations.*

*COL Brewer currently resides in Lawton, Oklahoma and has two children, Jessica, a dental student at University of Mississippi Medical Center and Ethan, a Junior at Mississippi State University.*



**COL John Brewer**

Chief of Staff

Air and Missile Defense Cross Functional Team  
U.S. Army Futures Command

*A&M had the chance to speak with COL John Brewer, Chief of Staff, Air and Missile Defense Cross Functional Team, U.S. Army Futures Command, regarding some key areas of current mission focus.*

**A&M: Speak to some priority areas that the Air and Missile Defense Cross Functional Team is focusing on to present.**

**COL Brewer:** Since 9/11, the Army has been engaged in a Global War on Terrorism and modernization had taken a back seat. Army leadership realized more emphasis needed to be placed on modernization. With the establishment of Army Futures Command (AFC) and the Cross Functional Teams (CFTs), the Army is rapidly moving in that direction. The Army has six modernization priorities and Air and Missile Defense is in the top five of those priorities. The Air and Missile Defense Cross-Functional Team (AMD CFT) works to reduce or eliminate capability gaps, by rapidly integrating and synchronizing the requirements development process, acquisition process, and resources to deliver Air



and Missile Defense capabilities to the warfighter faster. Our CFT is responsible for four programs, also known as Signature Modernization Efforts. We will continue to focus on these four areas, working to create programs to meet the goals of the Army.

## Our four programs are:

**Army Integrated Air and Missile Defense (AIAMD):** The Army's AIAMD program applies distributed mission command to maximize sensor detection and weapon system engagement capabilities. AIAMD's open architecture maximizes employment flexibility, reduces stress on the Air Defense force and enhances protection of additional critical assets over a larger battlespace. The AMD CFT will help to prioritize future software builds to integrate future AMD components, such as LTAMDS and IFPC, as well as integrate with other Joint Force systems such as C2BMC.

**Maneuver – Short Range Air Defense (M-SHORAD):** M-SHORAD provides the capability to defend maneuvering forces against Unmanned Aerial Systems (UAS), as well as rotary wing and fixed wing aerial threats. As a testament to the rapid acquisition strategy, the first IM-SHORAD prototype was delivered to the government in September 2019 in preparation for developmental testing. An IM-SHORAD prototype was also revealed at AUSA in October 2019. Another prototype was used on the set of ESPN's "College Game Day" show in December 2019 as a feature during the Army/Navy game. All prototypes are currently undergoing various developmental tests.

**Indirect Fire Protection Capability (IFPC):** IFPC provides the capability to defend fixed and semi-fixed assets against sub-sonic cruise missile and UAS threats, with residual capability against fixed wing and rotary wing aircraft. In accordance with the 31 October 2018 and 17 December 2018 reports to Congress, the Army intends to purchase two Israeli Iron Dome batteries as an interim IFPC solution. The Army awarded a contract on 5 December 2019 to procure two Iron Dome batteries. These units will also fulfill the Secretary of Defense certified need for an interim cruise missile defense capability in accordance with the FY19 NDAA.

**Lower Tier Air and Missile Defense Sensor (LTAMDS):** LTAMDS is a critical sensor capability to counter advanced threats and take full advantage of the Patriot Missile Segment Enhancement (MSE). It provides significant improvement over the current PATRIOT radar and lowers Operation and Sustainment (O&S) costs. Source selection activities were completed August 2019 and a single vendor contract was awarded to Raytheon on 16 October 2019. A Fast Start Orientation Meeting was conducted 3-4 December 2019 and was the first milestone payment event, which provided a start-up review of the program 60 days after contract award. Prototype development is ongoing, with six prototypes scheduled for delivery to the Army for testing in 3rd Quarter FY21.

**A&M: With the evolution of counter-missile capabilities, what are some directions of development and fielding you see the CFT taking?**

**COL Brewer:** Overmatch is key when facing an adversarial threat. As technology and tactics evolve, the CFT focuses on modernizing



The Initial Maneuver Short Range Air Defense (IM-SHORAD) system is mounted on a Stryker vehicle and provides the capability to defend maneuvering forces against unmanned aerial systems, rotary wing, and fixed wing aerial threats. (U.S. Army Aberdeen Test Center Technical Imaging Division)

systems to win on future battlefields. There are several on-going Science and Technology (S&T) efforts that AMD CFT, as well as all the CFTs are working on with the Rapid Capabilities and Critical Technologies Office (RCCTO). Some of our primary efforts include Directed Energy (DE) for M-SHORAD and IFPC and Advanced Radar Technologies. Our S&T efforts are primarily focused on improving the future capabilities of the Signature Modernization Efforts in our current portfolio.

