A joint publication for U.S. Artillery professionals

November - December 2018

Fires

Dynamic Fires

High technology of the future fight

Approved for public release; distribution is unlimited. Headquarters, Department of the Army. PB 644-18-

Table of contents

Fires

Editor
Marie Berberea
Art Director
Rick Paape, Jr.
Assistant Editor
Monica Wood

The Fires staff can be reached by email at usarmy.sill.fcoe.mbx.fires-bulletin-mailbox@mail.mil or by phone at (580) 442-5121.

Disclaimer

Purpose

Originally founded as the Field Artillery Journal, Fires serves as a forum for the discussions of all Fires professionals, Active, Reserves and National Guard; disseminates professional knowledge about progress, development and best use in campaigns; cultivates a common understanding of the power, limitations and application of joint Fires, both lethal and nonlethal; fosters joint Fires interdependency among the armed services; and promotes the understanding of and interoperability between the branches, all of which contribute to the good of the Army, joint and combined forces and our nation.

On the cover: A Soldier with 35th Air Defense Artillery Brigade, loads a Stinger onto an Avenger Air Defense System during the Rim of the Pacific Exercise (RIMPAC) 2018 at Pacific Missile Range Facility Barking Sands, Hawaii, July 24. The world's largest international maritime exercise, RIMPAC provides a unique training opportunity while fostering and sustaining cooperative relationships among participants critical to ensuring the safety of sea lanes and security of the world's oceans. (Capt. Rachael Jeffcoat/U.S. Army)

Col. Brian Gibson
U.S. Army Air Defense Artillery School commandant

Countering the unmanned aerial systems threat

In the last 20 years, no other branch in the Army has seen the enemy undertake such a dramatic expansion of capability inside its threat portfolio as the air defense artillery. Competing nations continue to evolve and adapt for future battlefields. To close the gap with the U.S., adversarial militaries and non-state actors engage in a continual cycle of improving strategy and technology. Current operations in the Middle East, Europe and the Indo-Pacific region all show an enemy making an expanded array of unmanned aerial systems (UASs) that survey, target and attack ground forces in ways not previously seen. To combat these evolving challenges it is paramount that we clearly define the UAS threat, analyze counter UAS (C-UAS) tactics, identify/develop new capabilities to meet these threats and increase the rigor of air defense training in our combat training centers (CTCs).

Countering the UAS threat has received significant interest across the Army, and within the combatant commands the air defense artillery supports. The proliferation of smaller and more capable UAS (see photo below) has dramatically altered how local, regional and global competitors will fight the U.S., now and in the future. Enemies have focused on low, slow and small platforms that are nearly undetectable, often using commercial off-the-shelf (COTS) technology. These systems operate in ways that we are unable to consistently detect, let alone

An unmanned aerial drone used the Islamic State of Iraq and Syria. (Courtesy photo)

defeat. Our adversaries will continue to develop more capable systems in the future, including weaponizing systems for a direct attack against the U.S. and allied forces.

Airborne threats were previously relegated to the near-exclusive focus of air defense artillery forces on the battlefield. The wide proliferation of UAS platforms now requires a holistic approach from the Army and joint force that combines both kinetic and non-kinetic defeat mechanisms. The Fires Center of Excellence, as the Army's proponent for C-UAS, is leading a detailed analysis of C-UAS equipment, doctrine, training and organization based on current and future threats. Every center of excellence in the Army, to include our joint partners, is participating in a growing community of interest focused on bringing critical capabilities, capacities and needs to the discussion. Every member of the modern battlefield plays a role in C-UAS, and no solution to this growing problem is possible without integrating the capabilities of each warfighting function into a coordinated and complementary system. Each contribution strengthens a robust

Spc. Matthew Williams, a cavalry scout assigned to 2nd Cavalry Regiment, fires a Stinger missile using Man-Portable Air Defense Systems during Artemis Strike, a live-fire exercise at the NATO Missile Firing Installation off the coast of Crete, Greece Nov. 6, 2017. (Sgt. 1st Class Jason Epperson/U.S. Army)

C-UAS system that provides detect, identify, mission command and defeat capabilities.

The air defense artillery and the greater Fires community are fielding capabilities and experimenting with new technologies now to address this threat. Upcoming additions to the capabilities of the Land-Based Phalanx Weapons System will field kinetic defeat mechanisms to our C-UAS portfolio. With the reintroduction of MANPAD training to maneuver forces, the ongoing upgrades to the Stinger missile system will be another huge addition to our C-UAS portfolio. Recent experimentation with electronic warfare capacities on a company-level fire support platform demonstrated both capability and capacity for the future force. Sensors also play a significant role in advancing this capability. The Fires community is developing multi-mission radars designed to detect, identify and provide engagement data for the full array of airborne threats.

Nothing happens in this demanding portfolio without training and enabling leaders at all levels to combat this growing threat. Each of the combat training centers

has expanded the threats and effects that rotational training units will face during their exercises. Expanded use of fixed and rotary wing assets, as part of the opposing forces, will utilize the same COTS systems our ground forces will see during operations. This added emphasis by the CTCs provides unit leaders a greater understanding and appreciation of all aspects of air defense and C-UAS tactics and techniques. The C-UAS fight is a demanding activity that takes manning, training, prioritization and coordination across all warfighting functions.

These factors are shaping the upcoming Maneuver Short Range Air Defense (M-SHORAD) capability for the Army. This capability will provide maneuver commanders with air and missile defense capabilities absent from their formations for more than a decade. Providing a detect and identify capability will enhance the maneuver formation's ability to engage these small UAS's with a broad array of kinetic and non-kinetic weapons. This new M-SHORAD capability will use a combination of previous SHORAD doctrine and new lessons learned to ensure today's forces are capable of defending against formidable enemies.

First to Fire!

Above: An artist depiction of a XM914 Stryker Stinger Hellfire weapon system. (Courtesy illustration)
Right: The Mobile Expeditionary High Energy Laser, or MEHEL, is a laser testbed on a Stryker armored fighting vehicle chassis and serves as a platform for research and development. MEHEL 2.0 is an improved version of the original MEHEL with a laser upgraded from 2kW to 5kW. (Courtesy photo)

The near vertical incident skywave loop antennae installed on the battalion fire direction center. (Courtesy photo)

ON COMMS

One battalion's pursuit of secure long-range digital communications

By Lt. Col. Leighton Anglin Sr., Lt. Col. Jonathan Shine, Capt. Lucas Fulmer, Sgt. 1st Class Brian Price and Staff Sgt. (P) Timothy Vinson II

The Army is looking for ways to achieve secure communications over greater distances in cannon artillery and we may have found a solution. With trust, support, and funding from the senior commander at Fort Riley, Brig. Gen. Patrick Frank, and operational leeway from the Dagger Brigade, 2nd Brigade, 1st Infantry Division, the members of the 1st Battalion, 7th Field Artillery Regiment began a year-long journey in pursuit of secure long-range digital communication. The platform of choice maybe the most underutilized communication system in the artillery— high frequency radios.

In preparation for our National Training Center rotation and deployment to U.S. European Command, 1st Battalion 7th Field Artillery, *Lightning*, through the Fires Forward Concept, began looking at options to improve fire mission processing via secure, long-range digital communications. We needed to mass Fires using all six firing platoons beyond standard frequency modulation (FM) range. Reports from previous NTC rotations stated that field artillery units had difficulty maintaining FM communication (both voice and digital) from

Parallel construct of three high-frequency radios (right) and standard frequency modulation voice and digital (left). (Courtesy photo)

the battalion to the batteries due to range and/or jamming. Continued use of common FM communication would likely result in a common after action review (AAR), such as, "poor retransmitting station (retrans) positioning" or "failed tactical operating center jump triggers to maintain communications." We needed a communication medium that had greater range, was less reliant on retrans, and less susceptible to jamming. Given current personnel readiness and budget, we looked within the division for solutions. A conversation with Wolf 07, the senior fire support trainer at NTC, who mentioned the success Multiple Launch Rocket Systems had using High Frequency Radios (HF), got us thinking, "Why can't we? Why don't we?" And so began a pursuit for high frequency (HF) radios for secure, long-range digital communications at the National Training Center. Throughout our NTC rotation, the radios were never jammed and the battalion maintained digital communications for the duration of the fight, regardless of range.

The problem

FM is a line of sight (LOS) platform with a maximum effective range of approximately 15km. In order to extend the range of FM platforms, it is necessary to establish retrans stations. Optimally positioned, a retrans station can double the range of two frequencies. However, retrans is a directional tool. If a battalion needs to communicate with a battery 20 km to the west, a single retrans station halfway between the two echelons will likely suffice. But if a second battery is 30 km to the east, north or south, additional retrans assets are required to extend the range in those directions. Additionally, we considered the following: 1) Due to manning and/or equipment shortfalls, the average direct support field artillery battalion is likely capable of deploying one retrans station at a given moment. 2) Retrans teams are often positioned by brigade to support priority FM networks, making their availability MET-TC (mission, enemy, terrain, troops available, time, and civilian considerations) dependent. 3) Enemy forces often target retrans stations because they are soft targets with a high value. 4) FM digital's back-up communication is FM voice, a redundancy that depends on the same medium, thus not independent. Therefore, if digital gets jammed, so does voice. 5) Using FM voice as back-up to HF is also not an option because the independent back-up is susceptible to all the challenges listed above. Therefore, we also needed another communication medium for back-up that could match pace and range with the HF. We decided that JCR would become the independent back-up to HF.

Based on modification table of organization and equipment (MTOE), most units have three radio platforms available. The first and most familiar is the Advanced System Improvement Program of FM, or ASIP radio. A second, and somewhat familiar option that units have for long-range communications, is Tactical Satellite (TACSAT). However, with limited channels and lower priority for satellite when stateside, most brigade combat teams only receive one TACSAT channel. Additionally, TACSAT is generally used for voice and is reserved for contingency communication, not the primary or the alternate. The third option is an organic communication radio platform that is available to many FA units: HF. If most units are like ours, we did not have the resident expertise for these radios and most were locked away in a communication cage, only pulled out for supply inspections, then put back in. Some forward observers use HF radios for voice communication to address range shortfalls with FM, but HF is seldom the primary means of communication in cannon artillery.

Despite these challenges, we decided to use HF because it was the only available option that had a favorable cost benefit outcome.

The approach

With the decision to use the HF (PRC-150) made, our team worked on the construction of a network that allows the battalion fire direction center (FDC) to conduct digital fire mission processing with six platoon FDCs simultaneously. Initial trials during weekly digital sustainment training revealed that in order to send and receive digital data, two radios must be linked. Unlike FM, HF requires a call to the station that you want to send data. After calling, the two radios link and digital data can be sent and received. This means that radios must link one at a time in order to transmit digital data. In other words, if you wished to send a fire mission to six platoon FDCs, you would need to link and send the mission to each platoon one at a time. Once a platoon received the mission, you would need to break the link and repeat the process with the five remaining platoons. That simply takes too much time, resulting in less responsive Fires.

Our team went back to the drawing board and sketched out a communication diagram on a whiteboard, leveraged the intrinsic routing capability of the Advanced Field Artillery Tactical Data System (AFATDS), and developed what we later called: "parallel construct." The battalion FDC would need three HF radios and three HF networks in AFATDS. The three HF radios allow them to establish a "direct" route in AFATDS with one FDC per battery. The second FDC establishes digital with battalion FDC via an "indirect" route using the first FDC as their gateway. This technique allowed the battalion FDC to communicate with all six platoon FDCs simultaneously and maintained the unit's ability to mass Fires or process six individual missions at a given time. For example, if the battalion FDC wished to send a mission to 2nd Platoon, B Battery, the mission is sent HF to 1st Platoon, B Battery, who's AFATDS transparently routes it to 2nd Platoon. The same is done in reverse when 2nd Platoon wishes to send a mission/message to the battalion FDC. There is no requirement for 1st Platoon other than to maintain FM digital communications with their sister platoon.

In order to outfit the battalion FDC with three HF radios, the *Lightning Battalion* restructured the interior of the battalion FDC vehicle. Typically, the M1068 is outfitted with three FM radio mounts with six FM radios, and one Harris HF radio mount (VRC-104) with one PRC-150 radio. We removed two of the FM mounts and replaced them with two HF mounts. This also required the replacement of FM antennas with Harris 30 foot whip antennas. These antennas are capable of ground waveform as well as near vertical incident skywave (NVIS) waveform depending on how they are positioned.

Once the battalion FDC vehicle was outfitted, we tested the viability of our designs first by conducting long-range digital communications checks on Fort Riley. We were able to send fire missions at ranges of approximately 20km using ground wave line of site with the 30-foot whip antennas. In order to truly test the range of HF, the battalion FDC then travelled approximately 90km from Fort Riley to Smokey Hill and attempted to send fire missions. While still only using ground wave LOS, the FDC was able to send digital fire missions to all six firing platoons at distance. However, ground wave LOS was inconsistent at these ranges.

Based on the inconsistency experienced at longer ranges, the unit decided to purchase Harris Loop antennas which are capable of ground wave LOS and near vertical ionosphere waveform (NVIS) simultaneously (See Figures 1 and 2). This NVIS waveform essentially sends radio waves into the ionosphere where the waves "bounce" back down. When using this waveform, the radios are capable of communicating across hundreds of kilometers, or a few meters. This configuration gave us the increased range we desired, however, it also had undesired second order effects. Having three HF antennas mounted so closely to each other, resulted in constant interference. The interference was not substantial enough to inhibit communications but it was enough to make the connection inconsistent. Not all transmissions made it from the sender to the recipient. Some missions were received within seconds while others took minutes. AFATDS may state "successful" with the station that you are communicating with, but it does not mean all transmissions were received.

Soon after installing the NVIS loop antennas, we began our NTC rotation where the new communication network faced its most challenging test. We leveraged the mandatory calibration of assigned propellant lots to test the Harris Loop antenna construct at ranges from 100 meters to 12,000 km in the desert environment. While still in the reception, staging and onward integration (RSOI) phase of training, we pushed the batteries out into the training box while the battalion FDC remained in the Rotation Unit Basing Area (RUBA) and pushed the missions forward. It was successful. We calibrated from the RUBA. For the next 14 days of training during force-on-force and live-fire, range from battalion to batteries became less of an issue.

The HF does have a number of downsides. Due to the interference caused by the close proximity of antennas, as well as atmospherics during battle periods, the battalion FDC could not guarantee that a mission sent would be received 100 percent of the time. Approximately half of missions sent were received complete within seconds. The other half took minutes to reach and some never confirmed receipt. JCR was used concurrently to inform platoons of missions sent and platoons then confirmed over JCR if they received it digital on AFATDS or not. If not, fire missions were sent over JCR.

FM versus HF (National Training Center observations)

Wolf 07 (Lt. Col. Jonathan Shine) Observations: When we learned that 1-7th FA was planning to use HF Digital as their primary means of communications during their training rotation, the Wolf Team reacted with a mix of excitement and skepticism. From our perspective, the experiment was a qualified success. We have not collected specific data on how often units are able to maintain communications and over what distances, so what follows are subjective estimations based on observations of the last 12 rotations. During all of those rotations, challenges associated with maintaining digital communications was a major topic of discussion during one or both of the battalion's instrumented After Action Reviews. Since the re-introduction of the decisive action training environment, every field artillery battalion has struggled. *First Lightning* struggled less. We estimate that the battalion maintained digital connectivity via HF from the battalion FDC to all six platoons over 95 percent of the time that they were "in the box." This includes while FDCs were moving, and with no requirement to maintain FM retransmission stations. However, without JCR, the battalion would likely have failed in at least 50 percent of their fire missions. About half of the time, the transmission was either not received at all, or was received with a delay of as much as four minutes after being sent

The near vertical incident skywave loop antennae installed on M1068 Battalion Fire Direction Center. (Courtesy photo)

from battalion. As a result, the battalion's tactics, techniques and procedures were to simultaneously send all fire mission data over JCR as well as HF. Subsequent adjustments were sent entirely over JCR. During periods when the opposing force was jamming JCR, the battalion relied on FM Voice and had to significantly reduce the dispersion of their firing elements, with the added risk to the guns from enemy counter-fire that this entails.

Again, without having collected connectivity as a metric, it is difficult to state precisely how a rate of 95 percent connectivity with 50 percent loss of data compares with the average FM-based unit. Every other FA battalion has failed to maintain consistent digital communications, especially on the move and over extended distances and with the dispersion necessary to survive against the current OPFOR (who identify FA units primarily with small UAVs and possess at least a 3.5-to-1 advantage in delivery systems). Our current ASIPs FM radios are not keeping up with the pace of change in our other digital systems and the evolving capabilities of our adversaries. Overall, HF alone was clearly not sufficiently reliable to be the primary means of fire direction for 1-7th FA. However, for a relatively low cost (compared, for example, to WINT inc2), *First Lightning* demonstrated that HF has extraordinary potential to substantially increase the range, survivability and dependability of a field artillery battalion, as it does for nearly all Multiple Launch Rocket System/High Mobility Artillery Rocket System-equipped units.

Recommendations

We have not broken the code on the employment and use of HF systems for digital fire direction. Through months of trial and error, we discovered "a way" that conceivably works. Though proven more reliable at NTC than FM, there are inconsistent gaps and delays that our team was unable to solve. Additional equipment, non-MTOE, is available that increases the reliability of HF digital communications. For units using the PRC-150, we recommend purchase of the IP6600 router ($600 ea.). This router is designed to translate the data between AFATDS and the PRC-150 more efficiently and allows for a more reliable link and faster transmission.

However, if funding is available, the optimal solution is the fielding/purchase of the RF-300H- MP wideband HF tactical radio. It provides continuous coverage from 1.5 to 60 MHz with data rates up to 120 kilobytes per second, compared to the current system's 15kbps. The 300H addresses most of the inconsistencies experienced by our team with the current radios. We did not stress the 300H radios in a field environment, thus unable to attest to their durability, only power and data rate. The pursuit for reliable-secure-long-range-digital-communications in the *Lightning* Battalion continues with expansion of HF to the Bradley Fire Support platform for digital communication.

Lt. Col. Leighton Anglin is currently assigned to the Office of the Vice Chief of Staff of the Army, Colonel Management. He was formerly assigned to 1st Battalion, 5th Field Artillery at Fort Riley, Kan.; 1st Battalion, 6th Field Artillery at Bamberg, Germany; 1st Battalion, 82nd Field Artillery at Fort Hood, Texas; Joint Multination Readiness Center at Hohenfels, Germany; Chief of Plans, 1st Armored Division; 4th Battalion, 27th Field Artillery at Fort Bliss Texas; and recently commanded 1st Battalion, 7th Field Artillery, Fort Riley Kans. He holds a Bachelor of Science degree in Mechanical Engineering and a Master of Military Operational Art and Science from the School of Advanced Military Studies

Chief Warrant Officer 2 Mark Horton serves as a Field Artillery Warrant Officer with the 1st Battalion, 7th Field Artillery, 2nd Armored Brigade Combat Team, 1st Infantry Division. Horton has conducted two combat training center rotations, and deployed in support of Operation Spartan Shield and Atlantic Resolve. He's served previously as a battalion targeting officer, target acquisition platoon leader, and brigade targeting officer.

Lt. Col. Dave Pasquale is the Senior Fire Support Trainer at the Joint Multinational Readiness Training Center in Hohenfels, Germany. Prior to his current assignment, he served in Grafenwohr, Germany as the battalion commander for 4th Battalion, 319th Airborne Field Artillery Regiment, as a member of the 173rd (Airborne) Infantry Brigade Combat Team.

Spc. Clayton McInnis, with 1st Battalion, 155th Infantry Regiment, Mississippi Army National Guard, reviews reports in the unit's tactical operations center in June 2018, at the National Training Center, Fort Irwin, California. (Staff Sgt. Shane Hamann/U.S. Army)

Operationalizing cyber, electronic warfare, space, special technical operations for decisive action

By Lt. Col. Clint Tracy

Army cyber and electronic warfare Soldiers are routinely conducting day-to- day operations that have little to do with their unique skillset. They are being used as school noncommissioned officers, Defense Travel System administrators, permanent gate guards, battle captains, battle non-commissioned officers, and the list goes on. This is an unfortunate circumstance that is the result of lack of understanding on what options these Soldiers can provide for a commander. In the aggregate, this results in poorly trained formations that have no ability to mitigate the enemy's maneuver in the electromagnetic spectrum with cyber and electronic warfare equipment to disrupt, degrade and deny command, control, communications, computers and intelligence within their formations.

Since cyber and electromagnetic activities (CEMA) are relatively new to the Army, and there are no programs of record (minus the counter-improvised explosive device systems) there is a perception that CEMA Soldiers don't bring much to the fight. There is a reluctance to ask what is in the realm of possibility because there is the assumption that without equipment there is little they can contribute. As a result, units maintain the status quo of "We'll figure it out when it happens." Unfortunately, in the cyber domain or the electromagnetic spectrum, your odds of "figuring something out" on the fly is practically zero. The prep work required for CEMA personnel to understand current threat capabilities, potential mitigation techniques, and the enemy's vulnerabilities is extensive. The 1st Cavalry Division just completed a warfighter exercise and it took a full six months of homework to be prepared for execution of the Warfighter mission. That was six months of daily research on Joint Worldwide Intelligence Communications System and Secret Internet Protocol to understand enemy ca-

pabilities, frequencies and vulnerabilities. Six months of building and refining processes for targeting, CEMA working group, generating and synchronizing requests and building standard staff products. Six months of training personnel on Command Post of the Future, staff interaction, and information receipt, analysis and distribution, and we still left capabilities on the table because we were not as informed as we needed to be. Especially with regard to cyber capabilities during execution.

CEMA, much like the G2, requires daily engagement and research to maintain currency on threats and potential mitigation techniques. Cyber threats pose a great risk not only to our networks but the very lives of our Soldiers. Imagine a cyberattack that shuts down a brigades upper Tactical Internet while they are in the middle of a movement to contact, or worse, while they are in contact. While not directly affecting maneuvering platoons that are probably communicating on FM, it has the ability to sever their link to the Fires battalion that is supporting their maneuver, can break the link to their sustainment support and potentially sever the links between them and the supporting close air support or rotary wing. Combine that cyberattack with GPS and communications jamming and you have a unit that is unable to communicate … soon to be followed by an inability to shoot or maneuver as they run out of ammo and fuel because they are unable to request resupply. While we may think this is a stretch, the Russians have already used similar techniques linked to lethal Fires in Ukraine with devastating effects on Ukrainian Army units. A cursory search of the Russian doctrine of "Information Confrontation" that combines cyber, electronic warfare, propaganda and information operations and how it has been used in Ukraine should be a wake-up call to everyone in the United States military.

As you read this article, the Russians, Chinese, Iranians, North Koreans and others have developed sophisticated cyber teams and tools, and have an arsenal of electronic warfare jammers and collectors that dwarf the current capabilities that exist in the U.S. Army. The first step in countering this growing capability is to start with employing electronic warfare Soldiers in their military occupational specialties and insisting they provide subject matter expertise when developing plans and orders in order to help mitigate the capabilities we know our enemies possess.

In the six months we spent training for Warfighter, the structural flaws of the division CEMA section became very clear. The 153 individual and collective tasks can't be accomplished by a five-man team that is spread between a division tactical command post and the main command post both conducting 24/7 operations. The ability to not only attend the required working groups, but to maintain situational awareness and to generate all of the required requests to support targeting can't all be simultaneously executed with five personnel, even if they are all in one place. Multiple times during the day there are more requirements than personnel and at some point people must sleep. The first step in solving a problem is to see yourself, and the five-man section looks anemic when compared to all of the requirements. In discussion with our G2, we discussed the CEMA section absorbing the space and special technical operations (STO) personnel into a combined CEMA, Space, and STO section. It provided three more personnel but more importantly it combined three sections that all possess complementary effects. After consideration and looking at the nine-man FDU proposal for a CEMA section I decided to use the additional personnel as a proof of principal, so we rolled the Space and STO sections into CEMA and we started training.

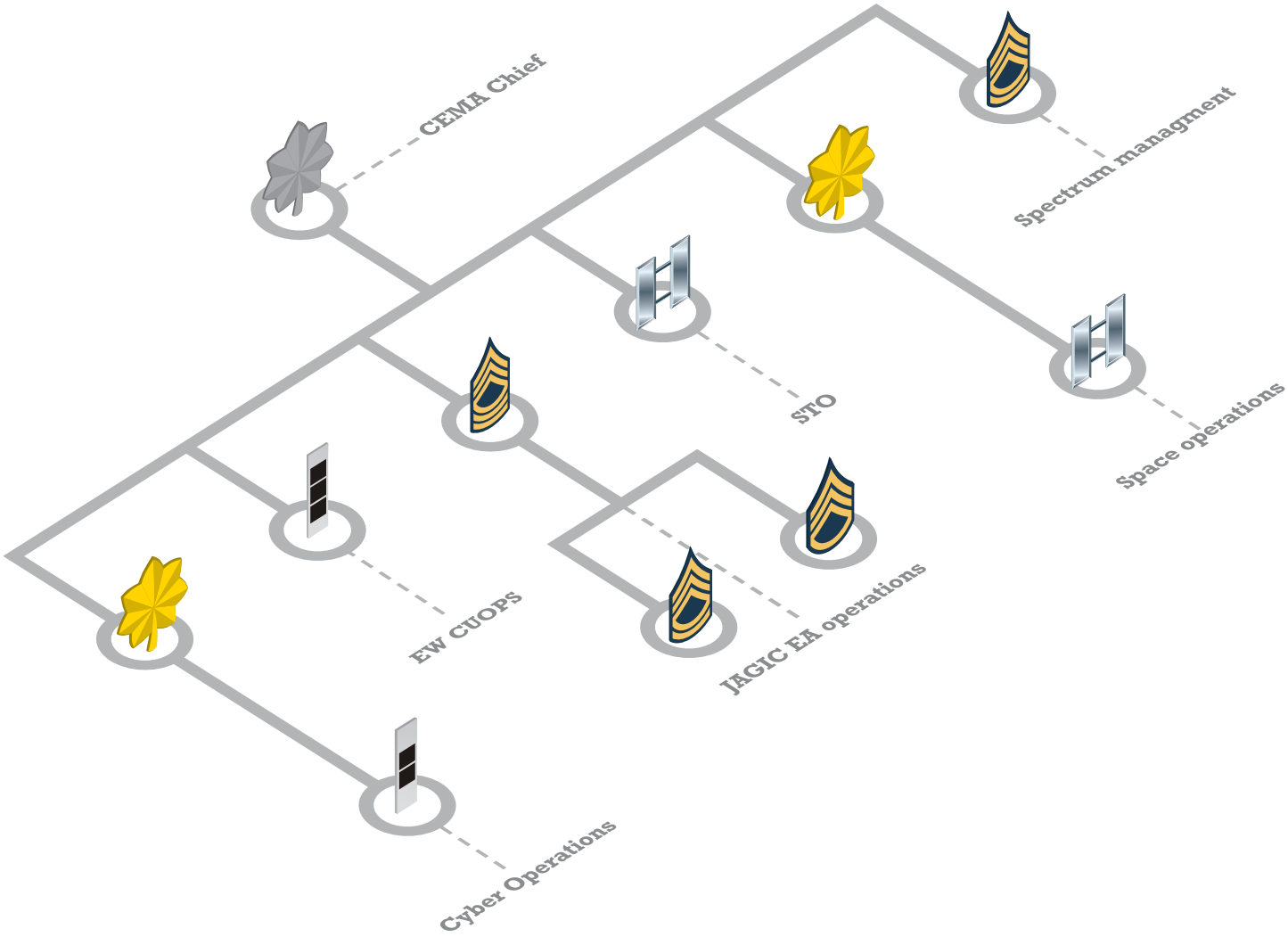
One of the initial objectives was to fully understand everything space and STO could offer and to train those officers on what CEMA could provide. This was a critical step in developing a cohesive team, as they understood what options I wanted to provide for the commander. In a very short amount of time, we all began to see where we could integrate the collective capabilities into an overarching plan, this layering of effects would later prove to be extremely effective.

