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Fires

Fires in support of large-scale combat operations

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The Fires complex

Organizing to win in large-scale combat operations

By Col. Chris Compton and Lewis Lance Boothe

As the Army refocuses on what it takes to win in large-scale combat operations (LSCO), determining the right organizational structure is a key component of the solution. Army Fires will play a critical role in LSCO and must be organized in a way that maximizes the timely, accurate employment of cross-domain Fires throughout the depth of an increasingly lethal, expanded battlespace.

Post-Cold War divestiture of Fires capability and force structure has left the Army at a disadvantage against peer and near-peer threats who have continued to invest in long-range Fires and air defense capability. While the newly formed Cross-Functional Teams for long-range precision Fires and air missile defense are addressing certain capability gaps to increase range and lethality in Fires platforms and munitions, the Concepts Development Division at Fort Sill is proposing force structure concepts that merge future material solutions with robust mission command for employing cross-domain Fires at echelon.

Creating a Fires force with the capacity, range and lethality to provide a credible deterrence and achieve overmatch

Top: Spc. Jimmie Robinson, assigned to the 2nd Battalion, 377th Parachute Field Artillery Regiment, gathers his T-11 advanced tactical parachute system after completing an airborne training jump at Malemute Drop Zone, Joint Base Elmendorf-Richardson, Alaska, March 22, 2018. (Alejandro Peña/U.S. Air Force) Bottom: Soldiers from B Battery, 4th Battalion, 27th Field Artillery Regiment, fire 155 mm rounds from their M109A6 Paladins. (Staff Sgt. Matthew Keeler/U.S. Army)

US Fires Complex in MDB
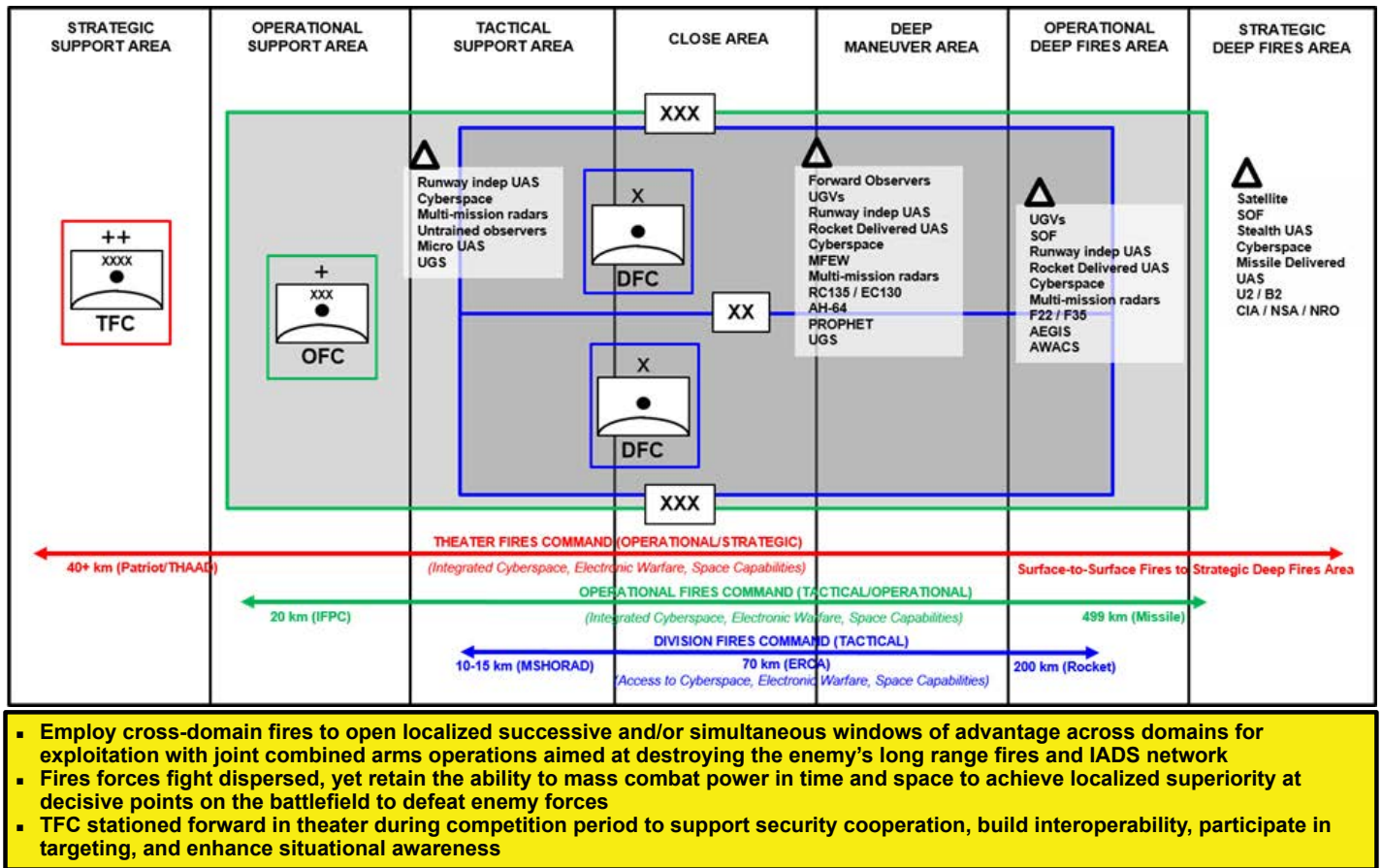
Figure 1. The Fires complex roles in multi-domain operations. (Courtesy illustration)

in multi-domain operations (MDO) requires a revolutionary shift in current Fires force organization, capability and employment. Peer adversaries already employ a recon-strike Fires complex with long-range Fires, integrated sensor networks along with counter-rocket, artillery, mortar and air defense systems designed to offset the maneuver and technological advantages of U.S. forces. To face the increasingly lethal threats of today and tomorrow, the Army requires a more formidable Fires complex capable of delivering precise, responsive, effective and multifunctional Fires against targets in all domains (land, air, maritime, space and cyberspace) and at all echelons (tactical, operational and strategic). This requires both reinvesting in ground-based Fires capabilities and reorganizing Fires forces.

The starting point for this proposed reorganization involves at least a cursory review of the past. Historically, the great strength of Army Fires was the ability to deliver timely and accurate massed Fires with field artillery and provide protection of critical assets with air defense artillery throughout the depth of the battlefield to enable maneuver and set conditions for

victory. Army Fires units assigned to formations at all echelons, supported by joint enablers, formed the necessary structure to fight with Fires and win. Success depended upon the right capability and the right organizations.

The Fires force from World War II through Operation Desert Storm was organized to fight and win against peer and near-peer adversaries. The Army invested heavily in FA and ADA in the 1970s-90s to optimize for large-scale combat. The Army had tactical, operational and strategic Fires capability that ranged the depth of the bat-

Figure 2. An example of a Division Fires Command unit. (Courtesy illustration)

HHB: Headquarters and Headquarters Battery
CMD: Command
FCE: Fire Control Element
LNO: Liaison
FC: Fires Cell
CEMA: Cyber Electro-Magnetic Activities
ADAM: Air Defense and Air Management
IO: Information Operations
M-SHORAD: Maneuver Short Range Air Defense
IFPC: Indirect Fire Protection Capability
FSC: Forward Support Company
BSB: Brigade Support Battalion
JPST: Joint Precision Strike Team

tlefield to counter peer adversary air and ground capabilities. The Army organized effectively at echelon to deliver accurate massed Fires as well as create integrated layers and redundancies of air defense to maximize capability and lethality against a threat with superior numbers.