**A&M: From an Army Modernization strategy perspective, how do you see the evolution of missile defense in addressing future Multi-Domain Operations?**

**COL Brewer:** The Army's AMD Modernization Strategy provides Combatant Commanders with a flexible, agile, and integrated AMD force capable of executing Multi-Domain Operations (MDO) in support of unified land operations. One of our programs, AIAMD will be one of the Army's contributions to the Joint All Domain Command and Control System (JADC2). Basically, all services are working together to ensure our systems are integrated and we can operate in a joint environment during Large Scale Combat Operations (LSCO).

**A&M: Feel free to talk about other goals/challenges moving forward.**

**COL Brewer:** AMD CFT's mission is to deliver future Air and Missile Defense capabilities to the warfighter faster, cheaper, and more efficiently than we have in the past. So far, we are accomplishing what we were established to do. Our M-SHORAD program is just one example of some of the great things we've accomplished. We've taken that program from concept to prototype in only two years, a process that normally took 5-10 years. Our goal is to continue to synchronize efforts across the AMD enterprise to drive capabilities to the warfighter fast. Our four Signature Modernization Efforts are programs that provide critical Air and Missile Defense capabilities that will fill gaps identified by Army Senior Leaders. These capabilities will one day protect our Soldiers on the battlefield from aerial threats. In a nutshell, AMD CFT is equipping soldiers with more modern resources at a faster rate and allowing them to complete their missions with optimal protection from air attack.

# ENGAGING THE GLOBAL C-IED FIGHT

The North Atlantic Treaty Organization (NATO) Countering Improvised Explosive Devices Centre of Excellence (C-IED CoE) is at the forefront of U.S. and allied global defense against state-backed, IED-employing international terror.

By COL Stephen Kavanaugh, Deputy Director, NATO Counter IED Centre of Excellence



The North Atlantic Treaty Organization Parliamentary Assembly visits NATO C-IED Center of Excellence. (C-IED COE)

The Improvised Explosive Device is a tactical weapon with strategic influence which is why it has been the leading casualty producing weapon against civilians and friendly forces over the last twenty years. While less present in NATO's collective consciousness since the end of the ISAF operation, IED's continue to be used regularly by terrorist and violent extremist groups of all types. 14,700 IED incidents with over 23,400 casualties were reported worldwide between 1 August 2018 and 31 July 2019, with Afghanistan, Iraq, and Syria as particular "hot spots." It is this continued use of the IED, the associated Threat Networks that support them, and most importantly the casualties that occur from their use that drives the work of the NATO Countering-Improvised Explosive Devices Centre of Excellence (C-IED COE).

## POST 9/11 SHIFT

After the 9/11 attacks, NATO recognized that the security environment changed significantly, therefore at the Prague Summit in 2002, the Heads of State and Government decided to establish a high level HQ, Allied Command Transformation in Norfolk, Virginia with its primary role to conduct transformation activities in order to help the Alliance adapt to newly emerging threats. They also decided

to establish Centres of Excellence (COEs) to facilitate this adaptation process. A COE is a nationally or multi-nationally sponsored entity, which offers recognized expertise & experience to the benefit of the Alliance, especially in support of transformation. All COEs are established to focus on the areas of Education and Training, Analysis and Lessons Learned, Concept Development and Experimentation, and Doctrine Development and Standards.

The NATO Countering-Improvised Explosive Devices Centre of Excellence (C-IED COE), located in Madrid, Spain, is one of 25 NATO accredited Centres of Excellence. The NATO C-IED COE was established in 2010 along the pillars of NATO C-IED Doctrine of Defeat the Device, Prepare the Force, Attack the Network, and underpin through Understanding & Intelligence. The mission of the C-IED COE is to provide subject matter expertise in support of NATO, NATO partners, and the international community fight against the IED system, to increase the security of Allied Nations and troops deployed in theaters of operations by reducing or eliminating the threat of IEDs used, in particular but not limited to, by terrorists and insurgents. As the Department Head for C-IED Education and Training for NATO the C-IED COE accomplishes its mission through NATO accredited courses to teach NATO doctrine and standards; Research



& Scientific Projects to facilitate the ever changing technologies and TTPs; Lessons Learned, Technology, and Interagency Workshops to facilitate the sharing of information; supporting NATO and Multinational Exercises to facilitate the training and understanding the operational impacts; supporting Defense Capability Building (DCB) to promote the development of C-IED within Non-NATO partners; and supporting the development of C-IED related doctrine within NATO. Currently there are 12 member nations at the C-IED COE; Spain, as the framework nation, Czech Republic, France, Germany, Greece, Hungary, the Netherlands, Portugal, Romania, Sweden, Turkey, and the United States. Furthermore, there is capacity for additional nations to join and provide their own expertise to the current pool of Subject Matter Experts (SMEs). The CIED COE is also unique in manning SMEs from multiple military services, national law enforcement agencies, and intelligence services.