Access and understanding

Access and understanding were initially two areas we struggled with. It would not be beneficial for the combined CEMA section to have all of the knowledge and simply interject ideas or "effects" during targeting if the staff around us did not have an understanding of what we could do or at least a concept of what was possible – the how we would do it was really irrelevant, it was the end effect they needed to understand. With that in mind, we began to develop a list of personnel that needed to be read-on to specific programs we could use during the exercise. The read-on was really less important than the baseline of information it provided to the commander and the selected group of senior leaders and primary staff members who would be involved in targeting. Once we had established a baseline of information on capabilities, we developed and named "CEMA Operations" that targeted specific enemy capabilities. In actuality, this prevented us from needing to have TS discussions and allowed discussion around the table at the targeting working group under this guise. This allowed us to focus on the effects at the working group and work the specifics for how to achieve the effect in an area with the appropriate classification in a small CEMA huddle. This smaller huddle was really where we leveraged the capabilities of the combined section and synchronized the effects in time and space with the maneuver and Fires plans. As we talked through the effects we wanted to achieve, we were able to discuss the options available from each functional area and then determine how best to employ those capabilities so that we did not establish patterns. As an example, we would use different capabilities on a daily basis to deny enemy command and control, this prevented the enemy from figuring out how we were denying their command and control and thus allowed us to maintain the ability to use capabilities throughout most of the exercise.

Structure, roles, responsibilities

As mentioned, we utilized our Space and STO team of three personnel to help round out the section, but there was still not enough manpower to accomplish all of the essential tasks. Doctrinally, there are 153 collective and individual tasks that must be conducted in the CEMA Section in order to meet the requirements of 71-DIV-5900 Conduct CEMA. With five personnel in a division CEMA section it's not possible to meet the requirements, much less be able to conduct 24/7 CEMA in a high operational tempo environment. The CEMA section we built with Space and STO added was responsible for integrating and synchronizing cyber, electronic warfare, space, and STO operations within the division and as part of the corps. This required continual integration with the G2 as the CEMA section was a customer of electronic intelligence, signals intelligence, human intelligence, and imagery intelligence among others. This also required integration with the G6 in order to maintain situational awareness of the threats the G6 was seeing on the network and compare those threats to the reporting that the G2 was receiving with



Cyber and electromagnetic activities (CEMA) **Early warning (EW)** **Joint air ground integration cell (JAGIC)**
Current operations (CUOPS) **Electronic attack (EA)** **Special technical operations (STO)**

Organization of the cyber and electromagnetic activities organization. (Rick Paape, Jr./Fire Bulletin, courtesy information)

regard to cyber threat actors. The CEMA section was also integrated with the Fires section joint air ground integration cell (JAGIC) and division current operations (CUOPS) in order to control EA aircraft on station, receive tactical elint (TACELINT reports and push requests to the Combined Air Operations Center for confirmation/location so identified threats could be targeted and engaged by the JAGIC. Finally, the CEMA section was integrated with targeting and plans in order to ensure the right assets were requested and synchronized in time and space to enable the division's operations in the deep fight.

Luckily the section received another warrant officer just before the Warfighter and we pulled two 29Es from our subordinate brigades for a total now of 11 personnel. As those brigades were not training audiences for the exercise and had adequate manning for CEMA there was no impact on their brigade operations (see figure above).

The structure provided the manpower necessary to effectively integrate with the staff and to generate the required requests to support division operations. In order to adequately integrate and synchronize with the staff, a CEMA section needs a minimum of eight CEMA personnel, two FA40 space officers and one STO officer. This places two 17 series personnel in the T-SCIF to provide 24/7 capability to generate offensive cyber operations requests and to integrate with Space (two personnel), STO (one officer), G2 SIGINT, collection and the field artillery intelligence officer. This enables real-time receipt and analysis of intelligence reporting and provides the ability to pass the analyzed information for lethal targeting to the FAIO for potential immediate strike. The importance of this integration in the G2 shop can't be overstated. The minute-to-minute receipt of intelligence followed immediately by the discussions and decisions on how to attack the threats in real-time was key to our success.

Three personnel were placed in the JAGIC, this provided 24 hours of coverage plus an NCO who was on-duty focused on EA requests working 16 to 18 hours a day. This cell in the JAGIC was the central point of EA requests (JTASRs (DD1972s) and EARFs), refinement of EA requests, management of subordinate EA requests, management of aircraft on station, central point for receipt of TACELINT reports from the CEMA personnel in the temporary sensitive compartmented information facilities or G2 SIGINT, and the principal integration point with the CAOC for confirmation of emitter locations. This proved to be an essential link in providing immediate input to the JAGIC for the targeting of fire support, air defense artillery, and electronic attack equipment on the immediate strike list. Once the process was ironed out we were able to routinely destroy enemy emit-

Lt. Col. Clint Tracy and Maj. Ryan Pless update the cyber electromagnetic activities common operating picture in the 1st Cavalry Division's command operations and intelligence center on the Command Post Of the Future system. (Sgt. 1st Class Michael Garrett/U.S. Army)

ters in less than 10 minutes (this continued to improve throughout the exercise) from the time of initial detection.

The final three personnel were used for current operations and planning. These personnel maintained situational awareness on the CUOPS floor, they understood what assets were available in addition to allocated assets and they ensured input to briefs and meetings were updated (battle update assessment, commander's update assessment, operational synch, working groups). In addition they coordinated with subordinate brigades, received Joint Spectrum Interference Reports (JSIR), and evaluated if on station aircraft needed to move or were providing effects on the appropriate areas during operations. Most importantly, this allowed the CEMA chief to participate in the targeting working group, targeting board and to run the CEMA/IO working group.

The final person required was the spectrum manager who maintained and de-conflicted the JRFL, pushed JSIRs up for resolution, conducted spectral scans, provided recommendations for emissions control and integrated with the G6 and G2 to ensure EA missions had no effect on friendly communications or collection operations.

The establishment of these positions with the previously described responsibilities allowed the section to simultaneously receive, analyze and distribute information, request, synchronize and integrate capabilities and provide options to the commander throughout division operations. This presented the enemy with complicated problems as his reconnaissance, mission command, and Fires systems progressively moved from disrupted to degraded to denied.

Integration

The roles and responsibilities described above would have been only moderately effective without integration and buy-in from the other staff sections. We worked to build relationships, especially with the G2, G6 and Fires in order to establish cohesive teams through mutual trust, create shared understanding, enable the exercise of disciplined initiative and inform the commander where it was prudent to accept risk. The result was ironclad trust in the information we were providing and receiving from the staff. The ability to rely on the information provided to be correct every time accelerated the throughput during analysis and ultimately helped the section synchronize both lethal and non-lethal effects on enemy formations throughout the depth of the division area of operation.

Final thoughts

Our success was directly attributable to task organizing for combat and our division leadership trusting we could deliver on the effects we were describing. Being given the latitude to define what the combined CEMA section needed to do up front (visualizing, describing and directing) and then working through our shortfalls with regard to personnel and capability was an ongoing process. After action reviews and discussion within the shop following every command post exercise allowed us to arrive at the right mix of personnel which equated to capability for the division. Unlike the warfighting functions where capabilities change in increments of years, CEMA, Space and STO all change in increments of weeks. In order to be value added to a commander, these Soldiers must be focused daily on learning and understanding the capabilities our adversaries possess; understanding tactics, techniques and procedures we can use to mitigate enemy systems or effects; and most importantly understand how to operationalize the effects we can deliver while integrating with the division staff, thus providing options for the commander. This only happens with command emphasis and recognition that daily work must be done by these Soldiers that is focused on CEMA, Space and STO. Ninety percent of the capability we will be able to provide for a commander is the result of months of homework, requests and condition setting. Due to the lead time required for many capabilities in these fields, all of the homework and training must be completed in Phase 0.

If you expect that a small section within the division or a brigade will be able to truncate the homework, training, or request process in Phases 1, 2 or 3, be prepared to "Figure it out when it happens" and quickly be combat ineffective. As stated above, our adversaries are investing heavily in these areas, as an Army we must recognize these threats and train our force to utilize the capabilities we have to their full extent. We must have nothing at rest when it comes to CEMA, Space and STO capabilities in order to provide our commanders the best options for defeating our near peers in an increasingly complex and contested cyber, electromagnetic and space environment.

Lt. Col. Clint Tracy is the Cyber and Electromagnetic Activities chief for the 1st Cavalry Division and has been assigned to the division since October 2017.

U.S. Army air and missile defense Soldiers in 35th Air Defense Artillery Brigade, take a knee to observe a live fire from an Avenger air defense system, during Rim of the Pacific 2018 at Pacific Missile Range Facility Barking Sands Hawaii, July 24. (U.S. Army photo by Capt. Rachael Jeffcoat)

Air defense artillery

An atrophied warfighting skill

By Lt. Col. Sean Dublin

The current environment the United States military is operating in is one of unfamiliarity and a general lack of training and availability of air defense artillery Soldiers assigned to the maneuver force. There is zero to minimal participation by the ADA community in the Mission Command Training Program's (MCTP) corps/division Warfighter Exercise (WFX) to assist in filling this void.

As the Army moves forward with training the next generation of Army officers, non-commissioned officers and Soldiers for the multi-domain, near-peer fight, the Army must be prepared to fill the current Air and Missile Defense (AMD) knowledge gap that has atrophied at the corps and division due to the lack of necessity during 15 years fighting the Global War on Terror and instead, begin rebuilding it. This is a monumental responsibility and must be driven by the expertise resident within the Patriot brigades and battalions who have flourished in their echelons above corps roles.

Over the past decade, the United States military has been fighting in counter-insurgency (COIN) operations that lack many of the air threat capabilities our near-peer competitors have and are trained to employ. Understandably, the maneuver force has not viewed AD as a necessary warfighting capability when preparing for the COIN environment. Instead of including AD planning and employment into their exercises, the maneuver force at all levels has ignored it and instead re-tasked those personnel to fill other vital roles in the COIN fight. Recent changes in the global geopolitical and strategic environment have highlighted a re-emergent aerial threat at tactical echelons to include rotary wing, fixed wing and unmanned aerial systems (UAS). Unfortunately, SHORAD is an atrophied skill and is only planned and employed as an afterthought during the WFX. Even with the shift from COIN to multi-domain operations, the maneuver forces are still ignoring the enemy's ability to effectively and at

times decisively, utilize the airspace during their WFX.

The current WFX operating environment permits short range air defense artillery (SHORAD) simulation to counter the air threat, but often results in early culmination due to a lack of SHORAD training and personnel. With untrained personnel to plan and employ the assets, and minimal participation by the AD community in the WFX, there exists a vacuum of air defense understanding throughout the maneuver community. At the staff level, Soldiers are not versed or experienced enough to conduct a proper intelligence preparation of the battlefield analysis on all the capabilities a near-peer enemy has or its potential effects on the commander's plan. Maneuver forces are instead, comfortable handwaving the threat away and assuming air superiority against near-peer rivals who have invested in strengthening their air breathing threats while the United States has been at war.

The lack of trained personnel to conduct proper AMD planning and employment is ever more prevalent in observations made within MCTP. At every stage of the planning process, there is minimal effort put forth to the proper planning and employment of AD assets against a well-defined and capable threat. Generally, the Avengers and Sentinel radars are pushed to the divisions with minimal consideration for their doctrinal employment. The lack of a sound AMD plan by higher headquarters when determining task organizations often excludes integrating the commander's most capable ground-based radar into the division's reconnaissance and surveillance (R&S) plan. The lack of planning is not due to derelict intent, but to a clear lack of understanding of how AD assets are to be employed and planned for. Training audiences often conflate a sensor and missile systems ability and assume they are covered by a notional AD "umbrella." There is no understanding of SHORAD capabilities, limitations or employment principles and guidelines.

There is minimal to no assessment done by units to nominate assets for the Critical Asset List and Defended Asset List (CAL/DAL). The CAL/DAL is what a corps and division headquarters produces to determine what will receive AD coverage. This very issue begins during mission analysis of the planning phase of the operations before the unit(s) deploy. As a result there is no enemy air threat capability planned for and no integrated air and missile defense plan to ensure that systems are placed in the proper location and the commander's assets are properly defended.

In the WFX the AD component is not being represented by knowledgeable personnel at the unit and work cell levels. Over the course of observing 10 warfighter exercises with units ranging from military police brigades, engineer brigades, maneuver enhancement brigades, field artillery brigades and division artillery there is an observed gap of knowledgeable personnel to properly plan and employ ADA assets within the units or their work cells. AD assets are, more often than not, placed in locations that prevent them from being properly employed, either there is no line of sight (critical to the Avenger and shoulder-fired Stinger) or the Avengers themselves are placed behind the assets they are supposed to be protecting. The lack of knowledge results in a frustrated training audience throwing up their hands and giving up on a system that if properly employed, integrated, planned for, and protected can be effective within it's given limitations. The less complex ADA responsibility of providing early warning is even lacking, and each Air Defense Airspace Management (ADAM) cell continues to struggle with the proper emplacement of their sensor as it relates to the enemy, the enemy's capabilities and the given terrain.

The division ADAM cells are often understrength, or the AD Soldiers are not doing their AD jobs within division headquarters. In my experience AD officers are placed in positions like assistants to the chief of operations or battle majors instead of being placed in the ADAM cell designated for them at the division level. During two WFXs with two different divisions the overall manning of the ADAM cell for the unit was at less than 40 percent. The observation made was, this had negative effects on the cell's ability to plan for future operations. This lack of manning also restricted the cells from being able to provide personnel to the Support Area Command Post (SACP), leaving the SACP with little to no AMD situational awareness or planning ability.

With more than a decade in a COIN fight the Army has not just lost the "garrison skills," so many screamed for, but also the ability to employ personnel and equipment to fight our near-peer competitors. No skill seems more atrophied than the employment of AD assets.

Given the current problem set, where

does the Army go next? I recommend that the Army fills the gap of knowledge and trained personnel by both utilizing and training the organic AD personnel within the corps and division for their core mission. Additionally, Patriot battalion's participation in WFXs for divisions and Patriot brigade's for corps WFXs is an essential part of the Army's preparation for the next fight. This also helps corps and division commanders begin to synthesize how they

An air and missile defense crewmember with 35th Air Defense Artillery Brigade, prepares a remote control apparatus for the AN/TWQ-1 Avenger air defense system during Artemis Strike, a live-fire exercise off the coast of Crete, Greece, Nov. 6, 2017. (10th Army Air and Missile Defense Command PAO Office)

plan on integrating with their area of responsibility senior ACC. There is an additional danger in thinking that the paradigm of the pre-GWOT force structure is still relevant in the multi-domain, near-peer fight; inviting Patriot battalions and brigades to WFXs will validate the necessity to have similar structures with similar experiences and expertise supporting the corps and division commander. The post GWOT AD force will need to be ready to plan and fight against threats ranging from unmanned aerial vehicles to intercontinental ballistic missiles and only through aggressively attacking the issue can the military hope to fix it and prepare the Army for the full range of enemy threat capabilities.

Lt. Col. Sean Dublin is a Mission Command Training Program military police observer, coach and trainer at Fort Leavenworth, Kan.

Soldiers from the 3rd Battalion, 7th Field Artillery, fire an M119A3 during a live-fire training exercise. (Courtesy photo)

An integrated brigade deep fight

Brigade Deep Battle 2.0

By Capt. Joseph Schmid, 2nd Lt. Hector Lopez, 2nd Lt. Zach Tousignant, and 2nd Lt. Paul Mirabile

A Product of Raider Fires University

"Small unmanned aerial systems will not replace the fire support team. It will enhance the fire support team by allowing teams to observe and engage adversaries that cannot be observed due to obscuration, distance, darkness, observation angle or flat terrain."[1]

Third Battalion, 7th Field Artillery and 3rd Squadron, 4th Cavalry Regiment are developing concepts intended to maximize manned unmanned-teaming among forward positioned fire support teams (FIST), small unmanned aerial systems (SUAS), indirect fire platforms, and rotary/fixed wing aircraft. The joint effort between these two organizations will serve to generate multiple dilemmas beyond the forward edge of battle area while specifically targeting advancing combat power attempting to contest terrain within the maneuver close fight as well as secure terrain within the adversarial tactical support zone. The integrated brigade deep fight leverages dismounted infiltration tactics, forward positioned observation posts, as well as an aggressive fire support plan to systematically deconstruct an adversary's will to fight due to catastrophic loss of key supply capabilities, target acquisition radars, critical air defense artillery platforms, as well as command and control nodes. Drawing on lessons learned from Joint Readiness Training Center 18-04 rotation, specifically friction associated with projecting lethal Fires into the brigade deep fight, the integrated brigade deep fight offers a technique to couple 3-4th CAV's forward positioned sensor plan with 3-7th FA's massed lethal Fires between the brigade coordinating firing line and the division coordinating firing line. The systematic execution of Brigade Deep Battle 2.0 during the initial reconnaissance phase sets favorable conditions for an infantry battalion's forward passage of lines with 3-4th CAV. Favorable conditions for forward passage of lines are created by fire support teams augmented with small unmanned aerial system operators who will infiltrate under period of darkness deep within an adversary's tactical support zone in order to project manned and unmanned sensors forward while directing 120 mm mortar, direct support artillery fire, and rotary/fixed wing assets. In support of Brigade Deep Battle 2.0 Raider Fires teamed with 3-4th CAV to conduct a FIST/SUAS experiment during the June 2018 3-4th CAV mounted gunnery rotation at Pohakuloa Training Center on the big island of Hawaii.

FIST/SUAS experiment

Raider Fires teamed with 3-4th CAV to conduct a deliberate seven-day FIST/SUAS experiment with the aim of validating an RQ-11 Raven's ability to accurately observe indirect fire. The FIST/SUAS research problem was as follows: How accurate are SUAS while observing indirect Fires between the brigade coordinated firing line and division coordinated firing line when given two lightweight laser designator rangefinders, two troop 120 mm mortar systems, 954 120 mm training rounds and two Ravens? The FIST/SUAS experiment compared one independent variable, a Raven's "did hit" data, with one control variable, the same target verified by redundant lightweight

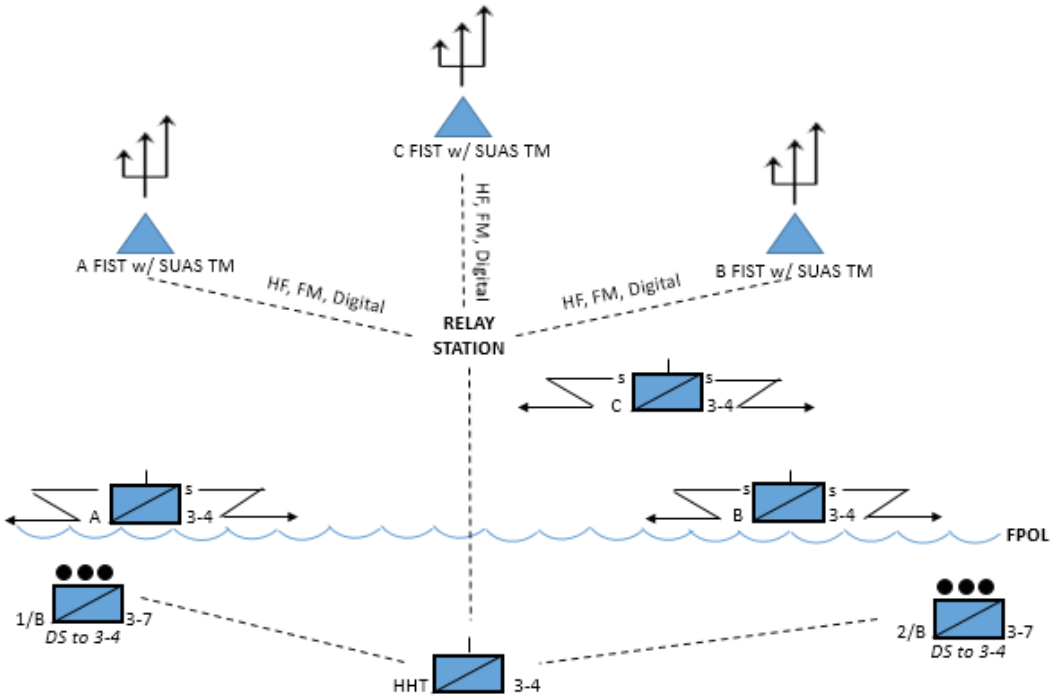
1 *Paul Niggl, Mark Sousa, Frank Miner, 2017. "Use Small Unmanned Aircraft Systems to Call for Fire," The Cove. JUL 2017, Accessed on 28 JUN 18. p. 1.*

Infiltrate
This phase begins 24-48 hours prior to 3-4 CAV main body SP. FIST/SUAS teams infiltrate beyond the templated FPOL IOT establish Op's able to disrupt an adversary's tactical supply zone.

Observe
This phase is continuous before, during and after FPOL. Troop FISTs will team with SUAS in order to locate an adversary's dismounted troops, light skinned vehicles, tracked/wheeled ADA pieces, as well as critical C2 and supply nodes.

Communicate
This phase is continuous and hinges on HF, FM, and/or digital coms between the infiltrated OPs, redundant relay station, and the 3-4 CAV FDC augmented TOC.

Dominate
This phase is achieved after infiltrated Ops and SUAS teams have saturated an adversary's tactical support zone effectively paralyzing his/her physical ability and mental will to fight.



laser designator rangefinders "should hit" data. In total, two Ravens and four operators performed 28 dry calls for fire and nine live calls for fire. Of the 28 dry calls for fire, 26 of the Raven's initial "did hit" data were within 75 meters of the "should hit" data. Raider Fires assessed the two outliers to be effected by heavy fog between the target and observation post. Of the nine live calls for fire, Raider Fires achieved effects on the first adjustment round after the initial round landed within 75 meters target location error. Raider Fires blended elements of manual gunnery with digital computations in order to compute accurate deflection/quadrant elevation from initial Raven corrections.

Raider Fires, 3-4th CAV Raven operators, and mortar men teamed while producing a simple mathematical equation for rapidly computing the Raven's "did hit" data into actionable deflection/quadrant elevation. Upon impact of first round, the Raven operator froze an image depicting target "should hit" data and point of impact "did hit" data. Initial corrections were generated by the Raven's line tool within its Falcon View operating system. The Raven operator manipulated the (S) and (T) icons placing them over the target and point of impact respectively.

This manipulation triggered the Raven's ground control station line tool to automatically generate highly accurate add/drop, left/right, range and elevation corrections. Key to note the Raven's elevation acted as a vertical observer target line and was already calculated into the left/right add/drop corrections. Exploiting this data, a Raider Fires fire support officer simply relayed the left/right add/drop correction provided by the Raven as well as the direction multiplied by 17.7. The multiplication is needed to solve for observer target line in mils from original data provided in degrees. This data enabled the mortars to solve for deflection/quadrant elevation producing effects on target with first round adjustment. Specific insights relating to FIST/SUAS teaming are highlighted below:

Observation: Target grid versus Raven location grid.

Insight: After the Raven operator lazes a target, the target grid appears in the bottom left of Falcon View while the Raven location grid appears in the top left of Falcon View. Both grids are unlabeled and easily confused by a Raven operator who has not called for fire from an RQ-11 platform. This confusion is easily mitigated by adding a Raven call for fire requirement into an operator's quarterly currency requirements.

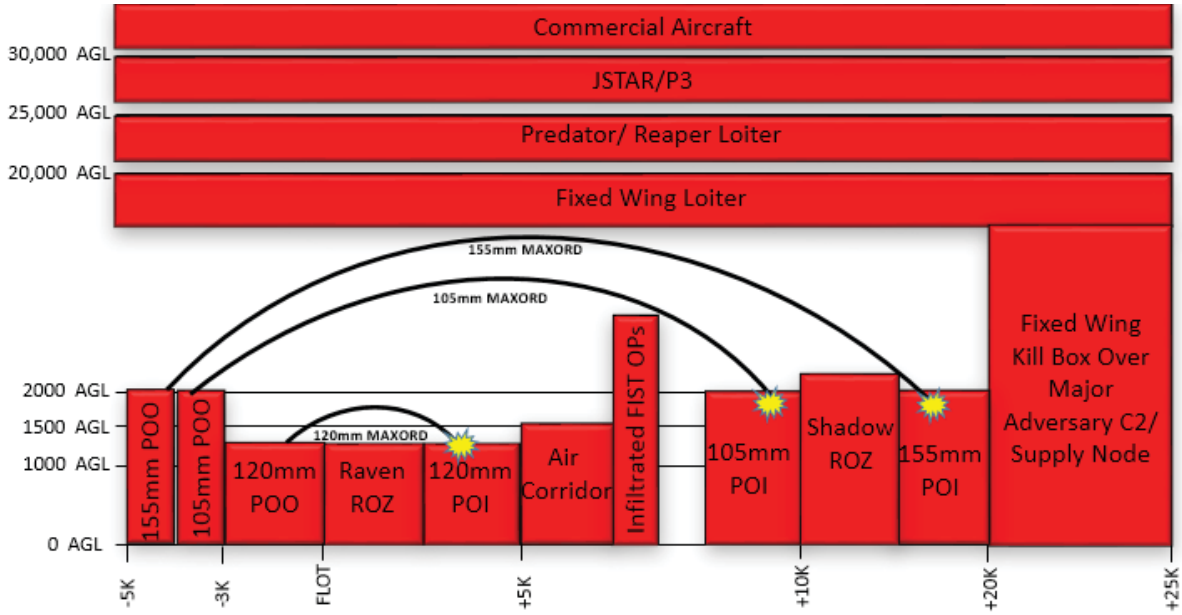
Observation: Leveraging time of flight and Raven target circle to solve for line-of-sight friction.