Today's Army is characterized by modularity and is no longer optimized for LSCO. As a result of the post-Cold War drawdown and modularity, the Army restructured to support operations in stability and counter-insurgency environments. During this period, the Army divested of nearly all short range air defense (SHORAD) in the active component and suffered a 70 percent overall reduction in field artillery platforms in the total force, eliminating a total of ~3,800 cannon and all Lance and Pershing Missile systems.[1] This resulted in a 60 percent reduction in range and no strategic strike capability. Transition to modularity also purged Fires structure at the corps and division level, eliminating corps artillery and DIVARTY structures. While the DIVARTY returned in 2015, it remains a mere headquarters leaving our divisions and corps with no organic firepower to shape the deep maneuver and Fires areas.

While the past provides a useful reference point for determining the right capability and organizations, re-optimizing for LSCO today requires adapting to an operational environment (OE) where the U.S. military will be contested in all domains and the information environment. This emerging OE is the driving force behind the Army's MDO concept and is redefining how the Army will employ Fires on the future battlefield.

Threat anti-access/area denial strategies (A2/AD) are challenging previously held assumptions that the U.S. will retain air and maritime dominance throughout all phases of conflict, creating the need to establish temporary windows of advantage across multiple domains in time and space to enable joint force operations. To that end, Army Fires forces must be structured to employ effective cross-domain Fires, that is, capable of employing lethal and non-lethal effects across all domains to create multiple dilemmas for an adversary and enable joint force operations.

The seamless integration and synchronization of cross-domain Fires throughout the depth of an expanded and contested battlefield requires Fires organizations at each echelon – an integrated Fires complex

– with the right capability and leadership to provide precise and responsive Fires. This is the central idea behind the proposed operational and organizational concepts. Each Fires command is structured to maximize organic delivery capability, enhance sensor-to-shooter linkages, and conduct cross-domain targeting and fire control using an integrated fire control network.

At the division level, the Division Fires Command expands the current division artillery structure as a tactical Fires formation capable of supporting divisions as a force Fires headquarters. Commanded by a colonel with supporting staff, the DFC contains an assigned Multiple Launch Rocket System battalion for deep shaping Fires and a composite M-SHORAD/Indirect Fire Protection Capability battalion to protect the division's maneuver forces and critical command and control and logistics nodes. Additionally, the DFC has an assigned extended-range cannon artillery or hypervelocity gun weapon system battalion to provide increased flexibility and lethality to support the division in the close area.

The division retains the current Joint Air-Ground Integration Center capability, but gets an expanded Fires cell with cyber electro-magnetic activities, air defense and air management and information operations (IO) cells for full cross-domain Fires integration in targeting and fire planning. To increase intelligence, surveillance, and reconnaissance coverage and responsiveness, the DFC includes an observation detachment with multi-mission radars, a runway independent unmanned aerial system platoon and joint precision strike teams (JPSTs) capable of engaging targets in the division's deep area. Additionally, the DFC concept includes an assigned brigade support battalion and signal company to provide required logistics and communications support to the formation.

This concept addresses the most fundamental needs at division level, the principle tactical warfighting headquarters in the Army. The DFC specifically addresses the current lack of organic long-range Fires capability for shaping the close fight and SHORAD needed to protect maneuver and critical nodes. The DFC provides a division commander with a force Fires headquarters capable of integrating the employment of cross-domain Fires between the division's coordinated fire line and the fire support coordination line (FSCL), setting conditions

for successful brigade combat team operations.

The Operational Fires Command addresses perhaps the most critical gap in the Army, the employment of ground-based operational Fires. The OFC is assigned to a corps, is commanded by a brigadier general and serves as a Force Fires Headquarters at the operational level. The OFC converges the lethal Fires capability of an FA brigade and ADA brigade along with non-lethal Fires capability in an intelligence, cyberspace, electronic warfare and space company into a single cross-domain Fires formation. The OFC is capable of executing joint suppression of enemy air defense, operational strike and shore-to-ship Fires through enhanced sensor-to-shooter linkages over an integrated Fires network.

Like the DFC, the OFC's observation battery contains a multi-mission radar detachment, a JPST platoon, and organic UAS platoon to engage operational deep targets. Additionally, the cross-domain Fires cell is designed for conducting operational targeting and fire planning. To support the corps as a joint task force (JTF), the OFC retains a number of liaison positions for interoperability with joint, interagency and multi-national (JIM) partners.

The OFC gives a corps headquarters what it does not have today – a force Fires headquarters with the capability for engaging the enemy beyond the FSCL at ranges out to 500 km. While today's FA brigades are aligned with U.S. corps, the brigade's structure is insufficient for corps needs in LSCO. The robust cross-domain Fires capability in the OFC, including the integrating functions residing within the headquarters, provides a corps or JTF commander with true operational reach to strike peer adversaries attempting to engage U.S. forces from standoff ranges.

The third organization completing the Fires complex is the Theater Fires Command (TFC). The Army lacks a strategic ground-based Fires capability. The TFC is assigned to a theater Army and expands the Army Air Missile Defense Command and the battlefield coordination detachment (BCD) force structure into a single theater-enabling command with strategic attack capability. The TFC is the senior Fires command in the U.S. Fires complex, commanded by a major general with supporting staff in a headquarters and headquarters battalion.

The most notable addition to the TFC is

1   McKenney, Janice E., "The Organizational History of the Field Artillery: 1775-2003," Center for Military History Publication 60-16, 2007, p. 338.

Air defenders from D Battery, 5th Battalion, 7th Air Defense Artillery, conduct march order and system validation training for the MM-104 Patriot missile system during Juniper Cobra 18 at Mount Eitam, Israel Feb. 27, 2018. The Juniper Cobra series consists of ballistic missile defense exercises that have been regularly conducted since 2001. (Sgt. 1st Class Jason Epperson/U.S. Army)

the inclusion of a strategic missile battalion capable of striking targets beyond operational distances with ground launched strategic attack missiles. Conceptually, this battalion is a component of a theater missile brigade equipped with High Mobility Artillery Rocket System battalions capable of providing additional support to corps operations or striking targets in support of the theater Army with long-range precision strike missiles, or potentially with sophisticated land-based cruise missiles. Additionally, the inclusion of an ADA brigade with Terminal High Altitude Area Defense and

Patriot launchers provides protection for strategic nodes in the theater.

Another unique capability of the TFC is the multi-domain task force (MDTF). Multi-domain capabilities from theater enabling commands combined with TFC firing units create an MDTF. This formation is designed specifically to counter threat A2/AD strategies by opening windows of advantage for joint force exploitation. The MDTF's ability to deploy forward in theater and protect critical nodes early in operational phases provides increased decision space for the joint force commander,

flexibility to address emerging threats with massed cross-domain Fires, and the capability required to prevent sequential threat escalation activities. The MDTF's ability to employ cross-domain Fires to disrupt and destroy threat formations prior to their interdiction of the joint force sets the conditions for follow-on operations and campaigns.

The TFC integrates fully with JIM partners through the combat coordination element (CCE), an expansion of the current BCD. The CCE provides the Army's "plug" into the air, maritime and special operations components of the joint force through real and virtual liaison teams to ensure Army cross-domain Fires are planned, resourced and employed effectively in all domains. Envisioned as a forward-positioned enabling command, the TFC is a powerful arm for the joint force commander to prevent, shape and win during competition and conflict periods.