## RECOGNIZING THE EVOLVING THREAT

Countering IEDs has occurred for decades. Before 9/11, IEDs were used in conflicts by criminals and terrorist groups operating around the world, but with more of the formal focus being within the law enforcement community, not the military. Two notable exceptions were the United Kingdom in Northern Ireland and Spain in their own Basque region. But it was the proliferation of IEDs by insurgent forces in Iraq and Afghanistan against the coalitions that brought the IED and therefore C-IED to the prominence it has today. The C-IED Task Forces that were built such as Combined Joint Task Force (CJTF) Troy in Iraq and CJTF Paladin in Afghanistan allowed Commanders to gain a better understanding of the enemy's "IED system" while building the C-IED approach we know and use today. The structure and capabilities that were brought together under these CJTFs allowed the synchronization of multiple efforts to give senior commanders more and better options to execute operations to defeat our enemies.

When talking about C-IED the key term to remember is the enemy's "IED system", which NATO defines as the personnel, resources and activities necessary to resource, plan, execute and exploit an IED event. Within the C-IED Community of Interest, both in the United States and in NATO it is recognized that C-IED is not only a military function, but requires a comprehensive approach that crosses Joint, Inter-Agency, Multi-Domain and Multinational lines of effort in order to maximize the success of all measures to Defeat the Device, Prepare the Force, and Attack the Network. Some nations both inside and outside of NATO view C-IED as synonymous with Explosive Ordnance Disposal (EOD), or IED Defeat (IEDD); both of which fall under the bigger function of Military Engineering (MILENG) in NATO. This misses the comprehensive approach of C-IED. In both theory and practice, C-IED is a coordinating function that brings together the initial and very important work of EOD/IEDD under the pillar of Defeat the Device. But, it also includes the follow on work of technical exploitation that comes from all the material and evidence recovered from an IED event, and the follow on laboratory analysis both inside and outside of an area of operations. The information that is gained through this analysis is critical and can lead down several follow on paths. One can be research and development for the design of specific tools and equipment or better forms of protection for personnel. Another is actionable intelligence that when fused with



Egyptian Soldiers conducting Level 1 Exploitation of an IED Event during a Bilateral Field Exploitation Course, or BIFEC. (C-IED COE)

operational planning can lead to kinetic or non-kinetic operations against targets that gets after Attacking the Network pillar which is the main effort of the C-IED approach in NATO.

## COUNTERING THREAT NETWORKS

Utilized by the United States and other nations, but not yet formally in the NATO Alliance, is the concept of Countering Threat Networks (CTN). This is where the comprehensive Interagency and Whole of Government approach comes into play because if you can go after the financial, and material resourcing aspects of IED networks you can potentially prevent the IED from being built and emplaced on the battlefield against our troops or civilians.

We know what the impact of IEDs has been in the recent past, and the effectiveness that C-IED has contributed to defeat the IED system, but what about the future? How will advancing technologies, such as 5G and 3D printing, affect the use of IEDs over the next 5, 10 or 15 years, both on the battlefield and in the homeland? How will IEDs potentially be used in a future conflict by a peer adversary, either in conjunction with other hybrid threats, or in support of a conventional military campaign? And therefore, what is the future of C-IED? Will it continue as a separate Function and Discipline within NATO? Will the necessary resourcing be allocated to ensure the manning, training, and equipping continues within our nations? How well do the pillars and tenants of C-IED support Multi-Domain operations? And probably most important, will our forces and our nations learn from the lessons of the recent past and current ongoing operations? These are just some of the questions that the NATO C-IED COE continues to seek answers to, and we do this by working with our nations and international partners as part of the Global C-IED Community of Interest. ■

**DISCLAIMER:** The information in this article represents the point of view of the NATO C-IED COE about the subject matter according to our knowledge and expertise, and does not reflect the official policy or position of NATO or national postures.

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**MARCH 31 - APRIL 2**

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**APRIL 2 - 3**

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**APRIL 15 - 16**

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