Insight: During three of nine live Raven calls-for-fire line of sight between the Raven's gimbal camera and target became obscured during 50 percent of the Raven target circle. As the Raven circled the target area 1,000 feet above ground level, uncontrollable crosswinds manipulated the Raven in such a way the wing itself obscured the target area. After timing how long the Raven took to complete one full circle above the target area, operators applied the round's time of flight in order to solve for when the Raven could observe impact while experiencing crosswinds.

Observation: Gimbal camera zoom affects accuracy of initial Raven call for fire grid.

Insight: A Raven's gimbal camera has four zoom settings: wide, medium, narrow, and ultra. During the third live call for fire the Raven pulled one grid for each setting while observing the same target. Raider Fires found accuracy of initial target grid is greatly improved while using the gimbal camera's ultra-zoom setting as opposed to the wide zoom setting. However, when in ultra-zoom setting, a Raven operator will have increased difficulty maintaining line of sight with target while experiencing high winds. This friction point reinforces the need for Raven operators to complete Raven call for fire in ultra-zoom setting during quarterly flight training.

Observation: Collocation of sensor shooter.



The methodology used for airspace deconfliction during the integrated brigade deep fight exercise. (Courtesy illustration)

Insight: During the FIST/SUAS experiment Raven operators collocated with the 120 mm firing point greatly reducing call for fire routing length. Raven operators literally stood next to tubes while verbally declaring targeting grids enabling rapid identification, computation of firing data and firing of rounds.

The quantitative analysis portrayed above suggests deliberate FIST/SUAS teaming has the potential to severely attrite adversarial combat power within the brigade deep fight. Raider Fires will integrate this tactic in four phases designed to offer both the squadron and field artillery battalion commander tailorable options for projecting lethal disruptive Fires into the brigade deep fight.

Infiltrate, observe, communicate, dominate

The integrated brigade deep fight is broken into four phases: infiltrate, observe, communicate and dominate. FIST/SUAS team infiltration occurs under period of darkness 24 to 48 hours prior to 3-4th CAV's main body establishing screen in preparation for forward passage of lines. Once FIST/SUAS teams establish observation posts within an adversary's tactical support zone, the observe and communicate phases are conducted in a continuous cycle until domination within the brigade deep fight is achieved. FIST/SUAS teams hunt for advancing adversarial combat power in order to initially disrupt and then destroy dismounted formations, light skinned vehicles, support platforms, air defense artillery and command and control nodes. All observation posts maintain communications with a forward positioned Raider Fires M1200 Knight relay station who assists by relaying digital and voice call-for-fire messages from forward positioned operations to a direct support platoon fire direction center located inside or slightly offset from the 3-4th CAV tactical operations center. This collocation shortens the call-for-fire routing process assisting in rapid indirect fire response time as well as enhanced common understanding between the cavalry and Fires organizations. The domination phase is achieved when a catastrophic amount of disruptive Fires is employed effectively paralyzing an adversarial decision cycle. The adversary's ability to contest terrain by moving combat power through the tactical support zone into the close fight becomes so degraded that he or she loses the will to fight.

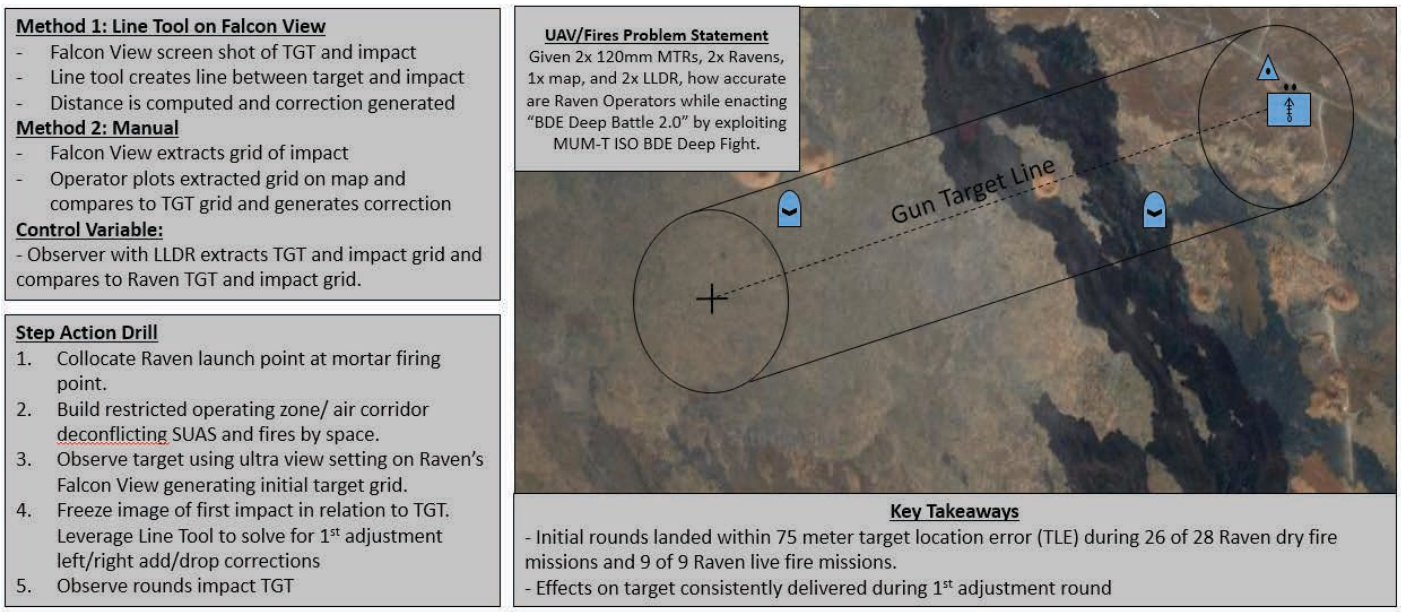
Manned unmanned teaming (MUM-T) essential to generate rotary wing freedom of maneuver

While contesting terrain with a near-peer or peer adversary, a critical component of the integrated brigade deep fight will be MUM-T initiated by forward positioned troop FIST/SUAS teams. This concept is further reinforced by Maneuver Center of Excellence in the June 20, 2018, Cavalry Warfighter's Forum. In reference to reconnaissance within the brigade deep fight, Col. David W. Gardner, 2nd Armored Brigade Combat Team, 1st Infantry Division commander stated "Manned-Unmanned teaming is essential, as is air-ground teaming (e.g. Bradley Fire Support Team and Apache Helicopters-64E)."[2] Within the integrated brigade deep fight forward positioned Raven operators provide critical targeting data on enemy air defense assets and [will team] with artillery to destroy those assets immediately.[3] Following the destruction of all known air defense artillery targets, Raven operators will conduct armored target handoff with 25th Combat Aviation attack rotary wing platforms. Loss of life is mitigated by leveraging troop FIST/SUAS teams to specifically hunt and generate targeting data for adversarial ADA pieces. Once destroyed, attack aviation will retain the necessary freedom of maneuver to destroy armored targets received via MUM-T with troop FIST/SUAS teams.

Artillery, armor targets, air deconfliction

The 105 mm weapon system is uniquely qualified as an all-weather 24/7 delivery asset able to inflict, when massed appropriately, a high level of battle damage over time within an adversary's maneuver close fight and tactical support zone. As the Army continues to pivot away from stability operations, while placing increased focus on peer/near peer adversaries, we project a higher rate of unobserved and area focused call for fire at the expense of stability oriented precision Fires. Yet, cannon artillery Fires are notoriously ineffective while employed against an armored target generating the need for target handoff with

2 *Gardner, David COL. 2018. "Cavalry Warfighter's Forum," Maneuver Center of Excellence. JUN 2018, Accessed on 20 JUN 18. slide 17.*
3 *Sickler, Bobby MAJ, Henderson, David MAJ, and Hansen, John, 2017. "An Integrated Division Deep Fight: Deep Battle 2.0," Center for Army Lessons Learned. FEB 2017, Accessed on 18 JUN 18. p. 4.*



The mission brief for the fire support team/small unmanned aerial systems-experiment live-fire. (Courtesy illustration)

rotary or fixed wing aviation. However, in order for fixed and rotary wing aviation to expeditiously close with an armored target, oftentimes it must traverse numerous gun target lines originating from multiple firing points. Multiple firing points within a brigade's area of operation tend to create varying projectile flight paths placing SUAS, rotary, and fixed wing aircraft in jeopardy. Haphazard air de-confliction at either brigade or battalion level has extremely debilitating effects on target decay time. Therefore, if both manned and unmanned aircraft hope to maneuver towards a position of relative advantage, key leaders within brigade, field artillery battalion and squadron tactical operation centers must achieve a collective conceptualization of how best to de-conflict air between shooters on the ground and flyers in the sky. During 3-4th CAV's recent June, 2018 gunnery rotation, Raider Fires teamed with 3-4th CAV in order to nest within 25th Division Artillery's goal post de-confliction method allowing "aircrews to fly under… incoming rounds [while retaining] acceptable levels of freedom of maneuver."[4] The air de-confliction method proven during 3-4th CAV's gunnery rotation can be further applied to de-conflict airspace within the integrated brigade deep fight between artillery, SUAS, Shadow UAV and rotary/fixed wing aviation.

The FIST/SUAS experiment coupled with Brigade Deep Battle 2.0 theory portrays how a light cavalry squadron, teamed with a direct support artillery battery, can integrate emerging SUAS technology with an aggressive fire support plan while attempting to paralyze an adversarial decision cycle. Brigade Deep Battle 2.0 was originally conceptualized at a May, 2018 Raider Fires University leader professional development session after reviewing how Russia, during the ongoing Russo-Ukrainian conflict, exploited FIST/SUAS teaming while projecting indirect Fires during the seizure of Donetsk airport. This event, along with friction within the brigade deep fight during our recent JRTC 18-04 rotation, served as a catalyst for the development of Brigade Deep Battle 2.0 theory. This theory will be continually tested during 25th Infantry Division's Lightning Forge field training exercise, upcoming JRTC deployment, 3-4th CAV tactical operations center validation exercise, and experiences gained at Cavalry Leaders Course.

In closing, Maj. Nick Brunetti-Lihach, a Marine Corps officer currently attending U.S. Army Command and General Staff Officer Course, said "a clear external threat coupled with rapid technological change presents challenge and opportunity."[5] The reality of FIST/SUAS teaming within Russian and Chinese conventional forces presents one of many threats to historical U.S. dominance within the military domain. Brigade Deep Battle 2.0 recognizes this challenge, conceptualizes how emerging technology can be joined with existing doctrine, and presents key leaders with a tailorable opportunity for the systematic projection of lethal Fires within the brigade deep fight.

Capt. Joseph Schmid is the fire support officer for 3rd Squadron, 4th Cavalry Regiment. He holds a bachelor of arts in English from West Florida University. Schmid attended Field Artillery Basic Officer Leaders Course at Fort Sill, Okla., He attended the Captains Career Course at Fort Sill and is now stationed at Schofield Barracks, Hawaii.

Second Lt. Zachary Tousignant is the fire support officer for B Troop, 3rd Squadron, 4th Cavalry Regiment. He holds a Bachelor of Science in Textile Engineering from North Carolina State University. Tousignant attended Field Artillery Basic Officer Leaders Course at Fort Sill, Okla., and is now stationed at Schofield Barracks, Hawaii.

Second Lt. Hector Lopez is the fire support officer for A Troop, 3rd Squadron, 4th Cavalry Regiment. He holds a Bachelor of Science in Management and Spanish from the United States Military Academy. Lopez attended Field Artillery Basic Officer Leaders Course at Fort Sill, Okla., and is now stationed at Schofield Barracks, Hawaii.

Second Lt. Paul Mirabile is the fire support officer for C Troop, 3rd Squadron, 4th Cavalry Regiment. He holds a Bachelor of Arts in Business and Economics from Virginia Military Institute. Mirabile attended Field Artillery Basic Officer Leaders Course at Fort Sill, Okla. and is now stationed at Schofield Barracks, Hawaii.

4 *Ibid.*

5 *Brunetti-Lihach, Nick, 2018. "Voices from the Disruptors: Profiles in Leading Military Innovation," Small Wars Journal. Accessed on 26 JUN 18. http://smallwarsjournal.com/jrnl/art/voices-disruptors-profiles-leading-military-innovation*

Strengthening light HIMARS for multi-domain operations

By Capt. Brennan Deveraux, 1st Lt. Sean Skelly and Staff Sgt. Evan Fowler

It is not just destructive power that makes artillery king. Throughout time the artillery has been an adaptable force, able to rapidly adjust to changes in mission and stay relevant. The uniqueness of indirect fire forces the artillery community to have an in-depth understanding of the battlefield as fire missions can range from support to an infantry squad through a corps headquarters. Increased battlefield situational awareness allows the artillery community to adapt to assume a pivotal role in the continuous development of combined arms warfare. As the military continues to develop doctrine to support multi-domain operations (MDO) it is no surprise that artillery, especially the High Mobility Artillery Rocket System (HIMARS), is at the forefront. A properly equipped light HIMARS package (LHP) provides an early entry option for a multi-domain task force (MDTF) to build combat power. When followed by the Air Defense and Airspace Management (ADAM) cell the combined capabilities create a Fires cell crucial to the success of the establishment of the MDTF. This article outlines the role of the LHP in support of the MDTF, as well as discusses the integration of the ADAM cell and the complementary communication capabilities it presents. The article is based on the experiences of B Battery, 1st Battalion, 94th Field Artillery Regiment as the LHP during the MDTF validation exercise, Rim of the Pacific (RIMPAC) 18.

Light HIMARS package

The LHP is designed for rapid deployment in order to provide a combatant commander a range of indirect fire options across an area of responsibility. The standard package for a C-17 aircraft has four vehicles: two launchers, a fire direction center (FDC) vehicle, and a command HMMWV with a generator trailer. The package is ready to shoot rockets or missiles, depending on the mission set, within 10 minutes of unloading the aircraft. For RIMPAC, B/1-94th FAR loaded four vehicles onto a C-17 and flew to the Pacific Missile Range Facility on the island of Kauai, Hawaii. Within one hour of downloading the aircraft, the element was on the firing point and in position ready to fire.

HIMARS loaded onto a plane equipped with the Joint Precision Airdrop System allows the panel inside the launcher to maintain its Global Positioning System while in transit; the launcher can then shoot guided munitions almost immediately upon landing. Once the plane lands the launchers are unchained and set a minimum of 500 meters from the exit point where the mission can be executed. After conducting the reconnaissance, selection and occupation of position at RIMPAC, the LHP established a hide site that allowed the simulation of exiting a C-17, ingress to a firing point and egress as if it was getting on a plane. During the exercise the LHP was able to execute a fire mission in under three minutes from the time of receipt of mission, to the time of the rockets fired, while simulating the exit of an aircraft.

Fire missions were one aspect of the role of the LHP during RIMPAC. The FDC was involved in more than just the prosecution of the two fire missions for the exercise. It acted as the MDTF tactical action center (TAC) due to enhanced communication systems. Outside of the normal FDC communication platforms, the LHP utilized the Command Post Node from the brigade signal company. This allowed the FDC to communicate digitally with the MDTF headquarters on Oahu. This capability enhancement provided a necessary role as a TAC, and not just the FDC for the LHP. Although the LHP was able to establish operations and prepare for follow on forces, it was the combination with the adjacent ADAM cell that allowed the full realization of the MDTF Fires cell.

Integrating the ADAM cell

The ADAM cell is a brigade-level asset and it is uncommon for it to be directly linked with a small battery level element like the LHP. The ADAM cell established operations adjacent to the FDC vehicle at RIMPAC, and once both elements understood how they complemented each other, a strong team was formed. Tactical Satellite (TACSAT) radios and LINK-16, a military tactical data exchange network, became instant combat multipliers. The arrival of these systems at the TAC location gave the MDTF the communication linkage, as well as necessary situational awareness of the battlefield. Once operational the LHP and ADAM cell became a cohesive team, rather than separate entities, and were thrust into a role as the Fires coordination center/TAC for the MDTF. This was primarily due to the capability to communicate with aerial systems that the headquarters on Oahu could not. The linkage and interoperability is vital to the fire cell. This was validated on the last day of the live fire when the Advanced Field Artillery Tactical Data System (AFATDS) and LINK-16 were directly connected. As this integration develops further it is imperative to continue to work the connectivity and training of these systems together, with a goal of sending fire missions straight through LINK-16 to the FDC, expediting fire mission processing.

LINK-16 is an integral part of a Fires cell for the MDTF. The system provides a constantly updating 360 degree view of the battlefield, and up-to-the-minute information on friendly and enemy forces in the region. This makes the ADAM cell the perfect partner for the LHP in order to conduct operations while building initial combat power. The 25th Division Artillery ADAM cell did this excellently at RIMPAC. The early integration and partnership gave the MDTF the ability to receive targets via aerial assets and send them direct to an AFATDS via LINK-16. The rapid relay of information available via LINK-16 allowed a real time update of the battlefield for the operation which created a high level of situational awareness in the TAC. Giving the FDC the ability to connect to LINK-16 is paramount for the MDTF in order to be relevant in future engagements. With the other military services already using the system, integration by Army assets would enhance situational awareness and allow for a more cohesive information flow throughout the force. TACSAT radios, coupled with the live LINK-16, allows for the successful and rapid integration of HIMARS. The LHP

Soldiers from B Battery, 1st Battalion, 94th Field Artillery Regiment, load a High Mobility Artillery Rocket System onto a C-17 Globemaster in support of the Rim of the Pacific 2018 exercise. (Courtesy photo)

can be thousands of miles from the MDTF headquarters and still receive digital fire missions with the use of TACSAT radios, greatly enhancing the range of the weapon system and the influence of the MDTF on the battlefield.

The methods of conducting warfare are forever changing, adapting to both updates in technological capabilities and emerging doctrine. As the doctrine for the employment of the MDTF begins to develop, two things are key for the artillery community: the LHP stays a pivotal role as an early entry asset, and the relationship with the ADAM cell is codified. Independently the LHP is not equipped to handle the communication systems necessary to maintain the fight long term, but combined with the ADAM cell it is clear the pairing has the potential to be the future of the MDTF. The LHP is rapidly deployable and provides an initial fighting force capable of basic mission command and Fires capability. If habitual associations are established with the ADAM cell to build and develop tactics, techniques and procedures for fighting in MDO then the combined capabilities will create a Fires cell critical to the success of the MDTF.

Capt. Brennan Deveraux is the B Battery, 1st Battalion, 94th Field Artillery Regiment commander. He also previously served as the Headquarters and Headquarters Battery commander for the 17th Field Artillery Brigade. Deveraux is a graduate of the Marine Expeditionary Warfare School and holds a bachelor's degree from the University of Washington in Political Science.

1st Lt. Sean Skelly is the 1st platoon leader of B Battery, 1st Battalion, 94th Field Artillery Regiment. He served as the fire direction officer for the Light HIMARS Package that executed Rim of the Pacific 18. Skelly holds a bachelor's degree from Liberty University in Religious Studies.

Staff Sgt. Evan Fowler is a 13J and the Headquarters platoon sergeant of B Battery, 1st Battalion, 94th Field Artillery Regiment. He served as the fire direction non-commissioned officer for the Light HIMARS Package that executed Rim of the Pacific 18.

RIMPAC '18 exercise highlights versatility of SHORAD

By 1st Lt. David Lara

The 6th Battalion, 52nd Air Defense Artillery Regiment recently had the opportunity to participate in the first-ever training exercise for the Multi Domain Task Force Pilot Program (MDTF-PP) in support of the world's largest maritime exercise, Rim of the Pacific (RIMPAC) 2018.

Their mission was to provide short-range air defense (SHORAD) capabilities in the form of Avenger firing units as part of an unknown aircraft live-fire scenario at Pacific Missile Range Facility located on the island of Kauai, Hawaii.

The tactical scenario of the live-fire exercise was a proof of concept for command and control of air defense assets that are forward deployed away from the task force footprint by combining all joint intelligence, surveillance and reconnaissance platforms into a common operational picture by utilizing Link-16. To accomplish this task, the force employed the 17th Fires Brigade to disseminate air defense warnings and weapons control statuses that come directly from the task force commander. They then employed members of the Sentinel Section from the 25th Infantry Division Artillery cell on the island of Kauai to act as a local command and control node and disseminate early warning to Avenger firing units.

In accordance with the training objectives outlined by the MDTF commander, Col. Christopher Wendland, the air defense and airspace management and division artillery cells trained to classify live air tracks and disseminate firing orders from the brigade tactical operations center (TOC) directly to the Avenger firing units. From there, the Avenger teams prioritized tracks and identified hostile ones using targeting consoles and crew chief air situational displays to send positive confirmation back up to the TOC on Oahu in real-time via data and voice communications.

In the first of the two live-fire engagements, Spc. David Fausz and Pfc. Matthew Munoz fired from the Avenger platform demonstrating fully operational SHORAD capabilities. They received their weapons control status and air defense warning updates, and were notified of a hostile unmanned aircraft entering their engagement area. They received the firing order which provided them the live track data necessary to complete the engagements. Simultaneously, other personnel ensured the battlespace was clear of all friendly aerial and maritime assets. The crew was able to immediately relay the engagement report directly to the TOC on Oahu after the engagement. This allowed the task force commander to have immediate knowledge of a destroyed enemy reconnaissance, intelligence, surveillance and target acquisition or RISTA threat in the task force's area of operations.

The second engagement conducted by Sgt. Aaron Nash and Spc. Cody Crabtree demonstrated the ability of SHORAD

assets to effectively operate in degraded operations. The scenario required the pair to simulate a loss of their Avenger system and convert to manned portable air defense (MANPAD) operations which is the shoulder-fired variant of the Stinger missile. They also lost the capability to communicate and receive air tracks through real-time data, restricting them to voice communications with the command and control node. The command and control node communicated the real-time track data to the Stinger team allowing them to identify the remote control miniature aerial target (RCMAT)

Army Pfc. Matthew Munoz, air and missile defense crew member with the 35th Air Defense Artillery Brigade, observes the sky prior to engaging an unmanned aerial vehicle target, during the Rim of the Pacific 2018 exercise at Pacific Missile Range Facility Barking Sands, July 24. (Sgt. 1st Class Claudio Tejada/U.S. Army)

which simulated an enemy unmanned aerial system. Utilizing their visual aircraft recognition training, the team executed a successful engagement. They then used the control node as a relay to send an updated situation report which allowed the MDTF commander to have the same updated situational awareness as when the team operates from the Avenger system.

The success of the live-fire scenario was a large victory for the air defense community as it was part of the first attempt at integrating U.S. Army SHORAD assets in support of the pilot program for the MDTF. The ability to demonstrate that these assets could tie into the joint network and successfully complete the mission while forward of the task force footprint met the commander's intent and showcased SHORAD during a time where the Army is working to rebuild capability throughout its forces. Moving forward, exercises such as this that employ a wider variety of intelligence, surveillance, reconnaissance assets and joint platforms will allow the knowledge and utilization of SHORAD capabilities to expand across the Army.

1st Lt. David Lara comes from Tehachapi, Calif., and earned his commission from Northern Arizona University in 2016. Upon graduating ADA BOLC as the Distinguished Honor Graduate, he was assigned as an Avenger platoon leader for E Battery, 6th Battalion 52nd Air Defense Artillery at Camp Casey, Republic of Korea. After the relocation of his unit to Suwon Air Base he was assigned as the officer in charge of providing short-range air defense to the 210th Counter Fire Task Force. He is currently a battle captain assigned to 6-52nd ADA at Suwon Air Base, Republic of Korea.

Tactical joint Fires integration training at Fort Sill

A success story in a resource-constrained environment

By Lt. Col. Nick Sargent

Being based at Fort Sill, Okla. since July 2015, I quickly became aware of the almost daily live artillery training conducted on the East and West Ranges. What took a little longer to notice was that adjacent to West Range is Falcon Range, the busiest range in the Air Force. In fiscal year 17, Falcon Range hosted 3,026 aircraft sorties with 561 involving joint tactical attack controllers (JTACs). I therefore asked myself, is it possible to synchronize any of this training?

A lack of resources?

There is a perception across the U.S. services and U.S. Special Operations Command that there are not sufficient close air support (CAS) sorties available for JTACs, forward air controller (airborne) [FAC(A)] and joint Fires observer (JFO) certification and qualification training to meet the minimum standards articulated in the associated Joint Fire Support Executive Steering Committee (JFS ESC) memorandum of agreement (MOA). When considering training beyond these minimum standards, to achieve proficiency in what are perishable skills, this perceived shortfall is even greater. Whilst the statistics themselves are plain to see – over the past 15 years the number of JTACs, FAC(A)s and JFOs has increased as the number of close air support capable aircraft has decreased. I believe this statistical mismatch is exacerbated by a disconnect that exists when considering the planning of training between JTAC, FAC(A), JFO and CAS capable aircraft communities.

Coming from a much smaller military in the U.K., but having had the good fortune to work as an exchange officer for both the U.S. Marine Corps (2009-2011) and U.S. Army (2015-present), I look at the number of CAS sorties the U.S. services can generate for training with envy. As an outsider looking in, I suggest the U.S. services could be much more efficient with the assets that are available. Planning is the key. The challenge is identifying common training objectives across all CAS players, airborne and ground-based alike, and then synchronizing training audiences in time and space.

Planning in combat

However, planning is a skill that has atrophied during recent campaigning over nearly two decades in the Central Command area of responsibility. CAS has been the most prevalent air mission on the air tasking order. Pre-planned CAS has been the exception and immediate CAS has been the norm. Pre-planned CAS existed essentially when air alert CAS was waiting for a higher priority immediate request, particularly as its ubiquitous nature and reach compensated for the limited range coverage of organic land component Fires assets. There is of course the contention that some missions were termed CAS but were not CAS when considering the Joint Publication 3-09.3 definition however, that is for another article. As transition back to large-scale combat operations occurs, a more proactive approach to CAS planning must be taken. CAS, in the context of counter-land operations, will compete with air interdiction for its apportionment and allocation of resources. Counter-land operations will also compete with other air missions for assets – strategic attack, offensive counter-air and defensive counter-air to name but a few – as it will likely be the same multi-role aircraft flying these missions. All this in the context of a contested or highly contested operational environment. Proactive planning for and requesting of CAS, in order to "compete" with the other tasks the joint force air component command is required to accomplish, becomes a necessity.