Optimizing for LSCO against emerging peer and near-peer threats requires a force capable of employing precise, responsive and multi-functional cross-domain Fires throughout the depth of the battlefield. The Army once had the force structure at echelon required to meet the serious threats of the past. Building on that understanding while adapting to the changing demands of

Figure 3. An example of a Operational Fires Command unit. (Courtesy illustration)

HHB: Headquarters and Headquarters Battery
CMD: Command
FCE: Fire Control Element
LNO: Liaison
JAMT: Joint Airspace Management Team
CEMA: Cyber Electro-Magnetic Activities
IO: Information Operations

FSE: Fire Support Element
TGT: Targeting Cell
JPST: Joint Precision Strike Team
M-SHORAD: Maneuver Short Range Air Defense
IFPC: Indirect Fire Protection Capability
FSC: Forward Support Company
ICEWS: Intelligence, Cyber, Electronic Warfare and Space

Figure 4. An example of a Theater Fires Command unit. (Courtesy illustration)

HHBN: Headquarters and Headquarters Battalion
CCE: Combat Coordination Element
TADCE: Tactical Air Defense Control Element
ADAFCO: Air Defense Artillery Fire Control Officer
ACC: Air Coordination Cell
MCC: Maritime Coordination Cell
SOCC: Special Operations Coordinatoin Cell
GLD: Ground Liaison Detachment

OPS: Operations
FSE: Fire Support Element
TGT: Targeting Cell
CEMA: Cyber Electromagnetic Activities
MISO: Military Information Support Operations
MDTF: Multi-Domain Task Force
THAAD: Terminal High Altitude Air Defense
FSC: Forward Support Company

* Functions expected to be supplanted by automation or executed through virtual liaison

the operational environment, the Army can once again regain the technological and organizational advantage required to win in MDO. As the Army pursues material solutions to address its range and lethality gaps, the need to create the right force structure to integrate and employ new capabilities is just as important.

The proposed operational and organizational concepts, creating a U.S. Fires complex, are currently undergoing thorough experimentation in numerous Army and joint exercises to ensure validity and design soundness. Additionally, the Concepts Development Division at the Fires Center of Excellence welcomes feedback from the force as the team continues to make modifications and refinements. The CDD plans to host a conference in early 2019 to discuss the concepts in detail, make necessary refinements and continue to chart a path forward for reorganization.

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An M142 High Mobility Artillery Rocket System is loaded onto a C130-J during Green Flag Little Rock April 10, near Alexandria, La. (Airman 1st Class Codie Collins/U.S. Air Force)

Shaping the division fight
Targeting doctrine reapplied

By Maj. Gen. Joseph Martin and Col. Rory Crooks

Virginia Army National Guard Soldiers assigned to the 1st Battalion, 111th Field Artillery Regiment, 116th Infantry Brigade Combat Team, conduct training on an air delivered field artillery raid April 14, 2018, at Fort Pickett, Va. U.S. Army Reserve Soldiers assigned to B Company, 5th Battalion, 159th Aviation Regiment, 224th Aviation Brigade, flew CH-47 Chinook helicopters to transport four M777A2 howitzers and Virginia National Guard Soldiers assigned to the 2nd Battalion, 224th Aviation Regiment, 29th Infantry Division, flew UH-60 Black Hawks to transport eight M119A3 howitzers. (Cotton Puryear/U.S. National Guard)

Targeting can confound staffs familiar with its application within stability operations yet attempting to apply it within decisive action. Developing target folders, dedicating multiple persistent intelligence-surveillance-reconnaissance (ISR) assets to "soak" areas hiding suspected high-value individuals, and disrupting networks long enough for civil authorities to assume greater security roles bears little relevance when facing near-peer adversaries. As recent warfighter exercises (WFXs) demonstrate, threats present as formations rather than individuals. ISR platforms must loiter only long enough to positively identify, guide Fires onto a target, and conduct battle damage assessment (BDA). Platforms that linger become subject to enemy destruction or interdic-

tion through means of electronic warfare (EW), and acquisition of these lethal, mobile formations increases in difficulty. Rather than buying time for host nation forces, decisive action targeting objectives seek to shape enemy forces and thereby create exploitable conditions of relative advantage against them. The incompatibility of stability operations targeting in a decisive action operational environment (OE) lies not in the targeting principles but in their application.

Joint Publication (JP) 3-60 Joint Targeting describes the joint targeting process as "…a rational and iterative process that methodically analyzes, prioritizes and assigns assets against targets systematically." This process applies equally across the entirety of an area of operations (AO)—including the deep, close, support and consolidation areas—using the same principles throughout. It provides commanders and staffs with a vehicle to prioritize and apply available joint assets to achieve layered effects in a way most advantageous to friendly maneuver. The process creates decision space for commanders, provides a method for applying combat power in a way that is both manageable and measurable, and achieves the objective of developing windows of opportunity to create relative advantage against an enemy. The following paragraphs illustrate ways in which a division fighting in a decisive action training environment (DATE) including a WFX or as a higher headquarters (HICON) for a combat training center (CTC) rotation can apply targeting principles throughout the depth of the AO.

Creating decision space

Divisions and brigades dedicate significant organizational energy toward analytical decision making (in the form of the military decision making process or MDMP) on the eve of a WFX or CTC rotation. In the absence of current operations, staffs exert maximum effort in gaining understanding of the OE, specifics of the threat situational template (SITEMP), and building running estimates within an unfamiliar environment. This includes understanding those elements valuable to the enemy that enable them to fight in the most advantageous manner, known as high-value targets (HVT). Staffs then constrain the variables of space and time to a window

of their scheme of maneuver, then generate a list of targets (a subset of the enemy's HVTs) that will provide maximum payoff for friendly forces known as a high payoff target list or HPTL. Fire supporters on staff choose a method familiar to joint services to constrain the time variable: the joint air tasking cycle—known informally as the air tasking order (ATO) cycle. While it affords air force and naval aviation assets with the most efficient means of managing their platforms, division and brigade staffs make it effective by applying lethal or non-lethal platforms upon selective formations during windows of time that best support maneuver. The predictable iterative nature of the ATO cycle provides common focal points for employing joint assets, most of which operate entirely or partly utilizing an air component. Constraining the staff to a time framework driven by the ATO cycle also creates manageable periods within which to engage and measure effects of engagement. Creighton Abrams advised, "When eating an elephant, take one bite at a time." Engaging and shaping enemy formations within the framework of the ATO cycle allows just this.

Developing the initial plan using the MDMP, staffs invest energy into phasing an operation that logically predicts transition points important for sequencing combat power. These transitions often generate associated decision points (DPs) for the commander to weigh conditions prior to proceeding to the next phase. When adopted across the staff to define time (and space[1]), the ATO cycle generates DPs on a daily basis with targeting battle rhythm events driving frequent smaller decisions based on most current running estimates. This often reduces the magnitude of course corrections characteristic of strictly waiting for DP conditions to be met.