Planning in garrison

Air tasking order planning in combat is driven by a multitude of factors, in particular mission and targeting requirements, which generate an air asset in time and space. However, when planning in garrison it is frequently a unit's maintenance schedule, more often than not established a year in advance to support a training and/or deployment cycle, which drives the availability of aircraft. Understanding this maintenance schedule reality, and other home station factors like approved takeoff and landing times, should not be overlooked by those planning CAS training from a ground perspective and can be accounted for by considering the following:

1. Identify potential "joint Fires" partners in your local area (account for flying units that are in proximity to your local range facilities), establish a network and build relationships.
2. Identify common training objectives, desires and goals based on higher headquarters' tasking and guidance.
3. With all parties involved, simply ask "what can I offer you?"

By way of example, here is what was accomplished when these factors were considered recently at Fort Sill.

Re-establishing tactical joint Fires integration training at Sill

In 18 ½ weeks, the Field Artillery Basic Officer Leadership Course (FA BOLC) teaches Army second lieutenants the critical tasks required of a platoon leader, fire direction officer and fire support officer (FSO). Since September 2016, the FSO syllabus has included JFO MOA tasks. The FA BOLC's capstone exercise, Red Leg War, sees student FSOs plan and execute the integration of Army and joint Fires with company-level maneuver.

After a 10 year absence, the Air Force once again routinely supports institutional training at the Army's Fires Center of Excellence, Fort Sill.[1] At the time of writing, there has been fighter and bomber support to four Red Leg War exercises since October 2017, with support planned for each of the 17 exercises out to the end of Fiscal Year 2019. During Red Leg War, student FSOs put their JFO skills to the test – requesting, adjusting and controlling cannon artillery Fires; providing target information to JTACs and FAC(A)s in support of CAS missions; and conducting terminal guidance operations. So far, live and dry CAS

1 *https://www.army.mil/ article/196484.*

missions have been executed by F16s, T38s and B52s controlled by JTACs and FAC(A) s, and supported concurrently by live artillery suppression of enemy air defenses (SEAD).

How was this achieved when resources are perceived to be scarce?

The planning technique used the combined lines of effort outlined above – along with networking and relationship building, identification of common training objectives and asking "what can I offer you?" Planning was collaborative in nature involving all stakeholders, training audience as well as training enablers. Notably, training enablers played a critical role. The Fort Sill Range Operations developed new weapons danger zones for CAS targets outside the existing target set; the two local airspace control agencies were also critical, ensuring that non-exercise participants could continue to train with minimum of impact and that exercise participants (air and ground) could optimize the use of local military operating areas and restricted airspace.

The foundation for planning this level of joint integration started with establishing a network of and relationships between joint Fires players within a 200 mile radius of Fort Sill. From an Army perspective this included the Army Multi-Domain Targeting Center, U.S. Army Field Artillery School, Fort Sill Range Operations and Fort Sill Army Radar Approach Control. From an Air Force perspective this included 80th Flying Training Wing, 138th Combat Training Flight and 457th Fighter Squadron. This network is ever expanding.

Once the network was established and relationships built, aspirations and objectives for training opportunities were discussed. In doing so, common JTAC, FAC(A) and JFO training objectives were identified by cross-referencing the three JFS ESC MOAs and service training regulations. Examples included:

- Live CAS attacks with JFOs providing targeting information to JTACs and FAC(A)s, while integrating live artillery SEAD.
- Lateral and altitude separation techniques in order to mass Fires on a common timeline using USMC SEAD procedures.
- JTAC-FAC(A) battle handover.
- FAC(A) live artillery call for fire.

Finally, having asked "What can I do for you?" the battalion commander of 1st Battalion, 30th Field Artillery (part of the USAFAS) offered a dedicated firing unit for one hour per day with 50 rounds in support of JTACs and FAC(A)s conducting call-for-fire training as the primary training audience. On two occasions, 138th Combat Training Flight integrated contract CAS night sorties scheduled to support their pre-JTAC Qualification Course instructor cadre work up.

An A-10 Thunderbolt II conducts a show of force over an observation point during a combined arms maneuver live-fire exercise at the Orchard Combat Training Center, Boise, Idaho in Sept. 20, 2018. (1st Lt. Robert Barney/U.S. Army)

The result is the establishment and continuation of outstanding tactical joint Fires integration training.

Although resources are finite, better planning can and will lead to better tactical joint Fires training opportunities for JTACs, FAC(A)s, JFOs and CAS capable aircraft alike. This planning must account for the training schedule of each community, endeavor to synchronize these schedules where resources are available in the same time and space, and consider the common training needs of each community.

For further information on tactical joint Fires training opportunities at Fort Sill in FY19-FY20 during Red Leg War, please contact the author. In particular, opportunities exist for CAS capable flying units as well as FAC(A)s. Upcoming Red Leg War dates are as follows:

1. Class 5-18, Oct. 15-19, 18
2. Class 6-18, Nov. 26-30, 18
3. Class 7-18, Jan. 14-18, 19
4. Class 8-18, Feb. 11-15, 19
5. Class 1-19, March 18-22, 19
6. Class 2-19, May 13-17, 19
7. Class 3-19, June 17-21, 19
8. Class 4-19, Aug. 5-9, 19
9. Class 5-19, Oct. 14-18, 19
10. Class 6-19, Nov. 18-22, 19
11. Class 7-19, Jan. 13-17, 20
12. Class 8-19, Feb. 17-21, 20

Lt. Col. Nick Sargent is the Army Multi-Domain Targeting Center Joint Integration chief. Sargent was commissioned in 1996 from the Royal Military Academy Sandhurst into the Royal Artillery. His service has been predominantly in the operational force with peacekeeping deployments to Cyprus, Bosnia and Kosovo, and combat deployments to Afghanistan (four), Iraq and Libya. The majority of his appointments have been fire support and targeting related, including battery commander of 148th Commando Forward Observation Battery, Second in command of 3rd Regiment Royal Horse Artillery, Naval Gunfire Liaison Officer and Air Officer. This is his second exchange tour in the U.S. having previously spent two years as I Marine Expeditionary Force's Assistant Force Fires Coordinator. He holds a Balchelor of Science degree in Sports Science and Business Studies from Brunel University and is currently reading for a Master of Arts degree in 'Airpower in the Modern Work' with King's College London.

Soldiers of the 5th Battalion, 3rd Field Artillery conduct tactical maneuvers during the Air and Missile Defense Exercise 17-02, May 2017. The exercise was a combined field training exercise between U.S. and United Arab Eremites High Mobility Artillery Rocket System. (Courtesy photo)

From Chai to compatible

Security cooperation in Middle East

By Lt. Col. Seamus Doyle

The 169th Field Artillery Brigade deployed to the Middle East as U.S. Army Central Force Field Artillery Headquarters in support of Operation Spartan Shield (OSS) and Operation Inherent Resolve (OIR) from January to September 2017. Assuming the USARCENT Force Field Artillery Headquarters mission, 169th FAB was operational control to 29th Infantry Division for OSS and general support to Combined Joint Task Force for OIR. The 169th FA BDE provided High Mobility Artillery Rocket System (HIMARS) Fires in support of both operations.

As our C-130 Hercules flew directly over the Burj Khalifa skyscraper, we pondered our brigade's security cooperation mission. Lessons learned during previous Middle East deployments reinforced the criticality of building positive relationships with our Arab partner militaries. Luckily, the relationship between U.S. and United Arab Emirates artillery forces was strong upon our arrival. We took over the relationship from the 197th Field Artillery Brigade with the intent to aggressively improve compatibility and contingency plan readiness. How would we determine our compatibility issues and how would we influence our partner artillery units?

We were determined to quickly transition from chai conversations to compatible operations.

One of 169th FAB's key tasks in support of OSS was to integrate the UAE field artillery forces into contingency operations in support of the combined defense of the UAE and the Arabian Gulf. The UAE Defense Force has the 79th Heavy Rocket Regiment which consists of a HIMARS battalion. As such, UAE is an integral part of the combined defense of the Arabian Gulf. Another task of OSS was to conduct artillery operations in the same geographic battle space as the Kuwaiti Land Force Artillery. The following provides an overview of the efforts between 169th FAB, 7th Artillery Corps (UAE) and the KLF Artillery to build partner capacity and provide for the combined defense of the Arabian Gulf.

Engagement rhythm

The Soldiers in 169th FAB established an engagement rhythm of at least one brigade or battalion-level collective engagement event each quarter consisting of field training exercises, live-fire exercises and command post exercises. Third-321st FAR and 79th HRR conducted HIMARS field training exercises and live-fire exercises during Exercise Saif Strike in March 2017. The exercise served to improve the integration between U.S. and UAE HIMARS units, and most importantly, identified compatibility issues which had the potential to negatively impact combined operations in UAE. The 169th FAB and the 29th ID command teams attended Exercise Saif Strike which fostered good relationships between the U.S. and UAE senior leadership. Next, 169th FAB and subordinate units conducted joint, combined, multi-national HIMARS general support artillery operations during the Air and Missile Defense Exercise 17-02 in May of 2017. In coordination with the U.S. Air Force Combined Air Operations Center – 169th FAB, 5-3rd FA Battalion, and B Battery, 3rd Battalion, 157th FA conducted a command post exercise and field training exercise along with the Emirati and Kuwaiti artillery units.

We collectively processed hundreds of fire missions — exercising the entire multi-echelon digital Fires process, from target acquisition to dry fire field operations. These exercises were also instrumental in identifying compatibility issues which could impact the defense of the Arabian Gulf. Finally, 169th FAB conducted a culminating engagement exercise named Exercise Spartan Thunder in August of 2017. This exercise was a combined, multi-national HIMARS general support artillery command post exercise and field training exercise. It served as a full digital and field rehearsal of the contingency plan along with our partner Kuwaiti and Emirati artillery units.

Interoperability

The Soldiers of 169th FAB implemented an interoperability model to assess, plan and execute engagements using the interoperability focus areas. We developed interoperability assessments using U.S. Army Regulation 34-1 (Interoperability), which identifies five focus areas: Fires, communication and information systems and information management, information sharing, sustainment, intelligence surveillance and reconnaissance and fusion. We assigned rating levels which spanned from no demonstrated interoperability to full interoperability. While conducting the multi-lateral and multi-echelon engagements described earlier, we assessed our focus area interoperability in the field alongside our Arab partners. We analyzed our assessments to create engagement plans, field artillery exchange curriculum, senior leader engagements and most importantly – collective field engagements. As a result of our assessment model, 169th FAB successfully rehearsed our contingency plans on numerous occasions by processing digital fire missions from the Combined Air Operations Center all the way to UAE HIMARS and Kuwait Land Force Artillery Soviet-made Multiple Rocket Launcher Systems.

Implementation

We conducted recurring staff engagements which helped influence the implementation of our engagement strategy. We met bi-weekly with the 7th Artillery Corps commanders or staff officers. It was uncommon for our Arab partners to conduct long-term security cooperation planning due to the uncertainty of their on-going operational deployment demands, so we focused instead on short-term engagement planning, usually four months in advance. We always included different 169th FAB staff members to reveal our organic Fires brigade capabilities and promote engagement opportunities. This was critical to establishing relationships across the UAE artillery force. This method was also implemented with the Kuwaiti Land Force Artillery leadership and our persistence resulted in numerous combined command post exercises and field training exercises with the

Soldiers in 169th Field Artillery Brigade drive a High Mobility Artillery Rocket System (HIMARS) during Spartan Thunder in August 2017. This was a combined field training exercise with U.S. military and the United Arab Emerite HIMARS units. (Courtesy photo)

Kuwaiti artillery forces. Next, we synchronized our efforts with our partner nation civilian defense advisors to create a mutually beneficial plan. The civilian defense advisors helped promote our programs and provide feedback to our interoperability assessments, and we subsequently helped to reinforce the advisors' curriculum as well. These discussions were always in the presence of our Arab partners. Our key to success was persistence. Our Arab partners were busy so it was necessary to constantly demand their attention, establish professional credibility and add value in order to gain participation in our engagements.

Adapting

Our Arab partners' military force structure and doctrine was constantly evolving, so 169th FAB sought creative engagement opportunities as the operating environment changed. The U.S. and UAE artillery battalions participated in a Subject Matter Expert Exchange Program. Officer, noncommissioned officer and Soldier participants conducted personnel exchanges throughout our deployment. The program promoted interoperability and built close relationships. Another example, we incorporated U.S. Air Force and Marine Corps joint terminal air controllers (JTACs) into our engagements. This helped UAE determine how the U.S. military differentiates between JTACs, joint forward observers and forward observers. Next, we conducted numerous engagements at the UAE and Kuwaiti Artillery Schools. We focused our curriculum on interoperability shortfalls and future field engagement objectives.

Finally, 169th FAB conducted the UAE Fires Lessons Learned Seminar in July of 2017. The seminar highlighted U.S. and UAE lessons learned in combat operations to improve our combined capabilities and interoperability. The seminar culminated with the U.S. and UAE military senior leadership discussing the lessons learned and developed plans to integrate the lessons into follow-on combined engagements.

Doctrine

Our combined engagements helped our Arab partners develop new capabilities and implement new doctrine. Our Arab partner artillery units trained at the platoon or battery echelon. During our engagements, we persuaded our Arab partners to operate at an echelon above battery level. Our exercises were designed to ensure the Arab artillery units operated as independent artillery battalions, developed battalion operational and fire control capabilities and incorporated the higher-level corps echelon into the targeting process. Our success and our strategy were sound and we provided a "way ahead" to our U.S. artillery successors to expand on our achievements.

During our final aerial movement back to Ali Al Salem, we reflected upon our performance as the USARCENT Force Field Artillery Headquarters in support of OIR

and OSS. Soldiers in 169th FAB performed their security cooperation duties in an exceptional manner. We successfully influenced our Arab partner artillery units, built partner capabilities and improved our combined interoperability. While numerous interoperability issues remained, our mission was rewarding and we established valuable relationships with our Arab partner Redlegs. On Target!

Lt. Col. Seamus Doyle is currently serving as the U.S. Northern Command Colorado Army National Guard Mobilization Element J3-5 staff officer. Doyle returned from deployment as the 169th Field Artillery Brigade deputy commander. Prior to deployment, Doyle served as the 147th Brigade Support Battalion commander and Colorado National Guard CBRNE Enhanced Response Force Package commander. In his civilian career, he is the director of operations and service delivery for NTT-Virtela, the leading provider of enterprise networking and virtualized IT services.

The synthetic training environment

Bringing reality to fire support training

By Maj. John Morris and Victor Bond

During my (Maj. John Morris) 10 years of service as a field artillery officer and Victor Bond's 28 years of service as an infantry and Special Forces officer, we realized the Army lacks the ability to replicate the effects of fire support during training.

This revelation was cemented when I served as the senior artillery/fire support observer controller trainer (OCT) at the Joint Readiness Training Center's Live Fire Division. At JRTC we wanted to provide rotational units a realistic understanding of the devastating effects of fire support. We were limited by multiple constraints such as minimum safe distances and surface danger zones. We partially mitigated these constraints by using full-range training rounds (non-explosive rounds), but this work-around failed to provide the rotational unit a full appreciation of fire support munitions and effects. Understanding this is critical for combined arms live-fire exercises, as commanders must truly understand and master how to effectively synchronize maneuver forces with the effects of fire support munitions. Understanding these effects allows maneuver commanders to effectively plan and assess risks, which cannot be fully achieved in training with existing training aids, devices, simulators and simulations.

Joint fire support personnel have limited ability to experience realistic training for multi-domain operations in diverse, complex operational environments. A potential solution to these shortfalls is the capabilities the Synthetic Training Environment (STE) Cross Functional Team (CFT) is currently developing.

The intent of this article is to explain the potential of the STE CFT's Soldier/Squad Virtual Trainer (S/SVT) (which will replace the Call for Fire Trainer, or CFFT, and Engagement Skill Trainer) to enhance joint fire support training. The Army and Marines are developing S/SVT together. The STE CFT is also working to enhance joint fire support in the live/virtual training environment and capture data points in training to apply in lessons learned. The STE CFT is also working to build the One World Terrain (OWT) capability for both rehearsals, training and support operations. The STE may also have the potential to augment the targeting process in both training and operational environments.

Fire supporter's individual and team training will be dramatically improved by the STE and S/SVT. Currently, the CFFT has two transportable configurations (1:4 and 1:12), a classroom fixed configuration (1:30), and one Immersive Training System available only at Fort Sill, Okla. Additionally, there is a mobile training team configuration developed for the Joint Fires Observer School. These systems represent legacy technology that will not provide for the joint fire supporter's future training requirements. Emerging technology requirements provided by S/SVT include new target locating devices; Lightweight Laser Designator Rangefinder and Joint Effects Targeting System; Precision Fires Warrior Dismounted; Precision Fires terrain databases; improved fire support coordination measures and airspace coordinating measures; and new Advanced Field Artillery Tactical Data System (AFATDS). The STE, through OWT, heads up display systems (HUDs) and other technologies are going to provide a robust joint Fires training capability combined with geographical terrain developed by OWT. By employing HUDs and OWT, Soldiers will be able to train in virtualized, realistic terrain from any part of the globe. The five terrain databases found in CFFT will be replaced with terrain of the user's choosing or deployment locations. This allows Soldiers to tailor the terrain to their upcoming operating environment (OE) prior to deployment. In addition, the depiction of patterns of life for civilian, friendly, neutral, coalition and enemy forces as well as updated vehicles and structures will provide more accurate representations of the OE. As the STE matures, HUDs will offer the potential to employ target acquisition capabilities — magnification and target recognition capabilities. The S/SVT will be more mobile due to its software-based technology that is primarily contained in a heads up display. The last leap for the HUDs will be the jump from the training environment to the battlefield being developed in conjunction with the Soldier Lethality Cross Functional Team at Fort Benning, Ga.

The S/SVT has the potential to make the combat training center "fire markers" a distant memory. The STE is improving joint fire support effects in the training environment with a two-pronged approach. The first approach is the previously mentioned S/SVT. Within this training capability are HUDs that project an augmented reality allowing Soldiers and Marines to view joint fire support effects which better replicate the live environment. This capability can potentially be achieved through integration of the HUDs and the Precision Fires Dismounted, which is the upgraded Pocket-Sized Forward Entry Device used by forward observers in acquiring and transmitting target data. This can be achieved by sending the templated point of impact and projecting the effects into the HUD. Other considerations that may be included are fuze/shell combinations, and proximity of the Soldier to the point of impact, which can assist to further bring reality to the live training environment.

The second prong of this effort is haptics which replicates the feeling of shrapnel. Haptics is a maturing technology currently constrained to a suit that is too bulky to wear in a field environment. The STE CFT is working with industry partners on this to allow Soldiers to "feel the heat" prior to touching the fire of combat. Haptics can replicate the effect of shrapnel raining down on friendly forces. When combined with HUD technology, it provides the disorienting effects associated with fire support munitions.

Currently, the lessons learned from training are typically compiled into a PowerPoint presentation, burned onto a CD, and then stored in a Modular Lightweight Load-Carrying Equipment or computer bag until … forever. As an OCT in a tactical environment, the capture of data is largely left to the naked eye, memory, the accuracy of notes, clear communications and luck. The STE CFT is working to change this by capturing data points during training while it is happening. Subjective observations will be combined with quantitative observations captured by the STE. The STE intends to use equipment to capture biometric data. There is potential to capture differences in the optical perception as the FO becomes fatigued. In addition, the STE has the potential to automatically incorporate accuracy details for joint fire support mission data into a feedback mechanism available to both Soldiers/Marines and their leaders.

During the Field Artillery Captain's Career Course I remember consistently being told by instructors pitching classes on mission command systems (MCS) such as Command Post of the Future, or AFATDS that each system is "the Army's mission command system." Unfortunately, my experience revealed a myriad of MCSs with different maps. The discrepancies in the systems' maps, their lack of transportability, availability and classification issues forced me to rely on paper maps or terrain tools to conduct planning at home station. While some of the issues are mitigated, we still lack a common virtual, interactive map of the world that is easily accessible and frequently updated. The solution is the STE's One World Terrain. This will allow fire supporters to plan complex training events, assess risk (range bearing tools, range circles, etc.), and analyze terrain using the same platform. This can facilitate collaborative planning, and assess the recent effects of munitions on both terrain and structures before arriving on the battlefield. During my time deployed and at JRTC it was difficult to review plans with fixed wing pilots prior to execution. The 30-45 minutes spent reviewing de-confliction measures and targeted areas of interest saved immense time and resources. In my experience, the time spent discussing this information allowed pilots to engage targets with little guidance after their initial check-in. Our primary issue was the inability to discuss topics such as de-confliction measures/targets with a common set of maps that could easily be shared. Employing a common set of maps allows personnel to synchronize operations from multiple locations using the same information. This capability will not be limited to training, but can be used operationally. OWT will be used in a classified up to secret, or unclassified level.

The combination of HUDs with OWT can revolutionize the targeting process through automation and greater fidelity. HUDs will eventually be employed operationally. The potential to apply facial recognition software to HUDs with augmented reality capability allows for increased target acquisition accuracy based on the target characteristics. Tying this capability to targeting priorities, target selection standards, and OWT can lead to automation of the targeting process. OWT allows recently acquired images to be imported into a common operating picture while simultaneously being analyzed by a computer using target selection standards and the maneuver commander's targeting guidance. The interactive capability of OWT allows those conducting the targeting/collateral damage estimates the ability to better forecast effects on the battlefield. The increased fidelity can be used to analyze the effects of munitions on different building types, ground surfaces, and more. When OWT is incorporated with drone mapping, recent changes to the operating environment can be incorporated and shared almost immediately. Furthermore, it can allow fire supporters to adjust observation posts and de-confliction measures based on weather or geographic changes to terrain, to include target areas located in micro terrain such as narrow mountain valleys. OWT replicates actual munitions effects when applied to the training environment. This increases accuracy for standard and precision munitions and allows for battle damage assessments and collateral damage estimates based on detailed target characteristics.

The STE with S/SVT can revolutionize the fire support effects in the live training environment and provide many other advantages. This capability is going to give maneuver commanders and fire supporters a true understanding of fire support prior to combat. It also has potential to bring greater collaboration, detail, fidelity and speed to the targeting process.

Maj. John Morris is a Synthetic Training Environment Cross Functional Team operations officer who previously served as a field artillery officer. He is a graduate of Texas A&M University (College Station) and holds a Masters of Military Arts and Sciences from the Command and General Staff College at Fort Leavenworth, Kan. He has served three tours in Afghanistan. His assignments include the 82nd Airborne and 101st Airborne divisions where he served as a company and squadron fire support officer, targeting officer, executive officer and battery commander. At Joint Readiness Training Center, Morris served as the Live Fire Division Fire Support/Battery observer coach trainer.

Victor Bond is a retired Special Forces officer with 28 years of service. Currently, he is a Department of the Army civilian, who serves as the Army and Special Operations capability developer for Joint Fires and Joint Medical. He holds a Master of Arts degree in Human Resources Development from Webster University in St. Louis, Mo. and Masters of Military Arts and Sciences in History from the Command and General Staff College at Fort Leavenworth, Kan. Bond served in numerous command and staff assignments in the infantry, Special Forces and the United States Special Operations Command. Additionally, he served as an advisor in Central/South America and Africa. Bond worked extensively with the Fires Center of Excellence and the Army Special Operations Command on the Call for Fire Trainer Program. He is the Joint Fires capability developer for the Soldier/Squad Virtual Trainer, Line of Effort, as part of the Synthetic Training Environment Cross Functional Team.

Soldiers assigned to 1st Battalion, 37th Field Artillery Regiment, 1st Stryker Brigade Combat Team, 2nd Infantry Division, send a round downrange from an M777A2 during Decisive Action Rotation 18-06 at the National Training Center, Fort Irwin, Calif., April 16, 2018. (Staff Sgt. Ernesto Gonzalez/U.S. Army)

Rising to the challenge

Fighting and winning with the M777A2 at National Training Center

By Capt. Aaron Palmer and Sgt. 1st Class Charles Lairson

The M777A2 howitzer provides general support field artillery firing for the U.S. Army's infantry and Stryker brigade combat teams. The M777A2 is the first ground combat system whose major structures are made of high strength titanium alloy, making it more than 7,000 pounds lighter than its predecessor, the M198.1 This decrease in weight allows the howitzer to be towed by any four-wheel drive vehicle over 2.5 tons, transported via rotary or fixed-wing aircraft and traverse terrain that was previously untrafficable using the M198 howitzer.

Throughout the Global War on Terror, the M777A2 continues to be used successfully on firebases and forward operating bases throughout the world, providing direct support artillery Fires to American and coalition forces. However, how does the United States Army use this asset to fight and win a decisive action engagement against an artillery-centric army while operating in challenging terrain? The following article attempts to answer this question using the Army's current doctrine, as well as the authors' experiences as an observer, coach/trainer at the National Training Center, in Fort Irwin, Calif.

Physical fitness

Fighting in high desert

As stated by the Sergeant Major of the Army, "Physical training may not be the most important thing we do that day, but it is the most important thing we do every day in the United States Army."[2]

High levels of physical fitness are required of all field artillerists, and cannon crew physical fitness plays a major role in the emplacement of howitzer sections during operations. M777A2 units routinely perform at a lower level than the operational environment demands. Many M777A2 units at NTC "run out of steam" within 72 hours of contact with the enemy, resulting in occupation times nearing 15 minutes and out of traverse missions averaging between 20-30 minutes.

Although many see the desert and mountainous environment of the National Training Center as a daunting physical and mental challenge, the desert is essentially neutral, affecting both the opposing force (OPFOR) and the rotational training unit.

1 *United States Marine Corps. 2005. Marine Corps Concepts and Programs. December. Accessed August 21, 2017. https://marinecorpsconceptsandprograms.com/programs/fire-support/lightweight-155-mm-howitzer-lw-155.*

2 *Tan, Michelle. 2015. Army Times. November 23. Accessed February 02, 2018. https://www.armytimes.com/news/your-army/2015/11/23/sma-dailey-s-top-10-leadership-tips-for-sergeants-major/.*

However, when properly prepared and trained, the desert and mountainous environment of the National Training Center offers specific advantages to units fighting with the M77A2.

Howitzer employment

The terrain at the National Training Center offers distinct advantage to a towed howitzer battalion through its ability to provide excellent concealment. In numerous locations within the training area, wadis and washes provide complete cover and concealment to individual M777A2 sections and sometimes to an entire battery. The use of the terrain gun positioning in conjunction with properly assembled camouflage netting enables the battery to decrease its probability of detection from enemy ground and air assets.