Initial MDMP produces a plan that provides a logical framework and sequencing of the operation, reflecting the best attempt to predict enemy actions while aligning resources to thwart them. Unfortunately, the heavy staff investment in the plan comes at a point where understanding of conditions on the ground are at their worst—before maneuvering and making contact. The enemy SITEMP has not yet matured as it soon will. Staffs, especially at lower tactical echelons, acknowledge that current operations

will consume them and resign themselves to reacting to enemy contact—at least until reaching transition points identified when phasing the operation. Priming the ATO cycle for the first 72 hours after initiating the operation during initial planning creates decision space for commanders and staffs. Battle rhythm events for targeting, including the target working group (TWG) and target decision boards (TDB), provide predictable periodic opportunities to cognitively get ahead of the enemy based on refined running estimates—if commanders and key staff place emphasis on them through their direct participation. Nothing replaces the value of battlefield circulation and evaluation shared face-to-face between commanders and subordinates on the ground, but relegating targeting to junior staff deprives commanders from running estimates derived holistically. Doing so leaves their assessments and corresponding decisions to chance, rather than prompted methodically through input from various sources. Commanders require refined understanding from both subordinates on the ground and structured engagement with key staff at targeting events.

Shaping through targeting: Manageable and measurable

Through initial analytical planning efforts, staffs painstakingly build running estimates. The targeting process refines these estimates through a multi-pronged emphasis on deliberate and granular assessment. Land and maritime components of the joint force doctrinally follow the decide, detect, deliver and assess (D3A) methodology. Applied at tactical echelons in DATE scenarios such as a WFX, phasing of D3A takes a different form to integrate joint assets on common focal points of enemy formations and time (expressed in ATO day). Figure 1 graphically depicts an adaptation of D3A phasing, beginning with assessment. Developing inputs prior to the TWG including a commander-approved HPTL and maneuver execution matrix, key staff participants approach four days of the joint air tasking cycle by ATO day.[2] Figure 2 offers an example of key staff at a division level TWG as well as their primary roles in phasing detect-deliver-assess or integrating shaping assets to facilitate this activity. The figure suggests "a way" of arraying TWG participants around analog (i.e., large map of the

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1   The depth of friendly maneuver, or time phase lines of a decision support template, can be expressed by estimated ATO cycle day (e.g., "BK" instead of D+48). Done habitually, it facilitates commonality of products and thereby enriches the common operational picture (COP) across the enterprise.

2   D+24 hours corresponds to the Review day, where joint assets apportioned/allocated in the form of a published ATO and will be executed the following day. The available assets programmed are reviewed to see if re-tasking must be requested. D+48 corresponds to the Validate day just one day after the ATO was published ("validating" that assets requested were apportioned/allocated). D+72 corresponds to the Approval day during which the staff recommends to the commander what joint assets to request for his/her approval. D+96 corresponds to the Guidance day during which the commander shares his visualization of the battle informed
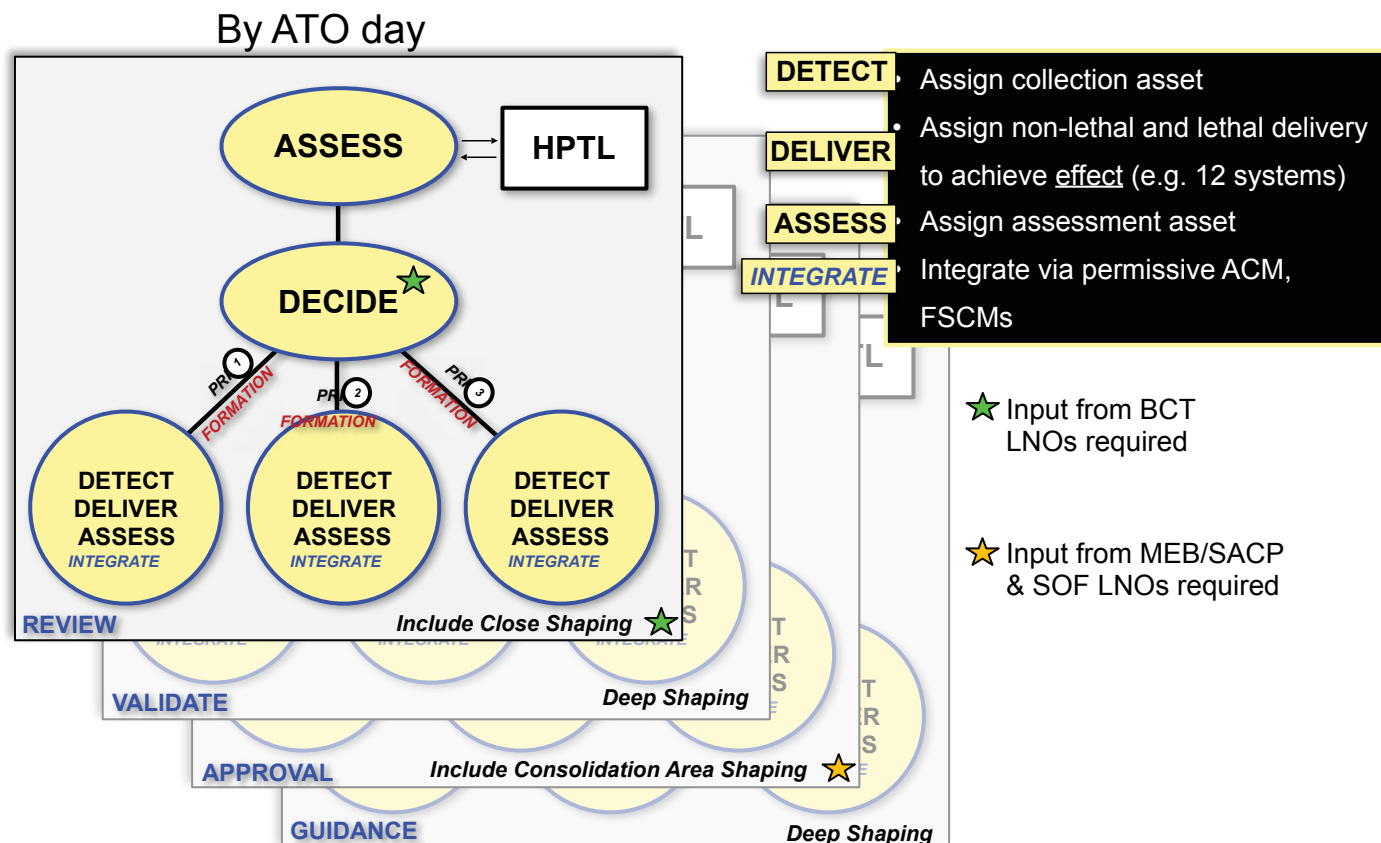
By ATO day

DETECT · Assign collection asset

DELIVER · Assign non-lethal and lethal delivery to achieve <u>effect</u> (e.g. 12 systems)

ASSESS · Assign assessment asset

INTEGRATE · Integrate via permissive ACM, FSCMs

★ Input from BCT LNOs required

★ Input from MEB/SACP & SOF LNOs required

Figure 1. Decide-Detect-Deliver-Assess (D3A) phasing adapted within DATE targeting at division level. (Courtesy illustration)

AO) and digital common operational pictures used in the process.

Within each ATO day, the division G2 or his target officer begins by arraying the enemy on the analog COP by numbered formations across the area of interest (usually by sizes two echelons down; for a division fight, arraying down to not smaller than battalion-sized formations). The G3 future operations (FUOPS) officer follows on the map adding friendly maneuver/disposition across the AO during the examined day. The USAF staff weather officer (SWO) describes environmental impacts of weather on joint and organic assets forecasted that day. The TWG then assesses the strength of capabilities within the enemy formations arrayed and compares these to the HPTL applicable for that day. These capabilities identified within the HPTL, such as artillery, are assessed down to numbers of systems when possible (e.g., 12 of 18 remaining 240 mm multiple rocket launchers or MRLs in the 12th Artillery Brigade). Based on friendly maneuver, TWG participants prioritize which arrayed formation poses the greatest threat to maneuver on that day and focus on shaping them based on this priority. The DIVARTY commander, as fire

support coordinator (FSCOORD) for the division, arbitrates any indecision. If the 12th Artillery Brigade happens to be the greatest threat to friendly forces that day because of its ability to engage at long range, followed by artillery organic to the 345th Armor Brigade and finally systems of the 67th Division Artillery Group, for example, TWG participants assign them as priority formations #1, #2 and #3 respectively.[3] This prioritization constitutes the Decide phase of the D3A methodology.

The Decide phase can vary day-to-day within the ATO cycle to accommodate the entire framework of the division AO (deep, close, support and consolidation areas). The division deep area can be defined by any graphic control measure (e.g., phase lines, BCT forward boundaries) or fire support coordination measure (e.g., coordinated fire line or CFL, fire support coordination line or FSCL). The majority of the division's shaping fight takes place in the deep area. For Validate and Guidance days, the enemy formations considered are almost exclusively within this division deep area. For Approval day, threats to the consolidation area can additionally be included with those in the deep area. These en-

sure that the staff addresses consolidation area shaping every working group and, by the timing, allows adequate coordination with the most effective joint asset operating in this area—friendly special operations forces (SOF) conducting counter-SOF. For divisions with a maneuver enhancement brigade (MEB) attached or a support area command post (SACP) for those without, the MEB/SACP staff may target down to individual level, similar to methods used in stability operations targeting. The outputs from this subordinate process, however, only enter the targeting process at echelon (i.e., division) when requesting joint assets (e.g., signals intelligence collection or electronic warfare platforms on elements operating within support and consolidation areas).

Division retains responsibility for shaping formations within its close area until the division main (DMAIN) conducts a deliberate battle handover of the fight. During this deliberate handover, DMAIN (either the chief of operations—CHOPS—or the Joint Air Ground Integration Center—JAGIC—chief) updates the BCT on enemy disposition for which it will assume shaping responsibility as well as disposition of any

by subordinate and staff estimates at the target decision board, approving a HPTL for that period. The staff then adopts this at the following target working group.

3   *The number of priority formations engaged is limited only by those arrayed and joint assets available to detect them, deliver against them, and assess the effects. For any given ATO, the number of priority formations rarely exceeded five.*
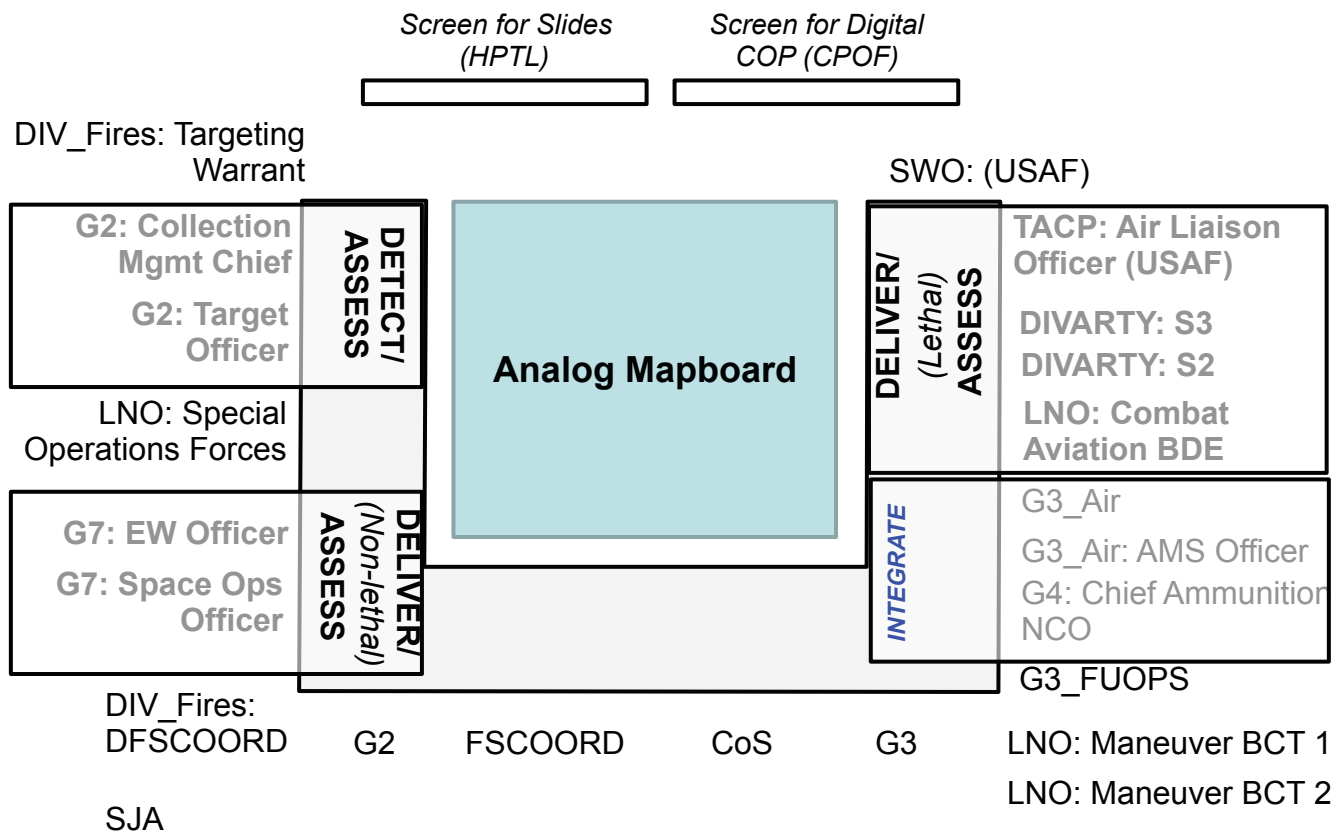
Figure 2. An example of target working group participants, layout, and roles within D3A. (Courtesy illustration)

friendly elements remaining in what will soon become BCT battle space. BCT liaison officers (LNO) provide ideal conduits for prompting and facilitating this handover as they are both situationally aware of current operations as well as being invested in the targeting process. Within the process, the Review day of the TWG provides the last opportunity for BCT LNOs to request additional emphasis on specific enemy formations of concern prior to assuming shaping responsibilities for them in the close area.

Within each of these priority formations identified in the Decide phase, TWG participants methodically align assets against detecting the targeted capabilities, delivering lethal and non-lethal Fires on these capabilities, and assigns assets responsible for confirming that the delivery had its intended effect. As Figure 1 depicts, the TWG iteratively assigns detect, deliver and assess tasks, as well as integration responsibilities for each priority formation. Each TWG participant will have developed prerequisite staff inputs prior to the event. The discussion around the table then proceeds succinctly as follows:

Detect. Against Priority Formation #1 (the 12th Artillery Brigade in the above example), the division G2 collection management chief assigns a line of MQ-1C Grey

Eagle UAV to acquire the 122 mm MRLs against a named area of interest (NAI) developed in conjunction with the DIVARTY S2 ahead of the TWG. Historic data from the DIVARTY's AN/TPQ-53 radars contributed to the NAI development.