Dispersion also plays a key role in the survivability of the M777A2 battery. The near-peer threat is an artillery-centric force placing great emphasis on massing indirect Fires. The average OPFOR field artillery battalions consist of 54 122 mm howitzers and 36 multiple launch rocket systems. On average, OPFOR fire missions consist of 45 rounds of a dual-purpose improved conventional munition fired in an open sheaf. This results in a large area within the position area for artillery (PAA) affected by a single OPFOR fire mission. Although doctrine teaches us that there should be 250 m to 300 m of dispersion between gun sections, it is best to provide a minimum of 300 m to 350 m dispersion between sections. And if terrain permits, to disperse up to 500 m or greater when in open terrain without concealment. Although this results in extremely large PAAs, it will greatly mitigate the formidable counterfire risk that is ever-present during the rotation and is a reality when fighting a near-peer adversary.

Another new threat faced by the M777A2 battery is that of unmanned aerial surveillance. Dispersion and use of terrain as concealment play a key role in mitigating the threat of unmanned aerial systems (UASs). Routinely, batteries will come in contact with a UAS through either sight or sound, and battery personnel are unaware of actions to take. This normally results in the OPFOR neutralizing or destroying a battery through observed Fires. In addition to using the terrain and dispersing the battery, it is recommended that the Fires battalion provide clear guidance to the batteries on the measures to take when making contact with a UAS. This guidance should be in the form of air guard requirements, reporting

U.S. Army Soldiers assigned to 1st Battalion, 37th Field Artillery Regiment, 1st Stryker Brigade Combat Team, 2nd Infantry Division, fire an M777A2 during Decisive Action Rotation 18-06 at the National Training Center, Fort Irwin, Calif., April 16, 2018. (Pfc. Carlos Cameron/U.S. Army)

requirements and survivability move criteria upon contact. Appendix B, Table B-4 of Army Techniques Publication 3-09.50 also provides a thorough pre-combat checklist for an air threat.

Moreover, in order to mitigate the high risk of enemy counterfire and observed indirect fire on the M777A2 battery, the gunnery sergeants must reconnoiter, identify and inform the battery of their alternate and supplementary positions upon receiving indirect fire. A common mistake made at the National Training Center is the gunnery sergeants and battery commander plan for one alternate battery position within the PAA. Thus, once the battery has moved to this position and receives enemy contact, there is rarely another position planned for the battery to survive into, resulting in a frantic (and dangerous) movement at night as gun crews attempt to find adequate positions to occupy. As stated in ATP 3-09.50 the gunnery sergeant is the battery's primary reconnaissance expert and spends a great deal of time away from the battery. Thus, the gunnery sergeants and battery commander must be constantly thinking ahead and reconnoitering future positions for the guns and fire direction centers.

Reconnaissance, selection, occupation of a position

Conducting a proper reconnaissance, selection and occupation of a position (RSOP) is also key to the M777A2 battery's survival at the National Training Center. As outlined in ATP 3-09.50, pages 3-4, Table 3-1, the battery commander should always use the reconnaissance movement order prior to movement and conducting the RSOP. In addition to the battery commander, gunnery sergeants and security element, an effective techniques, tactics and procedures (TTPs) found at the National Training Center is for the reconnaissance party to also include a fire direction center. This allows the battery to thoroughly test their ability to communicate at the new PAA and, if needed, provide bottom up refinement to the battalion staff as to the suitability of the proposed PAA. The battery commander should also conduct a time distance analysis of estimated battery movement time from the current to the future PAA. This estimation must take into account the terrain and whether or not the movement will be conducted during daylight or periods of darkness. This time distance analysis must be submitted to the battalion command post, as it is a crucial component of the staff's running estimates.

As stated in Chapter 3 of ATP 3-09.50, the battery commander selects the battery firing area and once the general location has been determined, the gunnery sergeants conduct a detailed preparation of

their respective platoon areas. However, it is commonly observed at NTC that this preparation is not fully conducted, resulting in the battery taking additional time to occupy and report in position ready to fire. This may be avoided by using a templated gunnery sergeant's report; an excellent example of which is found in ATP 3-09.70, Figure 3-2. Once the advance party conduct's RSOP, it must take up hide positions within the PAA. Often at NTC, the advance party will remain in the open for long periods of time resulting in enemy forward observers calling fire missions onto the new PAA and compromising the PAA prior to the main body's arrival.

As previously mentioned in discussing survivability, once the gunnery sergeants have determined the primary positions for the howitzers and fire direction centers, they must immediately begin thinking of the next positions the battery must move to upon receiving indirect fire. As stated in ATP 3-09.50 Chapter 3-5, the alternate position must be reconnoitered as part of position improvement activities for the gunnery sergeant. The alternate and supplementary positions must be far enough away to avoid the effects of enemy indirect fire while simultaneously ensuring that the battery can service preplanned targets.

In addition, the battery commander must take the sustainment of the battery into consideration when conducting RSOP. In doing so, they must ensure the battery will be able to conduct resupply operations in the PAA and that the terrain itself will not result in a risk to mission accomplishment to the battery by inhibiting it from quickly and efficiently conducting resupply operations.

Sustainment

As simply stated by Maj Gen. J.B.A. Bailey of the Royal Artillery, "Logistics are the foundation of artillery tactics, for where there is no ammunition, there is no fire concentration."

A lack of a detailed plan for sustainment will always result in inadequate Fires or no Fires available for the maneuver forces. As observed in the desert environment of the National Training Center, the following TTPs can assist the rotational training unit in creating a successful sustainment plan.

It is highly recommended that the battery task organization be modified in order to better assist the logistics of the firing unit. In order to facilitate the most flexible sustainment support, at least one palletized load system truck, normally a part of the distribution platoon, should be attached to each firing battery. This attachment greatly enhances the ammunition haul capacity of the battery as well as allows the battery to anticipate and be ready for future missions through the increased amount of ammunition on hand.

Furthermore, attaching forward maintenance teams (FMTs) with adequate resources to make repairs to the firing batteries, assists in keeping the maximum amount of howitzers in the fight. As observed at the National Training Center, the most successful FMTs are those that have been adequately resourced at the battery level. This usually includes the battery having at least one 91B and 91F, a contact truck, and/or a shop stock van, as well as at least one U6 qualified noncommissioned officer with the proper U6 tool kit. Through this modified task organization for combat in an environment such as NTC, the battery is better able to quickly repair and conduct important maintenance, ensuring maximum firing capability and mobility at all times.

Combat configures loads (CCLs) also provide the field artillery battalion the ability to provide a quick and effective means of managing ammunition at the battalion and battery level. Prior to arrival at the National Training Center, the unit should establish a menu of CCLs that are codified and published in the battalion's standard operating procedures. Prior to ordering CCLs, the battalion staff must take the field artillery tasks, commander's guidance and desired munition effects into account. The battalion fire direction officer and S3 then give guidance to the S4 on what CCLs to order and the staging location at either the Combat Trains Command Post or Field Trains Command Post. This deliberate planning of CCL composition and staging will greatly assist the unit in providing responsive and flexible Fires to the brigade.

At the battery level, maintaining the cranes equipped on the M1084s will greatly decrease the battery resupply time. The National Training Center utilizes a "one round, one person, per minute" guideline for loading notional 155 mm ammunition and propellants. Through proper utilization of the crane systems, the overall resupply times may be reduced from the current 30 minutes per M1083/1084 by hand, to five to 10 minutes by using the cranes. This reduces the times that resupply assets are exposed in a stationary position. It also saves the energy of the Soldiers, which is consumed quickly as the rates of fire and resupply increase during the duration of the rotation. Battery commanders and platoon leadership should make a dedicated effort to ensure that the cranes are operational and load tested prior to arrival at the NTC and that Soldiers are properly trained on their use to benefit from the distinct advantage this system provides. If the use of fully mission capable crane systems is not possible for the battery, then the battery commander must understand the amount of time it will take to resupply the battery. This is accomplished by understanding how long it takes Soldiers to breakdown and distribute Class V from flat rack to gun section using the planning factor of one round, per one Soldier, per minute to transfer a round from one location to another.

Fire control, digital fire control system advantages

When operating in a decisive action environment, the M777A2 battery will find improved situational awareness, personnel management, and massing of Fires when using the battery operations center (BOC) in conjunction with a platoon operations center (POC) that controls the howitzers. The BOC provides tactical situational awareness to the battery command team as well as providing pertinent information to the battalion main command post resulting in bottom-up refinements for battalion planning. Simultaneously, the POC controls all firing howitzers resulting in an increased ability to rapidly mass Fires and provide a larger sheaf onto a target. BOC/POC operations also allow the battery fire direction personnel a realistic long-term work/rest cycle that will be necessary during decisive action operations.

The block 4 upgrade to the Digital Fire Control System provides several advantages to the M777A2 battery. It provides howitzer location, navigation, digital communications and emplacement/displacement-aid capabilities.[3] The distinct advantage with the block 4 upgrade is in its ability to allow batteries to fight similar to that of a self-propelled howitzer using the "goose egg" concept of survivability moves. This concept of conducting survivability moves allows each howitzer to quickly displace and emplace within 1,500 m from their last location without relaying and conducting a dry fire verification in the new position. This is especially advantageous in the decisive action fight as it allows the battery to

3 *Systems, Towed Artillery. 2017. M777A2 Digital Fire Control System (DFCS) Operator's Notes. Picatinny Arsenal, January 11.*

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conduct survivability moves and quickly be in position ready to fire against a near-peer, artillery centric threat.

Recommendations for home station training

It is understandably challenging to provide realistic home station unit training. These challenges are normally twofold: 1. The challenge to simulate the effects of indirect Fires and 2. The tendency to focus primarily on technical aspects of artillery, while neglecting the tactical aspects.[4] Although we cannot always effectively simulate a battalion six at home station, leaders within the artillery battalion and division artillery are able to ensure tactical aspects of training are not atrophied at home. Home station unit training, to include all cannon qualification tables should encompass tactical aspects of training, such as dispersion of gun sections and react to counter-battery fire.

Physical readiness training (PRT) and the stamina required to sustain high volumes of fire are of the utmost importance to the battery. Prior to arrival at the National Training Center, units must diligently develop a physical readiness program that prepares Soldiers for the rigors of combat and their profession. Creating a PRT program to meet specified unit standards on the APFT are counter-productive, as many of the exercises are not tailored toward artillery specific functions. Field Manual 7-22, Appendix A, page A-1 states, PRT programs must be developed to take this base level of conditioning and raise it to help meet or exceed mission-related physical performance tasks. Commanders must ensure that physical fitness testing does not form the foundation of unit or individual PRT programs. In order to prepare for operations in the high desert, PRT must focus on conditioning geared towards sprinting from truck to trails; cross-loading ammunition; digging spades quickly and efficiently, especially in hard, rocky ground; and the ability to emplace/displace/shift azimuths. The conditioning required to occupy and displace multiple times (6-20 times daily based on survivability move criteria) enables howitzer sections to survive when enemy counter-fire radar and delivery systems fire counter-fire missions.

Repetitions of duty-oriented conditioning training during daily physical readiness training is necessary for all M777A2 units to gain and maintain the stamina needed to win the first fight. Only through incorporating both technical and tactical training into each home station training event, no matter how mundane, will the M777A2 battalion be enabled to overcome every obstacle that the Mojave Desert and the OPFOR can throw in the battalion's way.

Sgt. 1st Class Charles Lairson serves the Fire Support Training team (Wolf) battery first sergeant and headquarters trainer at the National Training Center.

Capt. Aaron Palmer serves as the Fire Support Training team (Wolf) battalion fire direction center trainer at the National Training Center.

4 *Bailey, Jonathan B. A. 2004. Field Artillery and Firepower. Annapolis: Naval Institute Press.*

Drone defense from combined arms for air defense to organic ground based air defense

By Lt. Col. Thomas Groborsch

The following conceptual thoughts are meant to describe a sustainable future air defense response to current and future threats in the third, fourth and fifth dimensions (airspace, space and cyberspace). This analysis is derived from the eight dilemmas which are:

1. The area/surface-space dilemma
2. The quantity dilemma – staff/material
3. The mobility dilemma
4. The connectivity dilemma
5. The camouflage dilemma
6. The signature dilemma
7. The mass dilemma
8. The definition and selection dilemma

The deductions and conclusions in this paper are a result of threats driving the optimization of force capabilities for the protective mission of the U.S. and supported forces. This paper does not reflect current German positions or concepts, but the author's own thoughts.

Taking the current systems and those under development into consideration, this paper elaborates on a sustainable future air defense (AD) capability and possible postures. Partly, current trends and developments are seen to be unsustainable in the midterm. Therefore, some aspects are not in line with the foreseeable setup concerning system solutions. The Army Integrated Air and Missile Defense approach as a whole is seen as the base for the future AD with some modifications concerning the links to the organic maneuver force (the lower end).

Future drone offensive and defensive operations are raising questions for classical role differentiation between the services (especially the Air Force) on the upper end of air defense. On the lower end, this paper touches the limits of drone defense using foreseeable technological development for at least the next 10 years in infantry units that are not mechanized-supportable due to the setup of the battlespace. This paper finally advocates for passive sensors and autonomous/decentralized command and control (C2) for Layers 1 and 2 to the largest extent possible.

The railgun seems to be the effector of choice for the second Layer as it answers the problem of many of the dilemmas and is available at this moment. Emission-free solutions autonomously executed concerning their organic abilities seems to be the sustainable solution for Layer 1 for maneuver forces. Installations with known positions should have organic solutions with greater range at Layer 1 and this fixed capability is what brings the laser back into the game. Offensive drone use seems to be the better defense for the infantry fighting in urban areas, mountains and in forests not directly supported by mechanized forces.

Throughout this paper, one will realize a lot of current problems, such as choppers or cruise missiles, are theoretically included and solved within the derived future setup. The deductions and conclusions for each dilemma will be described starting at Layer 1 and ending with the consequences at Layer 3.

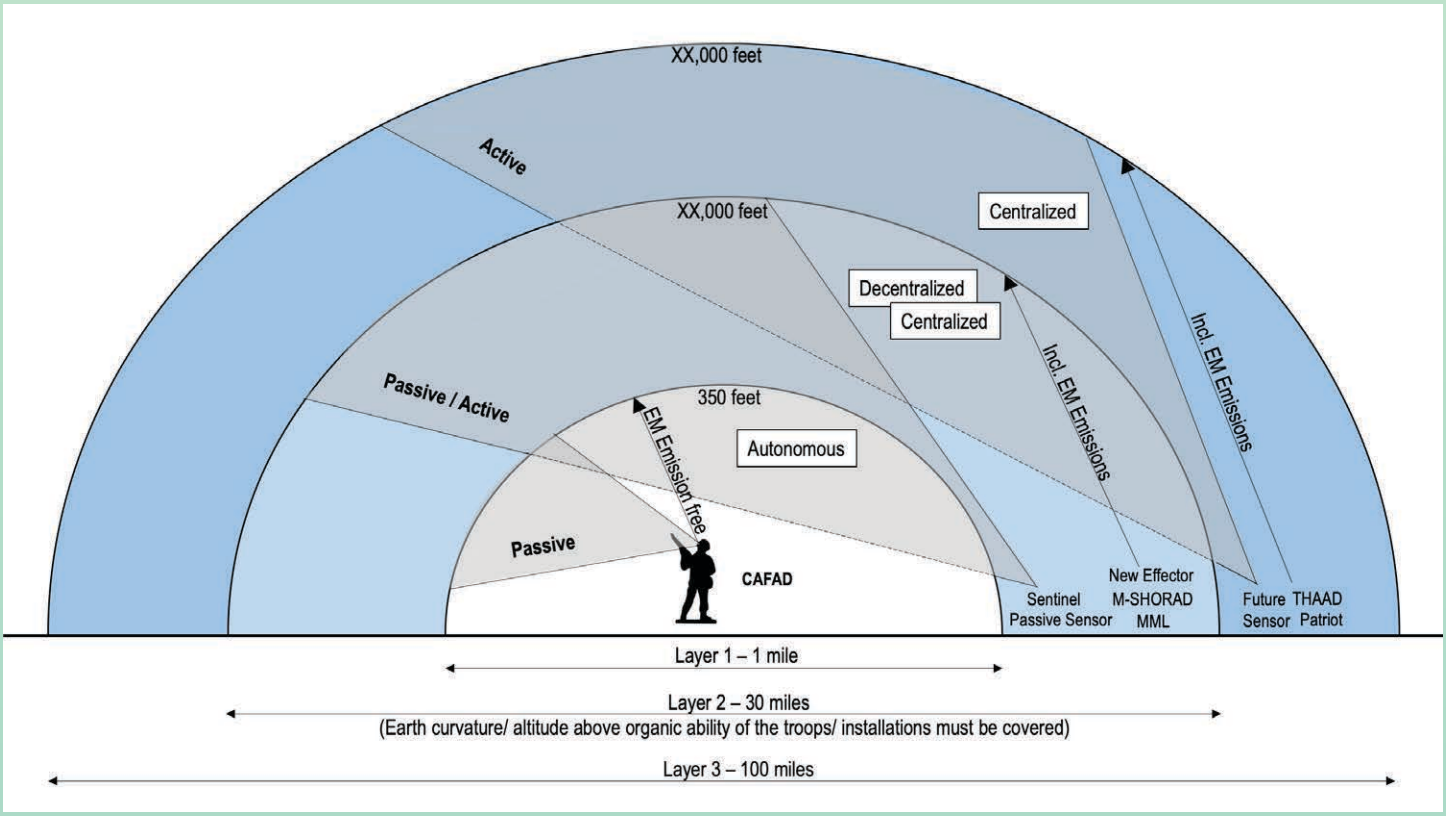
Below Layer 1

There seems to be demand for a different setup and way of thinking about the infantry fight as the Combined Arms for Air Defense has its limits when the fight is brought to areas where constant vehicle support to the fight is denied. In this environment, even with today's technology, the idea to enable the Soldier to defend himself from the opponent's hand grenade or bullets would be much too complex and would bring with it all the described dilemmas and power and weight issues to the Soldier. The very limited capabilities of the infantry in terms of mobility and payload should not be further dragged down by complex defensive systems against the thousands of different future means of nano and micro-size drone technology. Research and development should concentrate on small gadgets to beef up passive defense. Superior offense, including drone-based reconnaissance and weapons, is the best defense for the foreseeable future at this level. A war of attrition at the tactical level is not avoidable and drones can do an outstanding job of leveraging the efficiency of our infantry. Consequently, below the orchestrated Combined Arms for Air Defense, the near-future solution to the problem relies on drone technology enhancing the single Soldier's situational awareness, reach and killing efficiency. This could be sustainable economically. During the last couple of decades, the number of bullets shot per killed enemy rose from a few to several thousand, which is a lot in terms of weight, money and time used compared to what a drone could bring to the game. Since it is mass produced, the "flying hand grenade" and a simple camera could be the focus weapon on the infantry squad level with a reach of 2 to 5 km and would be economical. Within the firefight, the opponent would be attackable from all directions and in the third dimension. Even buildings shelter the enemy only if there is no hole in the building. A backpack with two to three single-use hand-started drones and a remote control would bring greater leverage to the squad on the ground.

Elaborating on Combined Arms for Air Defense starts not at the very bottom of the fight, but at a level where mechanized troops are the decisive force.

1. The area/surface-space dilemma – distance limitations caused by the flight level of the threat considering reaction times, earth curvature, urban structures and incrustation.

The fight against low, slow, small (LSS) drones can only be conducted by organic troops at platoon or company level and has to take place across the entire battlefield and on the lines of control (LOCs) in the vicinity of the friendly forces. Specialized AD Soldiers not trained in the mission behavior/tactical principles of the respective troops would first cause more risk, burden and friction than use. Think about missions in an urban environment and within areas with difficult incrustation. Second, it would cause an enormous demand of additional Soldiers. Third, it would drive the Army



A visual depiction of the result of a variety of facts, assumptions, deductions and conclusions in this paper. (Courtesy illustration)

into an organizational problem and last, but not least, it would lead to the question of whether the Army is responsible for doing this also for the Air Force and Navy installations/mobile components.

Therefore, it is recommended that all troops on the ground should have the additional task to fight LSS drones. But in terms of reach of their effectors, ground troops' abilities are very limited to fight drones of class two and higher. To fight those drones is a classic air defense task of organic air defense forces.

AD forces have to be enabled to cover significant amounts of airspace in a cost efficient manner with regard to sensors and effectors because drones are mass produced and fabricated on an industrial scale. They will be available covering the whole possible airborne mission set anywhere, anytime. Cyber space is the enabler, the drone is the means. Conclusively, AD sensors have a connection, camouflage, cost and signature problem, which seems (aside from tracking) to be controllable and manageable in terms of costs by passive radar technology. For the effector, this means there is primarily a connection, area, cost and mass problem. Missiles will not solve those problems. The price to overcome the space to the target and to navigate the missile to hit the relatively simple target are economically too high and in the mid to long term – especially concerning the mass aspect – they are simply not sustainable. To minimize the amount of systems needed (C2, logistics, force protection), the future effector has to be able to cover the respective flight levels of the drones in classes two and three nearby and also as far out as possible. Conclusively, the solution to the area/surface-space dilemma within Layer 2 is passive radar technology and railguns with embedded or remote tracking and engagement capabilities linked into Integrated Air and Missile Defense Battle Command System (IBCS).

2. The quantity dilemma – staff/material

Taken as given, that the fight against drones LSS at Layer 1 is a problem to be solved at platoon or company level, a quantity problem becomes obvious. As elaborated before, it does not make sense to create new military occupational specialties for this task, as costs to benefits are in no relation and as today existing and future material solutions will enable the force to deal with the problem with their organic means in terms of Layer 1. The quantity problem implies the growth of organic capability to fight LSS drones with the means of organic troops. The ability encompasses a material solution for the troops, which gets along with an additional qualification. In the good old days, this was the Air Guard with binoculars and target acquisition for the troops. With regard to the modern drone fight, this will be sensors, notational and information processing media that enables the troops to proceed and identify the findings of organic sensors and display them on organic notational capabilities of the troops at the platoon or company level. Based on this air picture, the engagement of hostile classified targets will be done relying heavily on one to be a developed effector as a focus weapon and the hand weapons of the troops. The actual developments of the Russian forces show clearly one threatening trend in that manner. Russia rolled out its first drone-borne anti-tank weapon. The new Russian tank is promoted to have at least organic anti-rocket artillery mortar (RAM) abilities working based on a passive sensor. This development could make friendly focus weapon systems like tanks and artillery irrelevant on the battle field of the future as long as they are unable to defend themselves against drone-borne engagements.

Above the Combined Arms for Air Defense in Layer 2, the quantitative problem in terms of the effector is only shrinkable with reach. The more reach we have at minimized costs, the lower the number of

Second Lt. La'Portia London, support platoon leader and 2nd Lt. Jessica Slade, launcher platoon leader, both assigned to Delta Battery, 5th Battalion, 7th Air Defense Artillery coordinate positions for the two launch stations during Juniper Cobra 18 at Mount Eitam, Israel Feb. 27, 2018. Juniper Cobra 18 is a ballistic missile defense joint U.S.-Israel exercise that uses computer simulations to train U.S. and Israeli military service members and to enhance interoperability. (10th Mountain Division)

systems necessary. Being part of the centrally organized AD fight, the effector and the sensor for Layer 2 will be part of the organic ADA forces. But, the effector also has to be fast in terms of mission execution to cover the air space as low as possible to create overlap with Layer 1. An anti-drone drone, for example, would be much too slow to overcome the distances at Layer 2 at the needed speeds.

It is highly probable we will never be able to cover the entire battle field and all LOCs at flight levels of Layer 2. Conclusively, we can counter the quantity problem at Layer 2 only by putting the enemy into a dilemma using his drone assets. Only by using passive (radar) technology, are we able to blur and hide the parts of the scenario we cannot cover which are in danger from enemy drones. The enemy is in a constant planning dilemma on where and how to use drones within Layer 2. Historically this effect showed up at the air operations at the no fly zones in Iraq, where Saddam still had a decent number of emission free Roland I systems, which caused the allies to avoid low flight levels. Unless Layer 2 is supported accurately by satellite or other technology, it needs to be covered by passive technology on the ground in addition to those active currently existing systems in order to deal with the fact that we will never have enough material to address the whole scenario.

3. The mobility dilemma

The mobility capability to fight drones at Layer 1 has to be 1:1 in line with the mobility of the respective troops dependent on it. In order to not endanger or deteriorate the tactical behavior of the fighting troops or to determine tactical decisions by the needs of a fight supporting task, no additional vehicles or trailers should be introduced when possible. Furthermore, the use of sensors and effectors should neither determine the mobility nor the dislocation of tactical units. The presence of those capabilities should not lead to further force protection tasks for the protected troops. The sensors, the display devices and the effectors should conclusively be mounted on the respective transportation means or focus weapons of the respective units, which is also important in terms of self-protection.

Above the Combined Arms for Air Defense, sensors and effectors are to be fully mobile on their own. The deployment concept of DA Weapons of Layer 2 is, beside the abilities of the current available missile-based weapon systems, similar to old short-range air defense concepts at a larger scale (belt defense, point defense, Layered defense, cloud defense, etc.). Mobility is not really the issue at Layer 2. The issue is logistics and force protection. Friendly AD assets have to morph into organic troop structures on the battlefield as much as possible to be protected and lined by those units. By being passive, they do not endanger the troops they are embedded with and being close to them provides significant air cover/protection.

4. The connectivity dilemma – marginal utility viewing

The embedding of the organic capability "Combined Arms for Air Defense" (Layer 1) into air warfare does not make sense. Some minor data exchange features that leverage the abilities on all layers are excluded from this statement.

On one hand, to connect the abilities of Layer 1 in order for them to be centralized or decentralized in our current understanding of such terms, are (beside some internet protocol (IP) based data exchange, material and staff elements) enormous task requirements and one quickly runs into the dilemmas 1 through 3. On the other hand, the sensor data of the battlefield with all the false alerts created by the battle turmoil and reflections would corrupt the allover RAP with a lot of clutter. Besides that, the redundant ubiquity of the internet in the battlespace (satellite, drone based, through cable and radio) enables us to provide an IP-based and encrypted RAP to the troops on the ground to give them additional help in terms of early warning and identification. This also gives our own air assets a further plus in terms of safety maneuvering at the flight levels of the Combined Arms for Air Defense. One should strive for a possibility of information exchange over radio horizontally and vertically without being a mandatory prerequisite for an engagement. All drone engagements will be in self-defense and the steady weapon control status (WCS) for the troops will be weapons hold (WH). The drones they can identify as hostile, but not engage, are the suggested hostile put by these forces on the net, which act in an autonomous-like mode all over.