Deliver. The division G7 EW officer then recommends disruption of the 12th Artillery Brigade's Fires nets during a given window of time relevant to friendly maneuver that ATO day, as well as messages delivered in support of information operations to noncombatants in vicinity of the targeted formation. The deputy FSCOORD then lists the division surface-to-surface target groups (e.g. A14B) delivered by DIVARTY assets upon detection. The DIVARTY S3 (without prompting during the meeting) announces the target numbers and total number of rockets/rounds delivered when initiating the group. The USAF air liaison officer (ALO) from the division tactical air control party (TACP) follows with the number of strike coordination and reconnaissance missions required to bring the remaining 122 mm MRLs down to a level acceptable for the BCTs to shape (e.g., three systems remaining of the original 18). The DFSCOORD checks the estimates to ensure delivery assets dedicated sufficient-

ly achieve the effects, then prompts the group for assets assigned to assess effects.

Assess. Since the F16CJs offer the greatest capability to both engage the MRLs and evaluate the results of the engagement, the ALO acknowledges the assessment task. The collection management chief follows by reiterating the same line of Grey Eagle that detect the MRLs. DIVARTY S2 announces responsibility for providing predictive BDA as well as assigning radars to monitor the NAI (in the form of a programmed radar zone) and share assessments.

Integrate. The division Fires and G3 air announce the permissive airspace coordination area (ACA) developed for this engagement to facilitate proactive airspace clearance.

By priority formation, TWG participants succinctly covered joint asset responsibilities for detecting the relevant capability, for delivering layered effects upon the capability, for assessing results of the engagement and for integrating friendly capabilities through developing planned permissive clearance measures within the ATO day. The TWG will repeat this cadence of detect-deliver-assess-integrate upon Priority Formation #2, fire support assets organic to the 345th Armor Brigade, this time incorporating a deep attack out of contact

Soldiers in 1st Battalion, 7th Field Artillery Regiment, 2nd Armored Brigade Combat Team, 1st Infantry Division, Fort Riley, Kan., conduct live-fire training during Dynamic Front 18 in Grafenwoehr, Germany, March 6, 2018. Exercise Dynamic Front 18 includes approximately 3,700 participants from 26 nations training together from Feb. 23-March 10, 2018. Dynamic Front is an annual U.S. Army Europe exercise focused on the interoperability of U.S. Army, joint service and allied nation artillery and fire support in a multinational environment, from theater-level headquarters identifying targets to gun crews pulling lanyards in the field. (Spc. Dustin D. Biven/U.S. Army)

with combat aviation brigade (CAB) assets in the delivery to destroy 20 of the original 36 152 mm 2S-19 self-propelled howitzers in this formation. During integration, the DIVARTY S3, G3 air, and CAB LNO brief the air corridors, suppression of enemy air defense (SEAD) targets initiated, and other permissive airspace clearance measures needed to conduct a joint air attack team (JAAT) upon the 345th AB howitzers. The

group assigns detect-deliver-assess-integrate against the 67th DAG before the DFSCOORD closes the ATO day by reviewing the HPTL, attack guidance matrix (AGM) and target selection standards (TSS) that has been published (or will be published) in the division fragmentary order (FRAGORD) for that ATO day. This process repeats over the period of 90 minutes until the TWG has prepared recommendations

for shaping four days out for the commanding general's (CG) guidance.

When reinforced by command group and key staff participation, the targeting process contributes to shared understanding—providing decision space to methodically shape and assess enemy combat power—while driving other staff processes. Just as TWG participants brought prerequisite inputs from other division and corps lev-

from all sources (including those assigned responsibilities in the previous TWG) into the overall assessment at the beginning of each TWG and each TDB chaired by the CG. The TDB—where the CG approves the method by which the division will shape the enemy and maneuver in space and time—provides outputs that formalize the Annex D (Fire Support) and leads ultimately to a published FRAGORD.[4]

The ultimate purpose of shaping and the targeting process, however, remains to create positions of relative advantage over the enemy. ADRP 3-0 defines a position of relative advantage as "…establishment of a favorable condition within the [AO] that provides the commander with temporary freedom of action to enhance combat power over an enemy or influence [him] to accept risk and move to a position of disadvantage." Targeting participants develop the HPTL with this focus in mind—prioritizing which enemy capability to interdict or destroy to create relative advantage. The HPTL retains a time component, based temporally on enemy posture and friendly posture within a defined window. Posture in this case applies broadly over multiple domains, as engagement of an HPTL within the electromagnetic or cyber domains still constitutes establishment of a position of relative advantage. This facet proves critically important when targeting against adversaries layering their defenses with multiple protection assets and enablers.

Recent WFX experience has witnessed an increase in enemy protection and enabler capabilities to reflect the layering that constitutes anti-access/area denial (A2/AD) developed by near-peer competitors. On land, the stratification of air defense systems of varying range and capabilities with enablers such as EW- or global positioning system- (GPS) jammers by these adversaries poses significant challenges to applying friendly joint capabilities—many of which rely on air platforms and GPS. This layering affords the enemy freedom of action to maneuver out of contact and to employ their Fires assets, some of which overmatch current friendly capabilities. Targeting formations with these protection and enabler capabilities seek to methodically strip away these layers (through destruction or disruption) and thereby allow friendly forces freedom of action to employ the entire range of joint capabilities.

Targeting protection capabilities and enablers requires assessing not only the extent of their capabilities, but their vulnerabilities in every domain. Targeting participants prepare prerequisite inputs to the TWG that examine each enemy capability populating a HPTL, listing a menu of friendly multi-domain capabilities that can be used to engage those systems directly or the formation with whom they are associated. Successfully creating windows of opportunity during which layered protection and enablers are negated shifts the preponderance of freedom of action from the enemy to friendly forces. Freedom of action (described in FM 3-0 as including "secure lines of communication, standoff, depth, access to cyberspace, maritime and air enablers, and friendly A2 and AD measures") also allows friendly forces to set operational tempo. The targeting process creates these windows, giving friendly maneuver a position of relative advantage to exploit.

In conclusion, targeting principles have neither changed with a changing OE nor are they less applicable in DATE than in stability operations. Adapting these principles thoughtfully to a more intense and dynamic environment, however, provides an iterative and methodical means of prioritizing an adversary's capabilities to defeat and the focal points to which the spectrum of joint assets can be applied. Leveraged by commanders and key staff members, the targeting process develops decision space. Its focus on assessments (often empirically derived but informed by subordinate commander intuition) generates in-stride decision points at a higher frequency than that afforded by current operations alone. Ultimately and most importantly, targeting as a central part of the battle rhythm enables a division to create conditions of relative advantage to exploit against even the most sophisticated enemy. The process allows even elephantine challenges posed by A2/AD to be reduced by manageable and measurable bites.

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el events to the working group, this battle rhythm event influences others in succession. The G3 and FUOPS officer, for example, take refinements to the execution matrix identified during the TWG into the operations synchronization meeting. commander's update assessments at echelon further refine running estimates through subordinate, adjacent and senior commanders' perspective. The assessments working group, led by the division's team of Functional Area 49 Operations Research/Systems Analysis officers, compile assessments

4   Appendix 2 to the FRAGORD's Annex D includes the DIVARTY's field artillery support plan (FASP) that aligns the resources required to deliver surface-to-surface Fires where and when needed to achieve intended effects.

Big data meets King of Battle

Methods for improving Army's cannon artillery system

By Maj. Jonathan Erwin
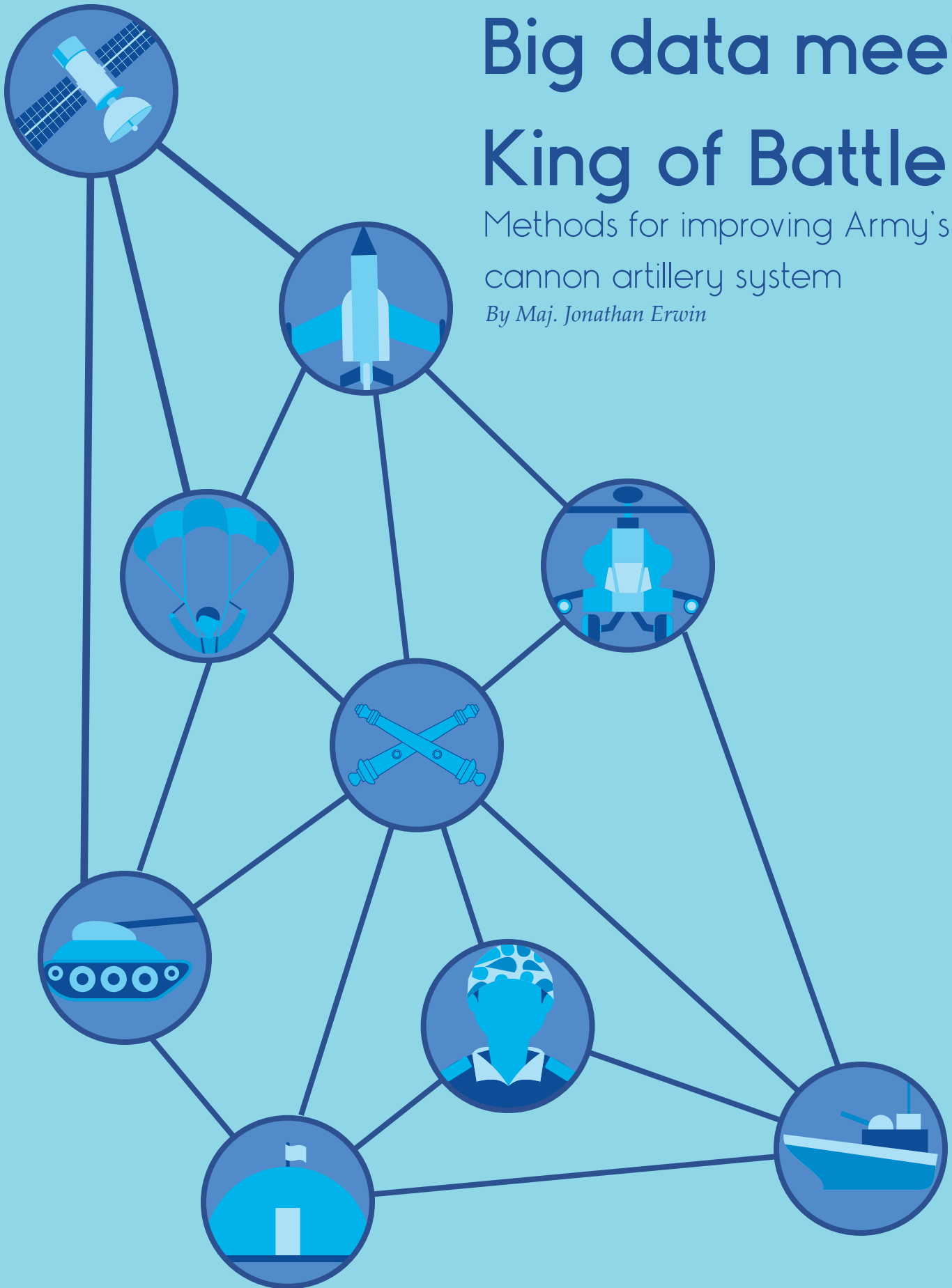
Spc. Clayton McInnis, a human intelligence analyst with the Mississippi Army National Guard, analyzes data at the National Training Center, Fort Irwin, Calif. (Staff Sgt. Shane Hamann/U.S. Army)

The United States Army's field artillery community faces a myriad of challenges on the modern battlefield. Areas of operations (AOs) for Army units deployed overseas are trending toward urban, built-up areas that include population centers and large amounts of civilian infrastructure. These AOs are crowded and contain numerous targets that are interspersed amongst large populations of non-combatants. Targets in these environments are often fleeting, presenting commanders with small windows for conducting an engagement. In order to remain relevant in these AOs, cannon artillery units require precision, responsiveness, and effectiveness. Designed as an area fire weapon, a howitzer firing conventional "dumb" rounds has limited precision. In an urban setting, the responsiveness of cannon artillery platforms is constrained by deconfliction procedures and collateral damage requirements. Furthermore, cannon artillery platforms are ineffective when they

require multiple adjustments to achieve effects on target.

Big data technology may provide the means to tackle some of the above-mentioned challenges. Big data technology may assist the Army's cannon artillery units in being more precise, responsive and effective by improving the accuracy of conventional artillery munitions, accelerating the target identification process, rapidly de-conflicting airspace, and speeding up the sensor-to-shooter link. The following sections will address the advent of big data technology and the methods in which big data technology can be applied to the cannon artillery system to improve precision, responsiveness and effectiveness.

Big data

Big data technology aids the user in inferring probabilities through the application of math to huge quantities of data.[1] In other words, it empowers users to make predictions about the future with a high

degree of accuracy. As an example, the online retailer Amazon uses big data technology to speculate on the buying habits of its customers.[2] If a customer has recently purchased a pair of running shoes via Amazon's online store, the customer's Amazon homepage will include advertisements related to running accessories. In order to determine what items to advertise on a specific customer's homepage, Amazon leverages big data technology to analyze other customer's buying habits. Amazon can run an algorithm through its databases to determine what item customers most often purchase after purchasing a pair of running shoes. If Amazon determines that the majority of its customers buy a digital watch after purchasing running shoes, then a customer can expect to see advertisements for digital watches on their home screen immediately after purchasing a pair of running shoes. To be clear, Amazon does not choose to advertise items that fall in the same cate-

1Viktor Mayer-Schonberger and Kenneth Cukier, Big Data: A Revolution that will Transform how we Live, Work, and Think (New York: Houghton Mifflin Harcourt, 2013), 12.

2José van Dijck, "Datafication, Dataism and Dataveillance: Big Data between Scientific Paradigm and Ideology," Surveillance & Society 12 (2): 200. http://search.proquest.com.lomc.idm.oclc.org/docview/1547988865?accountid=14746

gory as the original purchase. Instead, they analyze the buying habits of previous customers to determine the next probable purchase for another customer.

Amazon's use of big data technology to discern buying habits does not imply that Amazon can determine the causal relationships behind a customer's purchase decisions. Rather, Amazon uses big data to reveal the correlations between separately occurring purchase events. Analyzing massive amounts of data facilitates the discovery of correlation, not causation.[3] Correlation provides probability, not certainty. Probability can inform someone about what might happen, but not necessarily why it happened. Using a data-driven approach to determine the correlations between various phenomena can give results much faster than trying to determine the causal relationship.[4] As a fire direction center (FDC) crewmember, knowing the net effect of a weather condition on the impact point of a howitzer crew's rounds is more important than knowing why. If the FDC crewmember knows the effect, they can make proper adjustments for the howitzer crew to ensure their rounds impact on target. Knowing the why doesn't help accomplish the mission.