This is a very important point and cannot be stressed enough: If we give the troops too much airspace in terms of engagement by providing them means like a laser that fights a drone in five to 10 kilometers at an altitude of 500 meters, those troops become part of the all over AD fight in terms of C2. It is highly recommended not to do this as it would complicate/paralyze the whole AD machinery. It would drive inefficiencies for a limited improvement to the protection of the ground troops that may not be guaranteed. The troops are then put into a continuous dilemma of whether or not to follow their own tactical procedure, or give room to the needs of the AD combat supporter. Last, but not least, the poor Air Guard must become a tactical specialist for AD working with different WCSs, airspace control orders, airspace coordinating measures and so on.

To give as much efficiency as possible to the troops, but also to enhance and maximize airspace safety for the friendly air assets, the following conditions/prerequisites should be given:

- The troops should have an organic laser device as part of their equipment in order to determine the flight level of an object before an engagement. This capability will be part of the Air Guard sensor set and the optic of the focus weapon.
- The troops are autonomous with some IP-based information exchange. They are principally under WH and act in self-defense. Their limited battlespace in terms of engagement reach of their effectors justifies any engagement as being done in self-defense.
- An IP-based RAP tailored to the Air Guard's position gives additional help for the decision cycle. However, its availability is not a prerequisite for an engagement.
- Optical and acoustic sensor data together with optical verification are means of identification.
- Optical identification is mandatory before the engagement. The devices of the Air Guard and the focus weapons have the ability to magnify the picture and a processor that identifies the objects of the picture in the way of face recognition software. The database, of course, are shapes of drones, choppers, CMs and aircrafts.
- Any engagement can only be executed in a manual mode, no semi-automatic or automatic mode possible.
- Beside their crypto radio and an encrypted IP address, nothing in the cyber and electromagnetic spectrum (EMS) space should reveal the troop's position or type of weapon system used (characteristics of high energy (HE) laser, RS etc.).

Those taking the efficiency of avoiding blue-on-blue engagement into question should remember the old times with peer opponents when - with much less technical support - the troops had permission to shoot down whatever threatened them with their means on hand. Or, how the troops on the ground interact with their own air assets having loaded weapons on hand while those assets land or pick-up. Even if their own LSS drone is shot down on occasion – so what? Does this justify any additional burden to the troops complicating or hampering their mission execution?

Living in the age where every cart and fork-lift truck exchange uses GPS-based data within the internet, it should be possible to provide strongly encrypted IP-based identification assistance to the troops on the ground to foster the troops' decision cycle. Bringing this concept into reality would spare a lot of coordination in terms of C2 and make a lot of C2 entities dragging down the engagement order (EO) processes superfluous. Time is not money, but the main resource, blood, is saved while executing drone wars. Machines are superior to humans in terms of speed of executing the decision cycle. We should at least make sure that Soldiers on the ground are not further bogged down by decision cycles of the EO chain when they could react in a sort of coordinated reflex as self-defense.

Conversely, the live data of those troops fed into the net should not be more than assumed hostile tracks in IBCS. Providing this data, they can give an early warning to other units and receive support of the second layer. Even passively tracked targets can be provided to the net with a rough, but good enough, position and flight level if you have a laser measurement from your position to the threat – either produced by the sensors of the Air Guard including a distance measuring laser, or the measurement of the focus weapon. The reporting and data provided by the troops should not be more than a standard after-action report concerning origin points of drones, if possible on the EO and their organic chain of command.

Above the Combined Arms for Air Defense, all sensors and effectors should be on the net and contribute directly to the EO. Also here at Layer 2, the claim to lead everything centralized seems to be only doable via an existing internet. However, decentralized mode should stay as mode of operation in doctrine as the opponent may be only partially able to deny GPS/internet access. As local bubbles of systems are still able to identify, track and engage they should be encouraged to do so by doctrine.

5. The camouflage dilemma

The basic problem of all organic AD forces embedded in troops on the ground is to provide air cover, was in the good old days the active sensors of the surface-to-air missile (SAM) systems contradicting all camouflage measures of the troops by being deployed in their vicinity or accompanying them on the march. This mistake should

not be repeated today with the EMS and cyberspace being more and more the focal point of reconnaissance. That's why there are strong endorsements in terms of using passive technology within Layer 1. More than an IP address within a certain radio cell that could be the one of - for example - a civil truck or the one of an air guard with his passive sensors should not be revealed in the EMS and cyber spectrum in terms of Combined Arms for Air Defense. All signatures above this level like active radar, laser weapons, tracking beams etc. would lead to negative cost, risk and benefit relation doing the troops more harm than usage complicating the allover AD fight, revealing the troops position, overloading the troop with additional needed skills and tasks and slow down the decision cycles. Effort neutral Combined Arms for Air Defense in terms of mobility, energy demand, camouflage, staff, C2, material and detectability seems to be the way to go. Blurring our own position in all spectrums balances the advantages of the drones and has the potential to bring back the moment of surprise to our own troops on the ground. Limited reach is the price to be paid that has to be balanced by a sophisticated approach on Layer 2. We have to be able to cover large volumes of airspace while being able to endanger the opposing drones and other air assets.

Excluded from this statement is the defense of stationary objects, whose position has to be assumed to be known to the enemy. At those objects, signature poverty, tactical considerations, mobility, material, staff and energy demand are subordinate factors to maximum protection against the airborne threat. A basic survival factor to invest in is laser-based drone defense side-by-side to RAM protection.

For the rest of the battlefield, the formula for Layer 2 should conclusively be: Even if Layer 2 is only covering 60 percent of the battle space, this would give more than enough opportunity to hinder enemy drones in their mission execution. With this prerequisite given, we are able to hide sensor and shooter position at this layer as much as possible while constantly putting the enemy into a planning dilemma and the drone war evolves into a war of attrition within the execution cycle. The consequence for Layer 2 is to be as signature poor as possible. At least, the air surveillance should be hidden. The concept "any sensor, any shooter" gives enough maneuver space for the tactical directors to change positions of the revealed equipment, predominantly the shooters if they should have tracking mounted or the radar that guided the shot. Believe me, as I'm German Air Force, a war of attrition is never won by the air assets among peer competitors. The third Reich had some experiences there in Britain. It took a superiority of the Allies over Germany to successfully penetrate and execute an air attritional strategy. Even then, more than six or seven Schweinfurts would maybe not have been politically sustainable.

A last aspect of passive radar technology feeding into IBCS at Layer 2 is that one has additional radar coverage for those times he wants to stay passive with the systems like Patriot to hamper the enemy's suppression of enemy air defense approach. How relatively successful one can be by doing this, was best shown in Serbia in the '90s.

6. The signature dilemma

On a regular basis, the characteristics of LSS drones in classes one and two are not suitable to construct effectors based on those characteristics for the Combined Arms for Air Defense. This statement seems to be valid for the infrared (IR) spectrum as for the radar spectrum. Optics and acoustics appear to be plausible fields to register and track targets and guide effectors with maximum cost efficiency. The question that has to be answered is whether the use of these spectrums is, with the support of modern computer-based sensor data management and processing, sufficient to fulfill the task in terms of self-defense? In the author's view, it is. It is no problem that data is only given to the Air Guard if there is something hostile in the air, leaving the monitor black the rest of the time. With face recognition technology in place, why shouldn't the picture data processor be able to identify the drone as friend or foe? Magnification is not an issue as it exists in every commercial camera. Adding night vision and infra-red etc., as additional support is also not new technology. The laser can be used to calculate, out of the distance, the size of the object providing additional data to the recognizing software scanning its own database. So this should not be an issue.

Also in terms of the effector, the question is whether it should have its own sensors to give the projectile its own homing abilities. Also in that manner, the answer is obviously "no" as this would bring big cost benefit trouble with the drone technology enhancing in terms of miniaturization, swarming and more. The marginal utility in drone fighting is so low that any high tech consumed by shooting the high tech components into the air is too expensive. Keep it simple and straight seems to be the call of the hour in terms of Combined Arms for Air Defense, including defense against helicopters and more in self-defense.

Above the Combined Arms for Air Defense, it should be scrutinized what distances passive radar technology could cover in terms of the signatures of drones of parts of Class 1, and Classes 2 and 3. A minimum of 30-40 kilometers should be easily achievable. With 20-35 kilometers distance and the troops able to defend themselves up to a maximum of 200 meters altitude by themselves, there is – looking at the 4/3 earth curve diagram — a huge overlap of up to 100 meters in altitude given between Layer 1 and Layer 2 to be potentially eaten away by incrustation etc. This setup would enable passive radars to give early warning and cueing information to the troops and in the same way enable effectors in the area to engage the respective targets.

7. The mass dilemma

Based on rapid technological progress, we could be confronted with a mass problem against enemy drones within any scenario. Therefore, the LSS drone defense has to be set up to primarily answer quantitative aspects of the threat. Defense should be done with operating agents whose use produces as low of a cost as possible and needs a minimal technical effort and logistical footprint. Also if the example is not 100 percent accurate, here is another analogy: In WWII, the use of tiger tanks being superior and able to take out 12 Allied tanks per Tiger as an average rate, did not mean anything in terms of the final result. The same way, it does not make sense to give missile-based technology (like Stinger) to the troops fighting drones at least in Class 1 and Class 2. Also extra vehicles given to the troops going after this task on a larger scale than self-defense with highly sophisticated weapons based on laser, microwaves, EMP, missiles demand high development costs, brings possibilities for malfunction under rough battlefield conditions. This would be sluggish, create significant energy demands, an additional ballast for the troops and the AD in terms of C2 and tactics, reveal positions (by own high IR signature and emitting while engaging), are partly weather dependent and could cause collateral damage even to our own assets behind the target … up to the space etc. (All other disadvantages as described before.) Therefore, this solution set is not recommended, although they theoretically would solve the

problem for the troops on the spot in the first view.

Above the Combined Arms for Air Defense, the mass dilemma is much more complex as it shows up in combination with the space dilemma followed by the camouflage dilemma. The setup can principally only be addressed by having a sensor and effector being able to conceal those areas that cannot be covered, having unknown positions, and cover the largest volume of possible air space engaging in the shortest possible reaction time and at the lowest possible costs in terms of costs/shot and logistical/force protection footprint. The advantage that should be leveraged within Layer 2 is the fact that doctrine-wise Layer 2 would overlap with Layer 3 and therefore the capabilities of the robust SAM systems could be consolidated. In order to do this, the sensor (passive) and the effector have to be part of the IBCS battle-net. Furthermore, the primary targets are, besides the relatively small signature, easy ones. First, electronic warfare will physically not be a big capability as this needs much energy normally not provided within drones. Second, drones are relatively slow and do not have much situational awareness outside their task (e.g. most are not expected to have missile warning equipment). Third, they do not maneuver at high G-rates which makes them fairly sluggish. The space dilemma in combination with the mass dilemma leads to the conclusion that today's effectors like missiles are not feasible to cope with the drone threat on Layer 2. Consequently, the multi-missile launcher, even when updated with energy weapon solutions in the future (weather restrictions) is a possible answer to many threats, but has to be supported by another executor when it comes to drone wars including CMs. Anti-drones sound futuristic and smart, but those have the disadvantage of being too slow running heavily into the space problem on the executor side. The railgun with its reach, precision, low costs and speed seems to be the missing link needed by the ADA pushing through on drone wars from the author's point of view. Railgun technology was developed to penetrate hardened targets on long distances, but it is only beginning to be suited for the characteristics needed by the ADA. The capabilities of the Blitzer Railgun, in terms of size of the projectile, are even more than what seems to be needed. Physically, it should not be a problem to downsize the projectile in order to reduce the amount of energy needed to shoot without losing too much precision. But those things have to be investigated further.

As drone wars develop, one has to think about the sustainability of centralized C2 having the Tactical Battle Management Functions "identification authority" and "engagement authority" as much as possible within a given tactical situation. As mentioned before, an anti-tank drone hovering over the battlefield with a database of enemy tanks and other focus weapons onboard will constantly scan the battlefield it flies over. It will analyze its camera picture with the database of the onboard system recognition software and destroy its targets with a 0.1 second decision cycle. This setup puts humans at a disadvantage because they are outpaced in terms of reactive actions. That's why passive air defense including passive sensors and shooters becomes so essential. In terms of C2 and foreseeable masses of drones on the battlefield, the answer to this threat is not "any sensor – any shooter" with a centralized C2 stovepipe with regard to TBMFs in the background that is all about the avoidance of blue-on-blue engagements. But, in the

An Avenger Air Defense System crewmember with the 35th Air Defense Artillery Brigade enters the gun turret before a live-fire training exercise, during Rim of the Pacific 2018 at Pacific Missile Range Facility Barking Sands Hawaii, July 24. (Capt. Rachael Jeffcoat/U.S. Army)

author's understanding "any EO command post – any sensor – any shooter" having engagement authority executed at all command posts in the mid- to long-term. This point leads to Dilemma No. 8, which talks about how to deal with the much contested very low airspace, too low in terms of flight levels.

8. The definition and selection dilemma

In the future, it will get even busier at the lower flight levels as airspace congestion significantly increases while reducing space for the Air Force to be efficient without hampering the whole force in its mission execution. Soon there will be no space for the "Red Barons" of the future because their contributions to the fight on those low flight levels will hamper indirect field artillery and drone support to the fight. Taking the mass of the cockpits out of the lower flight levels (beside some airlift operations), will push the blue-on-blue problem enough to the background to open up AD tactics to paradigm shifts. It would give space for urgently needed drone attack concepts to enhance the friendly recce, offensive and area denial capabilities beginning with the future queen and ending at the future king of battle in their roles and responsibilities within the fight. Last, but not least, it would redefine the role differentiation between Army and Air Force.

Here, the railgun becomes the hybrid fitting into the last commanding general's vision of having one executor. The same railgun can be used for ground-to-air and ground-to-ground engagements (same counts for the focus weapon of Layer 1). The development for both has advanced sufficiently enough that it is not a question of if, but of how to further engineer that technology in order to make this vision a reality. Of course, the railgun will not produce the magnitude of effects in the target zone that rocket or other artillery is able to simply by physical limits. But, it could produce some addition as indirect support with a high cadence and more precision avoiding many of the physics taught at the gunnery education. As I am ADA, this is just rough first guess and should be investigated further.

Hovering drones will not necessarily be deployed by the Air Force as the Russian anti-tank drone shows. Drones are a hybrid indirect fire support means where the FA has to think about the drones' role in terms of recce operations for its classic means and in terms of secondary ground-based mean of indirect fire support on the battle field.

To sum it up, the new capabilities take the classic service differentiations into question the farther we go. We have to address this and start a discussion as this could lead us into a crisis with paralyzing concepts and a lot of money wasted senselessly invested into systems and structures. Terminologies as "air superiority" or "favorable air situation" will become relative and situationally contextual. We will likely redefine what we understand by saying "we have air superiority" while the enemy is still lethal using drones at the very low and lowest flight levels.

Alternatively, those discussions and developments could bring up the real symbiosis of Fires with the ADA providing aerial denial capabilities in terms of drone attacks and the FA simultaneously providing the same precision indirect fire support at all ranges with all scales of effects backed up by real-time drone reconnaissance bringing maximum support for the maneuver forces. Bringing such an approach into reality would enable the Air Force a return to their natural role, gaining air superiority by wrestling down the enemy's air force and going for decisive battlefield air interdiction and strategic bombing missions.

Finally, the Combined Arms for Air Defense could conceptually be described as the following:

- The troops are autonomous, the WCS is WH with self-defense as their primary reason to engage.
- The troops have, if available, no prerequisite, a GPS position and IP based RAP, and can actively feed identified hostile targets and identified positions of origins of drones that are shown as assumed hostile targets on the net on IBCS/the data net. A standardized C2 report is done on their organic C2 chain.
- Data accumulation and distribution within the platoon or company is sufficient in order to maximize force protection and the effectiveness of all means of engagement. Data display has to be not more than an app-like software at the individual Soldier level.
- The troops have passive autonomous sensors (e.g. optics and acoustic sensors) supported by laser measurement in order to support the Tactical Battle Management Function "identification" and "tracking" in the best way possible. An example is the Hover Mast-100 of Sky Sapience. The sensor data is processed by a "face recognition" like software and presented to the Air Guard already categorized F/F so that the reaction time of the troops to the air threat is minimalized. The laser measurement, if available, supports the face recognition identification software by measuring the shape of the object, giving distance and flight level of the object and therefore ensures troops stay in self-defense limits and engage only what is in the range of their weapons. The processed sensor data is translated into direction, distance and height to the single Soldier's app (little arrow with a distance and height figure) in order to leverage their weapons and passive force protection abilities within the AD of all troops to a maximum extent possible.
- The focus weapon's optic should also be directly linked with the passive sensor data and be able to give the gunner within the optics guidance on where to aim as a first step. Once they track the target, the second step is the optic, together with a distance measuring laser and a picture processing processor, should enable the device to create an accurate aiming point for the gunner. With such a synthetic aiming point, engagement should be easy within the reach of the focus weapon.
- It is highly recommended the focus weapon is also a minimal energy consumer and emission-free leading to a machine gun/cannon-like weapon also having optional programmable explosive grenades as effectors to be effective against air and ground threats like the standard cannon of the German PUMA for ground engagements. If an effector like this could be beefed up in terms of optical tracking as described and be able to shoot into the air, this could be a very promising solution. In comparison to a laser weapon, those effectors have not only the advantage to execute on ground and air targets, but also have the advantage to be efficient against a broad variety of air assets within range. The laser is not efficient against many other non-drone air assets besides some very complex blinding (needs to have the correct angle etc.).
- Such a weapon can efficiently support the ground battle one second later, if needed.
- Taking all those points into consideration, it could also be possible to bring it into one sensor/shooter package on one

vehicle. Losing some redundancy, one would win efficiency.

- Installations with known positions being able to afford a big effort of means to defend themselves, need a whole different approach. As active emission is not taken into question and AD experts as part of force protection is no problem, such entities can be given weapon engagement zones being part of the IBCS-net with their own sensors and effectors from MML and laser beams down to RAM to defend the systems defending the base.

Above the Combined Arms for Air Defense, additions to the setup could be described as following:

- A further passive sensor should be added to the IBCS AD family. This sensor is collocated with C2 entities on the battlefield to minimize the logistical and force protection footprint.
- There should be effectors added that cover significant amounts of battle space at minimum costs and maximum speed. As they have to overlap with the troop's abilities, they will be collocated no more than 20-30 kilometers away from the fighting ground troops. Those effectors should, besides tracking within an engagement, also be silent and part of the IBCS family.
- Although having some disadvantages, the railgun seems to be the technology that is able to overcome most of the dilemmas the ADA is confronted with for drone wars of the future.
- The disadvantages are predominantly that the energy has to be provided at the shooter and there are no experiences to shoot the projectile with remote sensor data. The railgun needs line of sight and the technology is still under development. But, with everything else going electric, not only the car manufactures, the armed forces will move in the same direction. The theoretical advantages of the railgun are in my view, that:
  - Each shot is theoretically up to 90 percent cheaper than missile technology.
  - You don't have to think about a missile mix at the effector.
  - One can shoot at a high cadence (mass problem).
  - Huge chunks of battlespace can be covered at high speeds (space problem).

A Patriot missile radar system set assigned to 1st Battalion, 1st Air Defense Artillery Regiment during the unit's table gunnery training exercise on Kadena Air Base in Japan, in October. Precision Fires and Air and Missile Defense are top priorities in Army science and technology research, and newer versions likely will be smarter and more accurate. (Capt. Adan Cazarez/U.S. Army)

  - Dependent of the distance, the whole air threat spectrum could be fought (ABT (2x), CM, BM).
  - One could choose a reach and effect mix based on the energy input in the future.
  - Ground-to-ground and ground-to-air engagement could be done with one effector going for one shooter for Fires.
  - As positioning and steering have proven to work within the projectile, the implementation of proximity fusing into the projectile should be doable which will enhance the kill probability.

Layer 3, overlapping with Layer 2, is reality and is to be further developed for the future. Current concepts are given and under development. However, long-range Fires seem to be the sweet spot to synchronize both sides of Fires. A railgun as a focus weapon for long-range indirect fire support and long-range air defense taking out sluggish targets like air surveillance technology, refueling and strategic bombing capabilities could be a starting point. Once the energy is in place, maybe two different guns on one vehicle could use the same energy. One gun focusing on the delivery of masses in terms of indirect fire support at a maximum distance of e.g. 70 kilometers and one gun focusing on speed delivering small projectiles at a range of 40 kilometers. It is, once engineered, only the question of what you want to achieve with the produced kinetic energy of K.E.=1/2*m*V2 at your gun.

Lt. Col. Thomas Groborsch spent five years at the Fires Center of Excellence as the assistant to the director in the Directorate of Training and Doctrine as part of a personnel exchange program between the U.S. and Germany. He has been involved with the German SHORAD system and the Patriot system and now serves as the commander of the System Center 23 for the German Air Force.

35th ADA Brigade leads the charge for C-UAS operations in PACOM

By Capt. Jonathan Pasley

Keen observers in the world of air defense have been watching one trend in particular during the past several years: the proliferation of unmanned aerial systems (UAS). Once an advantage enjoyed solely by technological Western nations, the use of drones has transitioned into the hands of the civilian consumers and by extension into the hands of insurgents such as the Islamic State militants encountered in Iraq and Syria. Their tactics and techniques could easily be adopted by hostile actors around the globe. Our military procurement system has struggled to compensate for the emergence of this new threat, but E Battery, 6th Battalion, 52nd Air Defense Artillery, under 35th Air Defense Artillery Brigade in Korea, has now become the leading element in Pacific Command to address this new and dangerous threat.

What makes drones dangerous? The Russians have demonstrated the ability of unmanned systems to put real-time intelligence, surveillance, and reconnaissance (ISR) capabilities to devastating use against Ukrainian forces as artillery spotters.[1] Many UAS models (military or civilian) can provide accurate location data from ranges that make them almost undetectable with the naked eye, so that the first warning forces on the ground will get is deadly incoming artillery fire. The insurgents in Iraq and Syria have added another spin, equipping off-the-shelf Chinese-made quadcopters with grenade munitions for precision placement of explosives in urban conflict.[2] Even commercial quadcopters are surprisingly difficult to destroy with small-arms or crew-served weapons, because they present a very small and highly maneuverable target and have redundant engines. A small "drone swarm" conducted an attack on a Russian airbase in Syria which resulted in several key airframes lost to fires started by the drones.[3] As hostile actors refine this type of coordinated attack, the drone threat will only become more dangerous to ongoing operations.

Why are we not able to engage drones with existing air defense weapons systems? In many cases, it is because such small targets did not exist when the current weapons systems were designed. The high-to-medium air defense, or HIMAD weapons systems, such as Patriot and the Terminal High Altitude Air Defense (THAAD) system that make up the bulk of U.S. Air Defense Artillery weapons are not well suited to counter-UAS operations. Even detecting such small and often nonmetallic targets is a tricky balancing act; most air defense systems are designed to filter out small objects in the environment (such as birds) so that they do not overwhelm a system with possible threats. This can allow small aircraft to slip through detection, which may have been what enabled Yemeni Houthi rebels to crash an Ababil-type unmanned drone into a United Arab Emirates Patriot radar being employed in Saudi Arabia.[4] Notably, software changes and system upgrades are refining the C-UAS abilities of existing systems, as illustrated by the successful Israeli engagement of a UAS with a Patriot missile in November of 2017.[5] However, this is a very expensive solution as drones may cost tens of thousands of dollars where a single Patriot interceptor will cost more than $2 million. This is a wasteful use even if you ignore the financial implications because every Patriot missile used this way is one not available for the primary system mission of defense against deadly ballistic missiles.

What about Short Range Air Defense Artillery (SHORAD)? While certainly a more practical solution than firing Patriot interceptors, even the Stinger-missile-equipped Avenger and supporting Sentinel radar systems employed in the Army's SHORAD batteries are not designed for C-UAS. In the absence of a credible air threat during the counterinsurgency operations of the past decade and more, there has been little emphasis on development or employment of SHORAD forces for this role. Most SHORAD batteries were relegated to the National Guard, and the unarmored Avengers they employ are typically not permitted to deploy overseas. There are programs underway to adapt these systems to C-UAS duties (including new Stinger variants and Sentinel radar upgrades). However, these systems still have the disadvantage of being kinetic systems which were originally designed for a wartime environment – they present a significant risk of collateral damage if employed in an environment with a large civilian presence. Operations during the armistice between North and South Korea provide an objective example – no risk to civilian lives or property will be tolerated during armistice operations. A non-kinetic solution is needed.

Enter E/6-52nd ADA. As part of Combined Task Force Defender, they are tasked with defending D Battery, 2nd Air Defense Artillery THAAD Battery at Seongju-ri near Daegu. This is a challenging mission with a genuine North Korean threat[6] and restrictive armistice rules of engagement. To accomplish this mission, the battery became the first unit in U.S. Pacific Com-

1 *Freedberg, Sydney J. "Russian Drone Threat: Army Seeks Ukraine Lessons". Breaking Defense, 2018, https://breakingdefense.com/2015/10/russian-drone-threat-army-seeks-ukraine-lessons/. Accessed 13 May 2018.*

2 *Watson, Ben. "The Drones of ISIS". Defense One, 2018, https://www.defenseone.com/technology/2017/01/drones-isis/134542/. Accessed 13 May 2018.*

3 *Trevithick, Joseph. "Russia Offers New Details About Syrian Mass Drone Attack, Now Implies Ukrainian Connection". The Drive, 2018, http://www.thedrive.com/the-war-zone/17595/russia-offers-new-details-about-syrian-mass-drone-attack-now-implies-ukrainian-connection. Accessed 20 May 2018.*

4 *Gibbons-Neff, Thomas. "Houthi Forces Appear To Be Using Iranian-Made Drones to Ram Saudi Air Defenses in Yemen, Report Says". Washington Post, 2018, https://www.washingtonpost.com/news/checkpoint/wp/2017/03/22/houthi-forces-appear-to-be-using-iranian-made-drones-to-ram-saudi-air-defenses-in-yemen-report-says/?noredirect=on&utm_term=.7f667ce035ac. Accessed 13 May 2018.*

5 *Associated Press. "Israel Uses Patriot Missile to Shoot Down Drone". Defense News, 2018, https://www.defensenews.com/land/2017/11/13/israel-uses-patriot-missile-to-shoot-down-drone/. Accessed 13 May 2018.*

6 *Reuters Staff. "Suspected North Korea Drone Spied on U.S. Anti-Missile System". U.S., 2018, https://www.reuters.com/article/us-northkorea-souhtkorea-idUSKBN1940J8. Accessed 13 May 2018.*

mand to receive the Expeditionary Low, Slow, Small UAS Integrated Defeat System (E-LIDS). Already employed in several countries in U.S. Central Command, this system uses many of the same components employed successfully in the Counter Rocket, Artillery and Mortar system and turns them against UAS platforms instead. E-LIDS was sped into production and is not yet a program of record, but operational testing has already been conducted to ensure the system is ready and capable of accomplishing its mission. In addition to this, E Battery has also fielded the Drone Defender man-portable C-UAS system which will enable a flexible and layered defense against any UAS incursion with minimal risk of collateral damage. These systems permit the battery to conduct not only area denial, but also to electronically "defeat" enemy UAS that could threaten critical U.S. assets. This in turn ensures that the THAAD system is able to continue to preserve freedom of movement around the peninsula.

The THAAD site at Seongju-ri presents a ready testbed for C-UAS systems, as systems like E-LIDS and THAAD have never before been integrated into a single defense design. Additional systems are already being considered for incorporation and testing. The 2nd Battalion, 1st Air Defense Artillery and 35th Air Defense Artillery Brigade are maximizing the opportunity and recording a number of lessons learned from the first such site in the PACOM area of operation (AOR). The units on CTF-Defender are engaged daily in shaping the doctrine for the use of these systems. From this initial test site comes the possibility of expanding the use of these systems to units across the Korean peninsula and across the PACOM AOR. E Battery has already demonstrated the capability to emplace the systems in new locations, and will continue to improve integration into air defense planning on the peninsula.

The danger from increasingly creative use of UAS is a real threat, and the capability gap for existing systems is clear. However, with such a unique opportunity for integration of the C-UAS mission set into air defense artillery units, E Battery and by extension the 35th ADA Brigade are in a key position to lead the development of tactics, techniques, procedures and doctrine governing the effective employment of these systems. Air defense artillery will help blaze a path in this new domain for the rest of the Army to follow. "First to Fire! Ready in Defense!"

Capt. Jonathan Pasley is E Battery, 6th Battalion, 52nd Air Defense Artillery commander. Pasley has deployed twice to U.S. Central Command in support of the Global War on Terror and Operation Inherent Resolve. While deployed he served as battle captain, Patriot tactical control officer, and served 18 months as an air defense liaison.

A Stinger missile team with the 35th Air Defense Artillery Brigade, identify an unmanned aerial vehicle target, during Rim of the Pacific Exercise 2018 at Pacific Missile Range Facility Barking Sands, Hawaii, July 24. (Capt. Rachael Jeffcoat/U.S. Army)

Target acquisition for long-range precision Fires

By Patrick McKinney

The Army has identified long-range precision Fires as a top modernization priority to support great power competition and defeat and deter peer competitors on the battlefield. Though informed by recent challenges in Europe and Asia, conflicts of the past half a century have taught the Army the criticality of not only long-range and accurate Fires, but also the need for accurate target acquisition. To utilize its future long-range precision Fires, the Army must field capable and reliable multi-domain long-range target acquisition capabilities.

At the start of the Cold War, the Army prepared for large-scale combat against the Soviet Union and its Warsaw Pact allies in Europe, but instead found itself committed to sustained combat in Southeast Asia. The Vietnam War taught the importance of firepower and artillery, but diverted the Army's resources and investments from modernization for fighting in Europe. Army studies and analysis identified an emerging Soviet force superiority of materiel and numbers in Europe and recommended that the Army refocus its force to the threat.

The Army's AirLand Battle and its "active defense" sought to keep the Army and its North Atlantic Treaty Organization allies fighting while attriting the larger enemy force. A critical component of AirLand Battle was long range precision Fires to disrupt and destroy Soviet targets at deeper echelons of the fight. These requirements led to the Multiple Launch Rocket System, Advanced Tactical Missile System, and improved lethal munitions that proved their effectiveness in Operation Desert Storm in 1991.

Combat in Kuwait revealed that though Iraqi artillery often outranged American cannon artillery, its lack of coordinated target acquisition and fire support made it ineffective. The Army however, maximized its target acquisition and fire support capabilities to provide accurate targets and deliver accurate massed Fires. Despite the successes, the Gulf War revealed limitations with U.S. artillery's range, mobility and rate of fire, and reinforced the need for dedicated target acquisition capabilities (such as unmanned aerial vehicles).

The Russian invasion of Ukraine in 2014 surprised the Army and raised new concerns of competitor superiority in Europe. Though the Soviet Union and Warsaw Pact dissolved in 1991, NATO continued an eastward expansion that included Baltic States bordering Russia. A possible NATO expansion into Ukraine and the Ukrainian government's western-tilt were deemed unacceptable to Russia, and through proxies and non-declared Russian "little green men," Russia invaded the Crimea and the Donbas regions of Ukraine.

These forces utilized massed artillery, unmanned aerial systems, electronic warfare, information warfare and other capabilities that have not challenged the United States in recent conflicts. Russia continues to develop missile technologies, air defense radars and other anti-access, area denial (A2AD) capabilities to slow and deter NATO forces in Eastern Europe. In Asia, China develops and fields similar systems aimed to deny its potential enemies access to China's shores and the region's waters.

More than a decade of combat in southwest and central Asia have diverted the Army's resources and investments from modernization for fighting a peer competitor, and the Ukrainian invasion exposed the Army's readiness challenge in Europe. In response, the Army identified new modernization priorities, with long-range precision Fires at the top.

The Army fears that Russian, Chinese or other competitor systems will outrange American Fires, and that threat A2AD systems risk American air superiority or control, and in turn, that the Army cannot assume it will have air support in future fights. If this is true, how will the Army identify and verify long-range targets in a future fight? If the Army needs long-range precision Fires due to this aerial capability gap in an A2AD environment, can it rely on air assets to provide target acquisition for its long-range precision Fires?

Traditional target acquisition comes from ground and air observers, radars, optics and sensors. In a contested A2AD environment, the Army may lack ground and air observers and electronic collection systems at the ranges needed for long-range Fires. There are non-materiel solutions (such as deploying batteries and launchers further behind the forward line of troops), but these will minimize the Army's ability to strike deep targets.

To utilize long-range precision future Fires in a contested A2AD environment, the Army needs to develop alternate multi-domain target acquisition capabilities. Studies questioned the need for long-range precision Fires in the 1970s and 1980s because of the challenges in identifying deep targets, and longer range enemy systems proved ineffective in 1991 due to their lack of target acquisition capabilities. Accuracy and long range are wasted if the Army cannot see its target. If the Army continues to prioritize long-range precision Fires, it must develop and invest in multi-domain target acquisition.

Patrick McKinney is a civilian working as the Department of the Army Systems Coordinator in Headquarters, Department of the Army. He served as an Army field artillery and military intelligence officer. The views expressed in this piece are his own and may not reflect the views of the U.S. Army or Department of Defense.

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Cross-domain concerns

Defeating a hybrid state's grand strategy

By Victor Morris

This article analyzes joint and multinational wargames designed to understand, mitigate and overcome dilemmas preventing long-term mission success. These dilemmas are at both the operational and strategic levels and are associated with the contemporary operational environment, multinational alliances and hybrid threat actors. The analysis also identified implications for NATO crisis response planning associated with a hybrid state's strategy.

State and non-state competitors develop strategies across competition continuum relative to rival advantages. The competition continuum consists of cooperation, competition below armed conflict, and armed conflict.[1] The resulting strategies emphasizes both direct and indirect approaches across all domains to reach strategic ends. A domain is defined as a critical macro maneuver space whose access or control is vital to the freedom of action and superiority required by the mission."[2] The domains included in this assessment are human, land, air, sea, space and cyber. Dense urban, information and electromagnetic environments are also overlapping spaces for military and non-military effects.

Cross-domain effects are accelerated by hybrid states and non-state actors. Hybrid states are described as states with a mix of autocratic and democratic features. This assessment uses the term "hybrid state" to describe a state blurring boundaries between organizations and institutions[3] enabling an unbounded grand strategy. This type of state also has low competition in elections and low constraints on governmental power. These characteristics facilitate statecraft and unbounded policy to offset perceived disadvantages, deliver key narratives and shape international norms.

Target states must understand the operational environment, cross-domain effects and evolving character of war to develop resilience to both direct and indirect approaches of the strategy. It is imperative this comprehensive understanding of the operational environment encompasses planning considerations including geopolitical rival or competitor's critical factors enabling strategic purposes and shifts to parity. Critical factors are the critical capabilities, requirements and vulnerabilities associated with interrelated centers of gravity (COGs).[4] COGs are the "doer"[5] or physical agents possessing the ability to achieve objectives.

The following lessons outline how a hybrid state builds its grand strategy and what critical factors it considers offsetting disadvantages. The lessons also elucidate countermeasures targeting vulnerabilities and enabling resilience to multi-domain drivers of conflict. The goal of the below assessment is identifying friendly and adversary critical vulnerabilities for engagement and conditions change.

Wargame lessons learned prioritize a geopolitical rival's indirect approach using enhanced proxy forces as a significant advantage and long-term dilemma for NATO and key partner nations. Waging so-called "Hybrid Warfare" within a grand strategy requires conducting political, conventional, unconventional, asymmetric, proxy and cyber warfare to both directly and indirectly influence objectives across all domains and instruments of national power.

1. A hybrid state develops an unbounded grand strategy across the competition continuum relative to perceived rival advantages.

Fundamentally, the western multi-domain operations concept acknowledges the competition continuum and involves achieving positions of relative advantage through joint reconnaissance, offensive and defensive operations. Limited stability operations and a whole of government approach are designed to consolidate gains and enable operational and strategic ends. Precision air, ground and naval fires, coupled with effective means of intelligence collection are advantages enabling effective large scale combat operations. The rival's grand strategy accounts for these advantages preventing their strategic ends. Every strategy has ends, ways and means interrelated with critical factors. Because ends, ways and means have limitations, indirect approaches reduce disadvantages and allow innovative alternatives oriented towards opponent COGs. A peer or near peer competitor operationalizes a hybrid approach through mixed threat actors operating across all domains.

Therefore, shaping campaigns with subversive actors prior to, or in concert with conventional force are critical strengths for the adversary. This refers to limited or major joint operations employing multiple forms of warfare across all domains to enable decisive conditions and affect. Manipulating national and international policy using fluctuating diplomatic, informational and economic elements of national power supported by overt, covert and/or un-attributable offensive options are also critical factors for deep operations.

Next, offensive options involve combined arms direct and indirect fires and electronic warfare capabilities. Cyber, electromagnetic and information environmental effects are technologically accelerated in this type of strategy and prioritized to affect the depth of the adversary's operational environment. The threat of nuclear weapons employment and large-scale military force capabilities reinforce deterrence and influence the near-abroad, and international community.

Furthermore, proxy organizations present significant dilemmas for joint and multinational alliances when used as a key component of an unbounded grand strategy. Proxy organizations, however, are not limited to non-state paramilitary or insurgent networks. These un-attributable groups also include convergent terrorist,

1 *McCoy, Kelly (2018, April). In the Beginning, There Was Competition: The Old Idea Behind the New American Way of War. Article retrieved from https://mwi.usma.edu/beginning-competition-old-idea-behind-new-american-way-war/*

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4 *Strange, Joe (1996). Center of Gravity and Critical Vulnerabilities. Article retrieved from http://jfsc.ndu.edu/Portals/72/Documents/JC2IOS/Additional_Reading/3B_COG_and_Critical_Vulnerabilities.pdf*

5 *Eikmeier, Dale (2016, October). Let's Fix or Kill the Center of Gravity Concept. Article retrieved from http://ndupress.ndu.edu/Media/News/Article/969689/lets-fix-or-kill-the-center-of-gravity-concept/*

Soldiers assigned to Company A, 1st Battalion, 155th Infantry Regiment, 155th Armored Brigade Combat Team, Task Force Spartan, bound toward an objective during a rehearsal for a combined live-fire exercise near Alexandria, Egypt, Sept. 10, 2018. The 155th ABCT took part in exercise Bright Star 18, a multilateral U.S. Central Command training exercise. (Sgt. James Lefty Larimer/U.S. Army)

transnational organized crime and international hacker organizations. Multinational companies, political parties and civic groups also act as proxy organizations with access to high-end technologies and capabilities. These organizations cooperate or compete with other proxy actors based on various motivations. All or some of these groups may be enabled or incentivized by the hybrid state or local population providing sanctuary for them. Regardless, the need to deliberately expand sanctuaries over time is a critical requirement and potential critical vulnerability.

Potential dilemmas for NATO military operations involve irregular and asymmetric warfare activities in member states against borderless proxy actors, during or after an Article V response and territorial restoration campaign. As mentioned earlier, both asymmetric and conventional operations occurring linearly or non-linearly across all domains and are included in the hybrid state's grand strategy as critical strengths. The battlespace may also vary between contiguous and non-contiguous physical terrain. Un-attributable proxy forces with access to emerging and disruptive technologies support the hybrid state's critical capability to accelerate both indirect and asymmetric campaigns, whilst assessing the effects of long-term lawfare and political warfare activities. Conventional limited military campaigns are also accelerated under unbounded policy to leverage vulnerabilities and manipulate non-military settlements.

Critical factors not translating across all institutions and levels of policy are mitigated by several combinations. For instance, supra-national, supra-domain, supra-tier and supra-means combinations[6] as well as non-linear systems behavior ensure effects escalation and third order effects. For example, supra-national combinations are a synthesis of national, international and non-state organizations.

To summarize, a hybrid state's critical factors are contained in complex systems capable of delivering effects across the competition continuum. The systems 1) conventional joint and irregular proxy forces with integrated air, ground and sea defense

6 *Liang, Qiao and Xiangsui Wang (1999, February). Unrestricted Warfare. Art Publishing House.*

capabilities, 2) emerging and disruptive technologies and 3) super-empowered individuals conducting subversive activities. Subversive organizations cooperate and compete in all domains to exploit vulnerabilities of targeted states.

Based on the above analysis, critical vulnerabilities are identified. Some adversary critical vulnerabilities are subversive state or non-state actors, combined arms tactical groups, proxy sanctuary and malicious information campaigns. From a NATO perspective, counter-irregular or hybrid warfare dilemmas include a variety of factors during states of exception, emergency and war.

The remaining two sections outline direct and indirect targeting of rival critical vulnerabilities to develop resilience to drivers of hybrid conflict. Identifying and transforming friendly critical vulnerabilities through self-assessment are also included to counter a hybrid state's grand strategy.

2. Conduct joint, bilateral and multinational collaborative planning early and often.

Understanding multinational systems is a key aspect of friendly or blue force critical factors analysis. Early and recurring collaborative planning is crucial to joint operations and assessment processes that fuel multi-level shaping and crisis response activities. Equally important for political level contingency planning is understanding an adversary's strategy employing indirect approaches and use of asymmetric proxies to reach objectives.[7] These objectives extend beyond the joint operation plan and hinge on limited military activities and frozen conflicts as desired end states. Reaching these objectives within a NATO member state or region presents even more complex dilemmas and lasting effects for the international community and alliance cohesion. An indirect or "Gray Zone" approach is more immune to NATO collective defense and strategic deterrence planning. The Gray Zone is "the hostile or adversarial interactions among competing actors below the threshold of conventional war and above the threshold of peaceful competition."[8] This approach also exploits seams in the competition continuum involving dual cooperation and competition in geo-politics and economic systems. The hybrid state's ultimate objectives are to discredit and degrade the target's governance and societal cohesion. These objectives are met through sustained lawfare and irregular warfare activities and operations. Lawfare misuses or manipulates the law for political or military objectives, effectively using the legal system against an adversary to delegitimize them.

Additionally, every citizen needs to be educated and prepared for resistance and role in hybrid defense[9] which includes deliberate planning and cumulative innovation. Populations must enable interorganizational resilience across the continuum of government and competition spectrums. NATO, European Union and United Nations partnerships are critical requirements for collective defense and deterrence. During states of exception, emergency or war it is imperative to synchronize unified action partners. These include law enforcement, special operations, volunteer defense and home guard forces in key support, close and deep areas.

Next, collective defense treaties and joint security cooperation consists of both foreign internal defense and security force assistance to shape and prevent conflict. Foreign internal defense when approved involves combat operations during a state of war, where offensive, counteroffensive or counterattacks enable forces to regain the initiative. Thus, defensive tasks are a counter to the enemy offense, while protection determines which potential threats disrupt operations and then counters or mitigates those threats. Examples of specific threats include explosive hazards, improvised weapons, unmanned aerial and ground systems, and weapons of mass destruction.

Defeating the enemy and consolidating gains inherently involves more forces and is an operational headquarters planning requirement. Specific requirements include joint force assignment, apportionment, contingency and execution sourcing. Additionally, adversary related Anti-access Area Denial (A2/AD) capabilities consisting of integrated multi-domain defense systems are a joint problem. They require joint capabilities to exploit windows of superiority, freedom of action and gains consolidation to revise, maintain or cancel the plan.

3. Get closer to the ground truth in the human domain and prepare for human-machine teaming.

World-class intelligence, surveillance, target acquisition and reconnaissance capabilities should not overshadow critical capabilities and requirements for security services, law enforcement and indigenous population intelligence development. Sharing intelligence is equally as important and inevitably involves interoperable intelligence functional services and shared databases. Multinational counterintelligence, human intelligence and identity intelligence sharing agreements must be refined and validated down to the tactical level adequately ensuring all that relevant intelligence disciplines are processed and disseminated in a timely manner.

Furthermore, mission command through human-machine teaming is inevitable and will undoubtedly leverage human adaptability, automated speed and precision as future critical factors. The global competition for machine intelligence dominance will also become a key element of both the changing character of war and technical threat to strategic stability.

Scenarios and wargames designed to force multi-national COG and critical factors analysis, decision making and assessments are critical to understanding 21st century conflict. The joint operational area must be assessed as one interconnected domain and put in the correct context to assess the level of military effort and where required service targets in domains that enable the land component to reach strategic objectives. The interconnected domain is where conventional, asymmetric, criminal and cyber activities occur at the same time in the same spaces with predictable and unpredictable effects. A long-term indirect and proxy-led approach within the hybrid state's grand strategy offers innovative, inexpensive and unbounded opportunities to reach geopolitical objectives below the threshold of armed conflict.

Victor Morris is a former military officer, irregular warfare and counter-improvised explosive device instructor at the Joint Multinational Readiness Center in Germany. He has conducted partnered training in 17 European nations, with four NATO centers of excellence, and at the NATO Joint Warfare Center. The views expressed in this article are based on the author's observations alone and do not reflect the official policies of any mentioned organizations.

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Soldiers of the 4th Battalion, 319th Airborne Field Artillery Regiment, assemble a M777 howitzer while conducting airborne operations during exercise Allied Spirit II at the U.S. Army's Joint Multinational Readiness Center in Hohenfels, Germany. (Sgt. 1st Class Caleb Barrieau/U.S. Army)

Competitive convergence

How is the field artillery battalion preparing against pacing threats?

By Sgt. 1st Class Andrew Campbell, Sgt. 1st Class Cole Deblieck, Sgt. 1st Class Randy Feliciano, Sgt. 1st Class Heath Weisiger and Sgt. 1st Class Brandon Williams

After years of fighting counter insurgency, how do we successfully transition to fighting against an enemy with similar capabilities as the U.S. military and the North Atlantic Treaty Organization? A few capabilities come to mind. We could attack with unmanned aircraft, or employ special operation forces. But what if it is not that simple? Field artillery battalions throughout NATO need to train to mitigate the capabilities of our pacing threat. We must consider the enemy's capabilities to observe our formations from the air and ground, as well as through cyber electromagnetic activities (CEMA). We must consider how we conceal ourselves while simultaneously maintaining the initiative, and further, we must realistically prepare ourselves if our efforts fail to mitigate the identified risk to force.

Preparation starts with complex and innovative training in a decisive action training environment (DATE), not just for U.S. military forces, but also our allies and partners. The DATE scenario at a combat training center (CTC) has been an integral step in preparing units for the next conflict. At the Joint Multinational Readiness Center, we focus training on complex scenarios with allied and partnered nations that improve interoperability. Exercises such as Dynamic Front, Swift Response, Allied Spirit and others challenge the United States military and NATO, as a unified force, to adapt to, prepare for and fight a modern-day conventional war against a near-peer threat. Disruption on the battlefield will come well before we can see the enemy. Constant threats of CEMA forces us to rethink the way we fight. CEMA can prevent the fire direction centers from distributing a valuable digital database and to linking the command and control system, thus hindering a common operational picture. Because of the struggle to remain ahead of any CEMA threat, at JMRC, we encourage units to develop and implement a primary, alternate, contingency, and emergency (PACE) plan on different echelons of communications equipment. Some units initially are reluctant to use high frequency and tactical satellite, but once they are implemented into their PACE plan, they are more capable of delivering Fires in an increased CEMA environment.

Some members of the alliance incorporate the use of Artillery Systems Cooperation Activities with their respective digital fire systems, similar to the U.S. Advance Field Artillery Tactical Data System to counter the disturbances, communicate, and send digital fire missions. With the rise of electronic warfare threats and the reliability on digital Fires, units are developing creative communications plans and furthering interoperability within the alliance to continue to deliver destructive Fires on the enemy.

In addition to the CEMA threat, prolonged exposure to enemy intelligence, surveillance and reconnaissance (ISR) assets pose a significant problem to artillery units. Prosecuting targets with 54 rounds of high explosives places the firing unit's survivability at risk. If firing units expose themselves for greater than 15 minutes while delivering a large quantity of rounds, they increase the potential of enemy counterfire or ISR assets honing in on their posi-

tion. To mitigate the risk, Paladin units can incorporate bounding techniques during fire missions. For example, units can shoot six rounds, move, shoot six more rounds, move, and continue until rounds complete. This method prevents the enemy from honing in on their position and limits the exposure time when delivering a high volume of Fires. Once complete, the guns position themselves in hide positions to conceal their location from possible aerial observation. A current concealment tactic used by most artillery is the use of tree lines and nets. This type of concealment has no effect on observation platforms equipped with IR and thermal sights.

To conduct counter-fire operations it must be a joint operation, involving all branches of the U.S. military and NATO due to our long-range capabilities, worldwide censors and global threats. In preparation for this, allied training should not be limited to the CTC. The alliance should constantly work together at home station through all training requirements. This ensures basic issues are resolved prior to spending millions of dollars for a CTC rotation. Through true commitment to our allies and under a similar style of leadership, our communication in training will strengthen our ability to fight as an alliance.

Training to win against a near-peer threat requires an expansion to the scope of mission planning to become a more dynamic fighting element. It is noted that our potential adversaries have documented a counter fire battle drill time that when triggered; will mass a battalion-sized element of destructive Fires in an 8-12 minute time frame. This type of destructive power can cripple a unit's capabilities and produce a high number of casualties.

Recognized throughout history, medics cannot answer every call for help on the battlefield. This realization has prompting the Medical Command to improve training and materials for all Soldiers. Tactical combat casualty care has replaced the outdated combat lifesaver (CLS) training providing every Soldier with effective life-saving techniques. The individual first aid kit and modern CLS bag have increased capabilities for self-aid and buddy-aid. The force has been educated and trained with basic lifesaving techniques and routinely train on how to quickly segregate, load and transport casualties to the nearby treatment facility on the battlefield but the medics are being left behind. To sustain the force during a field training exercise, medics establish a Role 1 Aid Station where they focus on the full spectrum of their skills. The Role 1 allows the medic to treat everything from minor illnesses to a notional blast injury with amputation. Practicing both clinical and trauma skills is essential for maintaining basic skills, but it lacks the realism that is needed to truly be ready for the battlefield. Real scenarios with sutures, starting IVs and applying bandages and tourniquets to a bleeding patient are needed to ensure success of the medic when it truly counts.

The military has many successful years of fighting experience and as our Warrior Ethos tells us, we will "Never accept defeat." Technology will continue to shape the battlefield and as new generations fill the ranks, our force will change as well. Now is the time to start the changes to ensure our success for the next battle. Now is the time to build our strength with NATO, to predict and counter CEMA, to ensure all our systems are field tested and ready, and bring realism to all aspects of training to ensure we will always be the *King of the Battle.*

Sgt. 1st Class Andrew Campbell is a 68W medical observer controller trainer.

Sgt. 1st Class Cole Deblieck is a 13B firing platoon observer controller trainer.

Sgt. 1st Class Randy Feliciano is a 13J fire direction center observer controller trainer.

Sgt. 1st Class Heath Weisiger is a 13R radar observer controller trainer.

Sgt. 1st Class Brandon Williams is a 13B firing platoon observer controller trainer/master gunner.

A Soldier wears a 1st Security Force Assistance Brigade unit patch. (U.S. Army)

Advising at the battery level

By Capt. Daniel Cummings

Fourth Battalion, 1st Security Force Assistance Brigade was rapidly established in August of 2017. The purpose of 4-1st SFAB is to provide expert artillery advisors to conduct security force assistance with foreign security forces (FSFs). Combat advisor teams (CATs) deployed under Operation Freedom's Sentinel experienced a wide range of diverse missions during their tour of duty in Afghanistan. One team experienced a unique situation while advising an Afghanistan National Army D-30 battery in Tarin Kot, Uruzgan Province. This team's experience provides lessons learned for future artillery advising missions at the battery level.

CAT 1412 began their walk-to-advise mission in April 2018. Since advising missions below the corps level are rare, CAT 1412 did not have much information on their ANA partners before the initial engagement. The team's information requirements focused on the five requirements for accurate fire, section certification program and maintenance status of the battery's D-30s.

While maneuvering to the firing point, the advisors noted the impact of the terrain on nonstandard conditions. The provincial capital resides in a high desert plain with an elevation of 4,300 feet. In April, the temperature would swing from 9 to 26 degrees Celsius (48 to 78 degrees Fahrenheit). These meteorological conditions would have a significant impact on the accuracy of the projectile if not constantly updated by the fire direction center (FDC).

Initial friction

The team's initial engagements with ANA partners exposed unanticipated friction points. CAT 1412 experienced frustration while communicating through linguists. Linguists must have a basic understanding of the nomenclature and functions of the D-30s and fire direction equipment to communicate effectively with FSF partners. To solve this issue, the team developed an introductory class for their assigned linguists. This class consisted of pictures with Dari and English captions of D-30 components and operating procedures. The class created a shared understanding between the advisors, linguist and ANA partners.

Advisors must be patient while attempting to develop rapport with their FSF partners. CAT 1412's partners accused past advisors of failing to follow through on promises. The truth of these accusations is not verifiable, and was most likely a tech-

nique to weaken CAT 1412's position while negotiating future training. Advisors must be prepared for their FSF counterparts to treat them as a necessary disruption to their operations until they prove their value.

The battery leadership was hesitant to provide candid feedback regarding their capacity to generate capable sections and conduct operations. CAT 1412's partners would not answer any questions directly or demonstrate their standard operating procedures (SOPs). They claimed most of their equipment was broken or missing; new equipment was required in order for the battery to function effectively. CAT 1412 carried the burden of proof that they could be trusted, and that their proposed changes were worth the effort.

Quick wins

CAT 1412's logistical advisor counterparts provided the team with credibility by delivering "quick wins" for the team. The logistic advisors rapidly resourced materials to fix non-mission capable faults. This caused a positive change in the team's relationship with their ANA counterparts.

At this point, the battery leadership was fully committed to conduct advisor-led individual and section training. The advisors attempted to adjust the battery's SOP in accordance with the ANA D-30 Master Gunner's guidance. This included accounting for meteorological conditions and ammunition information. While observing the battery fire live rounds, the advisors noted that the battery did not apply proposed changes to their SOP. When questioned, the battery leadership responded that they trusted the advisors, but would not implement any changes until they could verify their effectiveness with live rounds.

Live-fire exercise

The challenge was set. The battery leadership determined they would fire one round without the assistance of the advisors. CAT 1412 would then have one chance to solve all sources of error. Once the advisors applied their corrections, the ANA would fire a second round. If the second round hit the target, then the ANA would adjust their SOP.

The battery conducted an abbreviated radar-observed registration. Radar determined the difference between where the round was supposed to impact (should hit data) against where the round actually impacted (did hit data). Determining the difference between the "should hit data" against the "did hit data" allowed the FDC to quantify cumulative error. The battery fired the first round, and cumulative error was determined.

CAT 1412 assessed several challenges for achieving desired effects on the second round. Achieving accuracy with indirect Fires requires the FDC to compensate for nonstandard conditions. Nonstandard conditions include factors such as the type of projectile, erosion of the tube and the effects of weather. CAT 1412 possessed the capability to account for air temperature, charge temperature and the projectile zone weight. However, the team had no capability to account for any other nonstandard conditions. In addition, the team did not have the capability to provide a secondary independent check of the unit's directional control or computation of firing data.

The second round landed closer to the target due to corrections for charge temperature and projectile zone weight. CAT 1412 exploited this improvement by creating enduring changes to the battery's SOP. The advisors influenced their ANA counterparts to account for projectile zone weight and charge temperature while calculating firing data. The team also developed the ANA's procedures for storing ammunition by storing the rounds on dunnage with overhead cover. Additional changes to their battery SOP were not applied since the round did not directly strike the target.

After action review

Artillery advisors at the battery level must have the ability to act as a secondary independent check of their FSF counterparts. This capability enables artillery advisors to quantify the effects of all nonstandard conditions on the accuracy of their partner's indirect Fires assets.

This effect is achieved by equipping advisors with the same equipment that their partner's utilize. Artillery advisors should have their own aiming circle, gunner's quadrant and charge thermometer in order to verify that their partner's equipment is fully mission capable. In addition, artillery advisors must be able to account for meteorological conditions at the firing point. Environmental meters that account for air temperature, air pressure, wind speed and wind direction at the firing point are available at little cost. Finally, equipping advisors with a pullover gauge will enable teams to determine the shooting strength of their partner's D-30s. This equipment is adaptable for artillery advisors in any environment.

Recommendation for future advisors

Prior to this deployment, 4-1st SFAB provided its advisors with D-30 familiarization training at the Joint Multinational Readiness Center in Hohenfels, Germany. Advisors developed technical expertise on D-30 maintenance, theory of operation, emplacement standards and fire direction procedures. This training enabled its teams to advise with confidence during our walk-to-advise mission in Tarin Kot.

Currently, the Fires Center of Excellence is developing a similar Foreign Weapons Training program at Fort Sill, Okla. This capability will be an asset for future advisor teams. One aspect that this program should emphasize is maintenance. The ability to conduct pullover gauge readings and correctly identify faults on the D-30 would greatly enhance the credibility of future advisors with their FSF partners.

Future artillery advisors must have a plan to earn the trust of their counterparts following their initial engagements. Artillery advisors must exercise patience until they have earned the trust of their partners. Once they have earned the trust of their partners, the onus is on the artillery advisors to provide their counterparts with compelling quantifiable evidence that will convince their partners to adjust their SOPs. Finally, artillery advisors must have the ability to serve as a secondary independent check for their partner's firing data. They may have to provide compelling quantifiable evidence without notice as part of a live-fire exercise.

CAT 1412's mission was successful due to the ability of the advisors to adapt in an uncertain environment. The team increased the lethality of their ANA partner's indirect Fires, and enabled their success for future missions. The team experienced much frustration while developing rapport and negotiating with their ANA partners. However, the positive effects of their mission were immediately evident during their partner's operations. The advisors sought out to improve an ANA battery, and ultimately improved themselves in the process.

Capt. Daniel Cummings is the 4th Battalion, 1st Security Force Assistance Brigade team leader in support of Operation Freedom's Sentinel.

THAAD, Patriot, and Avenger/ Sentinel interoperability within Guardian Battalion

By Capt. Adam Patterson, 2nd Lt. Matthew Becker and Warrant Officer 1 Adam McGee

Patriot, Terminal High Altitude Area Defense (THAAD), and Avengers assigned under a single battalion (2nd Battalion, 1st Air Defense Artillery Regiment, 35th Air Defense Artillery Brigade) provide a unique opportunity to exercise integrated air and missile defense (IAMD), creating a significant advantage to the combatant commander.

This article discusses the capabilities of each weapon system, their tactical missions, and the importance of integrating them into one common network. The *Guardian Battalion*, based out of Camp Carroll, South Korea, truly embodies the concept of air and missile defense.

The mission of the United States Army Air Defense Artillery branch is to protect the force and selected defended assets from enemy/hostile aerial attack, missile attack and surveillance.[1] The threats that air defense artillery units prepare for extend from intercontinental ballistic missiles costing millions of dollars, to unmanned aerial systems (UASs) costing as little as $100. Developing the capabilities to respond to and meet these threats make the ADA one of the most versatile branches in the United States Army.

Across the force, you will find a unit's mission consists of THAAD, Patriot or Avenger. As a result, air defenders often describe the different components as "three separate worlds." Second-1st ADA is the first battalion in the United States Army that has integrated the three distinct weapon systems, consisting of an organic Patriot battalion, Avenger battery and a THAAD battery.

THAAD's mission is to "protect the United States, forward deployed forces, friends and allies against short- and medium-range ballistic missiles."[2] The radar component of THAAD (AN/TPY-2) is highly mobile, multi-functional and capable of long-range surveillance.[3] It acquires targets in boost, midcourse and terminal phases, providing commanders and operators a proper air picture long before the threat is in range of the weapon system itself.

Patriot's mission is to "Provide protec-

1 *Field Manual 3-01 paragraphs 1-6*
2 *Field Manual 3-01 paragraphs 3-1*
3 *Field Manual 3-01 paragraphs 3-10*

BLUF: Improving Command and Control via fully integrated Air Defense operations utilizing Link-16 architecture to combine Sentinel and PATRIOT Radar Picture

- **Theater Benefits:** Allows for simple integration of additional Air Defense Assets across SHORAD, C-UAS, C-RAM, PATRIOT, and THAAD operations into an organic Air Defense Battalion
- **Operational Benefits:** Patriot Radar's capable of enhancing forward stationed Avenger Unit's air picture, providing an in depth view of approaching threats to maneuver force commanders
- **Tactical Benefits:** Enhanced Early Warning from Patriot Radar to Avenger Systems allows for more time on target when engaging approaching enemy ABTs or Class III & Class IV UAS

Link Architecture

1. Sensor C2 Node 1 connected to Sentinel Radar via Forward Area Air Defense (FAAD) Data Link (FDL) cable.
2. Sensor C2 Node 1 connected to Air Battle Management Operation Cell (ABMOC) via SINCGARS Broadcast.
3. The ABMOC is routed through C BTRY's Battery Command Post (BCP) switch, providing a network connection using Joint Range Extension Application Protocol - Charlie (JREAP-C).
4. C BTRY BCP utilizes a High Frequency Communications shot between C BTRY's Engagement Control System (ECS) and Information Coordination Center (ICC) for a network tunnel using the Ruggedized IQ1000 (RIQ) switch.
5. 2-1 BN's Tactical Control Station (TCS) connects to E BTRY 6-52's ABMOC and C-BTRY 2-1's BCP using the network tunnel between the ICC and ECS.

An Avenger system crew from E Battery, 6th Battalion, 52nd Air Defense Artillery Regiment, 35th ADA Brigade, fires at a target during a live-fire exercise. (Staff Sgt. Todd L. Pouliot/U.S. Army)

tion against theater missiles and air threats to critical assets in the corps and theater areas."[4] Theater missiles constitute the primary threat to be countered by Army ADA forces. Patriot can be tailored to the tactical situation in defending against air and missile attack. The radar set of the Patriot missile system (AN/MPQ-53) is monitored and controlled by the engagement control station and performs very low to very high-altitude surveillance, target detection, target classification, target identification, etc.

Finally, the Avenger's mission is to "provide protection from enemy reconnaissance, intelligence, surveillance and target acquisition (RISTA) efforts."[5] Avenger is designed to counter low-altitude UAS, high-speed fixed-wing/rotary-wing aircraft and RISTA threats. The Avenger is highly mobile and provides the fire unit flexibility with its variety of functions. It employs eight ready-to-fire Stinger missiles with the capability to convert those Stinger missiles into man-portable air defense systems. Additionally the Avenger has an M3P .50 caliber machine gun mounted on it.

Given the growing level of complexity of the battlefield, the need for increased mission command between THAAD and Patriot is even more critical. Mission command is defined by the U.S. Department of Defense as, "the exercise of authority and direction by the commander using mission orders to enable disciplined initiative within the commander's intent to empower agile and adaptive leaders in the conduct of unified land operations."

This criticality alone provided the initial implementation of these weapons system integration.

Mission command allows commanders to quickly and accurately employ the troop leading procedures and expedite the military decision making process and is critical to mission success. Secretary of Defense James Mattis summarizes the importance of mission command, "[Mission command] is something that I am passionate about. I believe it's absolutely critical to our warfighters … It is also something that encompasses all the military functions of leader-

4 *Field Manual 3-01 paragraphs 4-1*
5 *Training Circular 3-01.64 paragraph 1-1*

An Avenger system crew from E Battery, 6th Battalion, 52nd Air Defense Artillery Regiment, 35th ADA Brigade, reloads an M3P .50-caliber machine gun during a live-fire exercise. (Staff Sgt. Todd L. Pouliot/U.S. Army)

ship but nothing is more important because no essential warfighting function or activity is possible without [mission command]"8 (Institute for Defense and Government Advancement, 2009).

The purpose of the integration is to provide commanders and operators an enhanced air picture that allows the commander to make better informed decisions. With the enhanced air picture, the commander can implement decisions that would increase the protection of friendly assets and units. The integration of all three weapon systems is a difficult process and continues to present new challenges as the unit looks to incorporate additional weapons systems, such as counter-unmanned aerial systems.

The integration of multiple tier air defense assets into one operational air picture at 2-1st ADA was conducted in three separate phases. The first phase consisted of integrating THAAD and Patriot into a consolidated network utilizing multicast Tactical Digital Information Link – J over the Indo-Pacific Command Ballistic Missile Defense Tactical Interface Node architecture. The two weapon systems were successfully able to pass numerous Link-16 message sets and validate their ability to conduct automatic engagement coordination between the two.

The final phase of this operation will be consolidating all three tiers of air defense into 2-1st ADA's base operations center. The implementation of this integration of capabilities provides the battalion with the enhanced air picture that provides commanders with appropriate command and control within their respective units. Additionally, in the event of an Avenger unit being co-located with a forward stationed unit, this enhanced and integrated air picture will provide the forward-based unit commander with enhanced early warning and allow them to make better informed decisions. The consolidation of these air defense assets will ultimately enhance early warning across the Korean Peninsula and increase the readiness status of the force.

Once the network architecture is built, 2-1st ADA will be able to seamlessly incorporate additional air defense weapon systems and ultimately expand the footprint of the ADA branch. Maintaining this network allows for 2-1st ADA to operate in accordance with the Fires Center of Excellence's stated goal of transitioning to the Integrated Air and Missile Defense Concept outlined in the 2017 Joint Publication 3-01. Focusing on the latter half of the definition of IAMD, interoperability amongst all three tiers of air defense provides "overlapping operations to defend the homeland and U.S. national interests, protect the joint force and enable freedom of action by negating an adversary's ability to achieve adverse effects from the their air and missile capabilities."[6]

Additionally, the training value that it affords the junior enlisted, noncommissioned officers and junior officers at the battery level is essential to rebuilding the short range air defense capability, especially within the 14G military occupational specialty. This integration has afforded the opportunity for Soldiers of different ranks and MOSs to work together to create a blueprint – one that will allow other units to integrate their systems and will have the capability to augment any unit into their air pictures. Ultimately, it has provided a comprehensive understanding of Joint Data Networks to the *Guardian Battalion* and its Soldiers.

Capt. Adam Patterson is the 31st Air Defense Artillery Brigade assistant S3.

Second Lt. Matthew Becker is E Battery, 6th Battalion, 52nd Air Defense Artillery platoon leader.

Warrant Officer 1 Adam McGee is the 2nd Battalion, 1st Air Defense Artillery C2 Systems integrator.

6 *Joint Publlication 3-01*

Paratroopers from Alpha Battery, 1st Battalion, 319th Airborne Field Artillery Regiment, 3rd Brigade Combat Team, 82nd Airborne Division sight in an M1193A Howitzer during an air assault and live-fire exercise held Oct. 24, 2018 on Fort Bragg, N.C. The operation tested the paratroopers' and aviators' abilities to integrate their capabilities while demonstrating their technical expertise and tactical capability to provide lethal Fires. (Maj. Thomas Cieslak/U.S. Army)

If Henry Knox were alive today

A discussion on future artillery warfighting

By Maj. Jeremy Blascak

An artillery unit is conducting a mounted tactical movement when a fire mission comes over the radio. Months of training kick in like second nature as everyone takes immediate action. Without losing a second, artillery Soldiers speed off the road, howitzers move into position and the fire direction center (FDC) quickly computes fire mission data. Soldiers begin rapidly establishing sectors of fire around the howitzers to provide security with dismounted machine guns and grenade launchers, howitzer section chiefs give their orders, and artillery Soldiers put muscle to metal as they heave high explosive projectiles into place

to rain hell on the next target. This process is known to a select few as the artillery fire mission. The unit achieves a ready-to-fire status in only a few minutes from the first radio call, but to the Soldiers, it felt like mere seconds. Anxiously, the howitzers wait, protected by fighting positions that cover all possible avenues of approach the enemy may attempt. The metal dragons eagerly standby for permission to breathe fire as the FDC completes final calculations and sends word across the radio. Finally, the howitzer section chief shouts and motions as if chopping wood by hand…FIRE!

An artillery unit preparing to fire is a thing of beauty—a well-oiled and rehearsed machine with the mission to destroy, neutralize, or suppress the enemy. What if Maj. Gen. Henry Knox, appointed the first Chief of the Artillery by Gen. George Washington, was alive today to see the current state of U.S. Army Field Artillery? He would likely appreciate the effort for precision and ever-increasing range through any environment or weather condition, but may not understand current technology in use or the consequences if digital systems were not operable. With the ever-changing character of war, the artillery community strives to be at the forefront of technological innovation to provide maneuver commanders with the most lethal fire support asset available. As the future battlefield evolves, it is paramount that units are able to operate with and without digital systems since the next conflict may not be as permissive across the electromagnetic spectrum (EMS) as the last. As Henry Knox would likely say, artillery must continually train fundamental core competencies while maintaining the ability to provide fire support in a contested environment through complex terrain. To understand the future direction in which the field artillery community must go, it is important to understand how artillery training and employment evolved under the guidance of the first Chief of the Artillery, Henry Knox.

Background on Henry Knox: A focus on artillery core competencies

Since 1924, the artillery community has celebrated Knox's contributions with the annual presentation of the Henry A. Knox Award to the top active-duty Army field artillery battery. The award acknowledges the top battery based on "performance, excellence, leadership, and proficiency," all characteristics that Knox lived and embodied during his service to the Continental Army and Gen. George Washington. In 1775, Washington tasked Knox to retrieve as many artillery pieces as possible from New York, and specifically, from the recently captured Fort Ticonderoga in order to prepare for a siege of Boston. Despite

U.S. Soldiers of the 1st Battalion, 41st Field Artillery Regiment, 1st Armored Brigade Combat Team, 3rd Infantry Division in M109A6 Paladin howitzers maneuver while conducting a Fires mission during exercise Combined Resolve IV at the U.S. Army's Joint Multinational Readiness Center in Hohenfels, Germany. (Staff Sgt. Carol A. Lehman/U.S. Army)

the magnitude of this task, Knox returned just nine weeks later after traveling over 300 hundred miles through extremely challenging terrain in the middle of winter with nearly 60 cannons. Knox's cannons proved essential in the 1776 seizure of Boston and more importantly changed the future of fire support by demonstrating that "artillery could be made mobile, even in the frozen wilderness and [through] difficult terrain."

A study of Knox reveals his focus on the fundamentals of employing artillery on the battlefield, which if trained and applied correctly could result in extremely capable and lethal artillery units. During the winter of 1778, Knox established an artillery academy where leaders studied and trained to "confront the specialized complexities of artillery and warfare … [with] lectures on a variety of topics such as tactics, gunnery and mathematics in order to master basic

Soldiers assigned to A Battery, 3rd Battalion, 27th Field Artillery Regiment (HIMARS), 18th Field Artillery Regiment, Fort Bragg, N.C., fire an M142 High Mobility Artillery Rocket System at Fort Greely, Alaska, Oct. 19, 2018, during Red Flag-Alaska 19-1. Their unit was tasked to provide long-range artillery support during RF-A, allowing the unit to showcase its capabilities and develop relationships with other services. (Airman 1st Class Jonathan Valdes Montijo/U.S. Air Force)

military principles that they could apply to combat." Due to the artillery school's rigorous winter training, the Continental Army's artillery became a key component in its future success. Only a few years later, Washington requested that Congress promote Knox to major general and chief of the Continental Army's four artillery regiments. Congress approved Washington's request, making Maj. Gen. Knox the youngest person to hold that rank at the age of 32.

When studying Knox, it is important to highlight how he gathered concepts from recent European conflicts and applied them to the Continental Army's artillery. As artillery units trained in the newly established artillery schools, Knox transitioned the organization to smaller and lighter field guns focused on the ability to quickly shoot and move across the battlefield. From humble beginnings with the Continental Army, modern artillery in comparison to today's fixed-wing and rotary-wing aircraft has the ability to provide 24/7 fire support regardless of weather conditions or crew rest cycles, and with limited fuel/power generation requirements. Thus, Knox refined for the early American military what is now one of the most capable and lethal fire support assets in the U.S. military's inventory.

Fires in a contested environment

If the first chief of the artillery had the opportunity to see modern fire support in action, the capability, speed and discipline would shock him. Knox likely would not understand the technological developments, but would certainly see room for improvement as artillery Soldiers struggle with proficiency on the continuous flow of new and updated digital systems. Artillery units acknowledge the added benefit of speed and reduced human error with digital systems when functioning properly, but Knox may question how well artillery Soldiers could provide fire support if those systems ceased to function. The ability to provide fire support in a degraded environment (without digital systems), has atrophied over the years as a result of the emphasis on the technological innovation of artillery and continuous deployments and training rotations where degraded operations lose focus. In training for decisive action at the Joint Readiness Training Center on Fort Polk, La., observers reported a pattern of units that failed to plan or train for degraded operations. Over-reliance on digital systems along with the atrophy of degraded artillery skills creates a significant vulnerability in a contested environment against a competitor with similar if not better capabilities.

A study of the systems used in the 2014 Ukrainian conflict shows the capability exists for potential adversaries to utilize electronic warfare (EW) to electronically jam global positioning systems (GPS) signals, disrupt electronic fuzes on artillery projectiles, and locate/target signals from artillery units presenting an electronic signature. As artillery units train for future conflict, it is necessary to prepare for an enemy who may have the ability to deny U.S. forces the use of digital systems through cyber-attacks or EW. The current application of digital systems in the artillery community has certainly increased speed and overall capability, but exposes a new weakness that requires protection through electronic signature management or SIGMAN, and the ability to provide Fires without the use of computer-aided devices and GPS to process fire missions and occupy/fire howitzers. Some of the current precision munitions have undergone changes to protect against GPS jamming/spoofing and to operate without GPS if necessary, but it is still vital to maintain a degraded capability across the inventory of howitzers and associated munitions.

The 2017 National Security Strategy states that great powers such as China and Russia are "fielding military capabilities designed to deny America access" and that past adversaries have studied the "American way of war and began investing in ca-

pabilities that targeted our strengths and sought to exploit perceived weaknesses."

In a future multi-domain operation, great power competition could see U.S. forces outgunned and outranged further necessitating the need for a precise and accurate first strike that, if necessary, can operate between digital and degraded systems seamlessly. U.S. forces will need to function with reduced and protected electronic signatures in a contested environment against an adversary with EW capabilities. Several examples exist in the warfighting doctrine of comparable military forces such as China where the goal of the People's Liberation Army is a paralysis "through kinetic, and non-kinetic attacks, as either type of attack may be able to destroy or degrade key aspects of the enemy's operational system, thus rendering it ineffective."

As described in "U.S Army's Operating Concept: Win in a Complex World 2020-2040," it is necessary to both train to protect digital systems across the EMS while also ensuring units can fight without them in order to effectively prepare for the next conflict.

Digitization of artillery, degraded operations

In October 2016, the Chief of Staff of the Army, Gen. Mark Milley stated Soldiers will "operate routinely in a partially or significantly degraded environment … that means we must invest in hardening our systems and, equally important, train on the techniques of operating with limited electronics. That'll be a shocker for all of us. We may have to read a paper map again and learn to use a magnetic compass."

An issue arises with artillery innovation that leaders need to acknowledge and units must train for: a loss in the ability to effectively fight degraded or without the combat multiplier of digital systems and communications.

In this age when a GPS is in everyone's pocket, Soldiers still train land navigation with a compass and paper map before using a digital tracking system to navigate. This training method engrains an understanding of how to navigate with analog systems before using a modern digital method. This method is similar to training artillery core competencies where Soldiers must continue to train degraded methods of processing fire missions, how to lay howitzer positions and how to fire them without the aid of digital systems. Army Reference Doctrine Publication (ADRP) 3-0: Operations describes the necessity to "train in contested conditions that emphasize degraded capabilities [because] threats will attempt to impede joint force freedom of movement and action across all domains [and] disrupt the electromagnetic spectrum." Over-reliance on modern systems can create a culture that no longer sees the need for analog methods and foregoes training on them. This creates an inability to quickly transition to degraded systems and methods when the situation necessitates it.

In 2017, JRTC produced a study of the top 10 shortcomings across the warfighting functions. Rotation after rotation of Fires units at JRTC further highlighted that artillery battalions lacked procedures for degraded operations in a GPS-denied environment or when a loss of digital connectivity occurred. As evidence of a loss in degraded expertise, "all fiscal year 2016 live-fire firing incidents attributed to the firing unit occurred while units were operating in a degraded status."

In a contested environment where potential adversaries have the ability to impact digital operations and the EMS, it is crucial for the artillery community to place equal focus on training for both digital and degraded operations. Artillery units must not lose focus on the importance of training on degraded systems to transition between the two without impacting the ability to provide accurate and responsive Fires to the maneuver force.

Finding time on the training calendar to sharpen both digital and degraded skillsets will always be difficult. To gain and maintain an advantage over the next adversary, it is crucial to equally integrate digital and degraded training plans so that they reinforce each other where one or the other will not become an exploitable weakness in a contested environment. Recently, several artillery units started a culture change by referring to degraded operations as "manual procedures" in order to eliminate what some consider a negative connotation with the term "degraded." This is one example that acknowledges the issues surrounding degraded procedures and shows that it is the job of artillery leaders and professional Redlegs to ensure training is thorough, creative and challenging to Soldiers on both aspects of providing Fires while finally putting a stop to years of atrophied core competencies.

Where some artillery skills have atrophied, some have also grown, marking a time to shift focus towards the future of artillery warfighting and the challenges presented by the next adversary. In 2016, Milley stated that "we are on the cusp of a fundamental change in the character of war. Technology, geopolitics and demographics are rapidly changing societies, economies and the tools of warfare."

This change in the character of war is evident with the growing digitization in all areas of artillery from the observation post to the gunline. The artillery community will continue to innovate and implement new digital systems to increase lethality, but must not forget the adversary has a vote as well. Therefore, the ability to provide the maneuver commander with integrated, synchronized and responsive fire support requires artillery units to train digital and degraded operations equally as well as the ability to transition between the two without fail.

In preparation for the future of artillery warfighting, it is important to understand how the Fires community has evolved and taken lessons learned over the years to provide the most lethal and capable force possible for the next conflict. A look at the history of Knox's Continental Army Artillery in the winter of 1778 reminds leaders to continuously train and hone fundamental core competencies as they are critical to success on the battlefield. While the implementation of digital systems in the artillery community has certainly increased the speed at which a unit can execute a fire mission, it has simultaneously created vulnerabilities through an over-reliance on digital systems and failure to properly train digital and degraded methods equally. If Fires units focus training plans on artillery fundamentals, train digital and degraded systems equally, and are able to shoot and move while also protecting against adversaries, then there is no doubt that Knox would be extremely proud of how the artillery community has evolved for future conflict.

Maj. Jeremy Blascak, is a field artillery officer and a division Fires planner with 3rd Infantry Division. He earned a Bachelor of Science in Information Technology from George Mason University, a Master of Arts in Management and Leadership from Webster University, and a Master of Arts in Military Studies from Marine Corps University. His military experience includes assignments with 82nd Airborne Division, 101st Airborne Division (Air Assault), Pacific Command and two deployments to Afghanistan.

In the next issue of Fires

Jan.-Feb. 2019, The 2018 Red Book. The Red Book is a year in review for the Fires force including Reserve, National Guard and Marine units. The Red Book highlights U.S. Army Field Artillery, Air Defense Artillery and U.S. Marine Corps Field Artillery unit activities at the brigade-level and lower.

The deadline for submissions is Dec. 1, 2018. Submissions should capture significant events, such as deployments, training, etc., for the past year. Send your submissions to usarmy.sill.fcoe.mbx.fires-bulletin-mailbox@mail.mil or call (580) 442-5121 for more information.

Col. Shane Morgan (right), 1st Brigade Combat Team, 10th Mountain Division commander, points out areas of interest to Brig. Gen. Gregory Anderson (left), Deputy Commanding General-Support, during a live-fire iteration at Range 44 during a combined arms live fire exercise, Fort Drum, N.Y., Oct 19, 2018. (Staff Sgt. James Avery, U.S. Army)