In order to reap the benefits of big data technology, there are three key requirements: processing, storage power and analytical tools.[5] Processing refers to the computing power necessary to search through and sift large troves of data. Storage power refers to the physical hardware that is required to capture and maintain the datafied information. Lastly, the analytical tools refer to the algorithms that data scientists produce in order to mine data sets.[6] Processing and storing the information could be considered the science of big data technology, while the development of algorithms could be considered the art. The algorithms require creativity and critical thinking, since they serve as the primary tool for gleaning the relationships between various data sets.

Another important requirement to maximize the benefit of big data technology is datafication, or the capturing of quantifiable information for subsequent storage, processing and analysis.[7] Fortunately, the Army can datafy many aspects of cannon

artillery operations. Targeting and fire mission processing produce large amounts of data. Existing fire control systems, such as the Advanced Field Artillery Tactical Data System (AFATDS), capture much of this data. However, other data will require the development of new methods to measure and capture the information to facilitate analysis by computer.
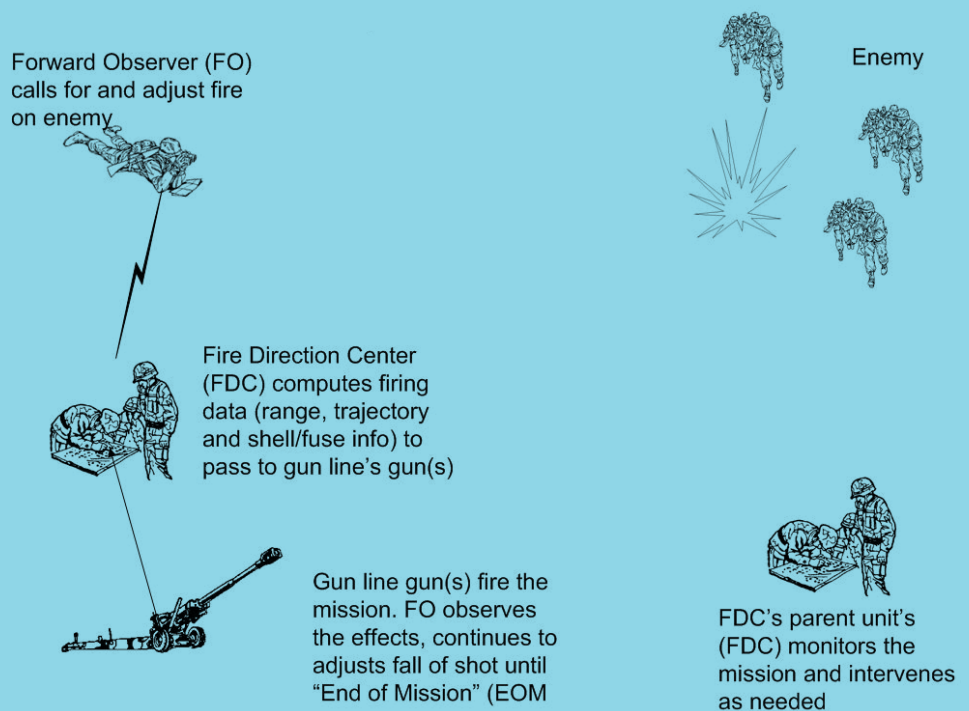
Before delving into methods for applying big data technology to the cannon artillery system, it is first important to explain the components of the system and its design. The cannon artillery organization has three main components: the firing platform, the FDC and the forward observer (FO).[8] The firing platform is the shooter, and the forward observer is the sensor. The FDC is the link between the sensor and the shooter (see Figure 1). The FDC receives the target location from the FO, and subsequently translates the target location data into firing data for the howitzer. In addition to the FO, numerous other sensors now exist that are capable of providing target location information to an FDC. Examples include the various unmanned aerial systems (UASs) in the Army's inventory, as well as the Persistent Threat Detection Systems found on many forward bases in Iraq and Afghanistan. Rotary-wing and fixed-wing aircraft pilots are also capable of transmitting target data to FDCs. The FO is not obsolete, but is now just one of a vast number of sensors that communicate with an FDC.

Improving precision

On the modern battlefield, collateral damage is a primary concern for ground force commanders (GFCs). Excessive collateral damage during operations presents adversaries with the opportunity to exploit the employment of certain tactics. In an operating environment (OE) where adversaries can rapidly disseminate information, those adversaries can propagandize collateral damage incidents to erode host nation support for United States Army activities. United States domestic audiences are subject to influence by the same propaganda. In such environments, Army units must be consistently precise when applying combat power. However, the Army's cannon artillery platforms have limited precision when employed without precision munitions. Precision artillery rounds such as the M982 Excalibur are available, but are exceedingly expensive at almost $70,000 per unit. On the other hand, a dumb artillery round such as the M795 high explosive projectile has a production cost of only $333.[9]

In order to improve the precision of conventional cannon artillery munitions, AFATDS' gunnery solutions require improvement. The gunnery solution is the firing data the FDC produces after it processes target information from the FO, or other available sensor. The gunnery solution does not account for inherent error, which is defined in Training Circular 3-09.81 (Field Artillery Manual Cannon Gunnery) as those

Figure 1. The cannon artillery call for fire system. (Wikimedia)

Forward Observer (FO) calls for and adjust fire on enemy

Enemy

Fire Direction Center (FDC) computes firing data (range, trajectory and shell/fuse info) to pass to gun line's gun(s)

Gun line gun(s) fire the mission. FO observes the effects, continues to adjusts fall of shot until "End of Mission" (EOM

FDC's parent unit's (FDC) monitors the mission and intervenes as needed

3Viktor Mayer-Schonberger and Kenneth Cukier, Big Data, 7.
4Viktor Mayer-Schonberger and Kenneth Cukier, Big Data, 55.
5Viktor Mayer-Schonberger and Kenneth Cukier, Big Data, 27.
6Viktor Mayer-Schonberger and Kenneth Cukier, Big Data, 125.
7Viktor Mayer-Schonberger and Kenneth Cukier, Big Data, 15.
8Headquarters, Department of the Army. Field Artillery Manual Cannon Gunnery. TC 3-09.81. Washington, DC: Headquarters, Department of the Army, April 13, 2016: 1-1 to 1-2.
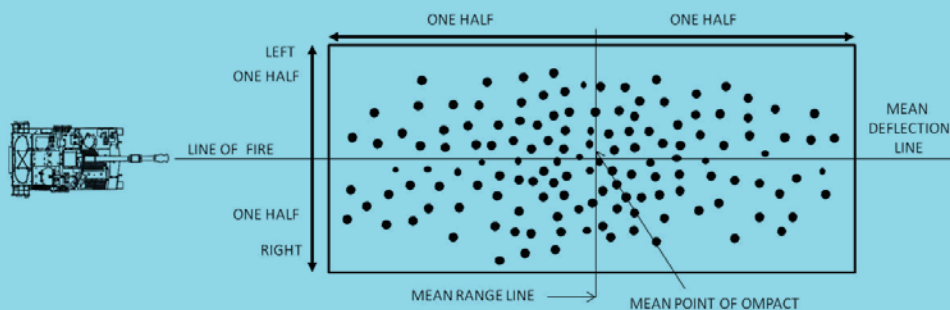9http://www.globalsecurity.org/military/systems/munitions/m795.htm

Figure 2. The dispersion rectangle. (Training Circular 3-09.81)

errors "beyond control or … impractical to measure."[10]

Inherent errors in the Army's cannon artillery platforms result in the dispersion of rounds relative to a given target location (see Figure 2, opposite page). Minor differences in projectile weight, propellant temperature, tube erosion and meteorological data affect the impact point of a dumb artillery round relative to the actual target location.[11] The bottom line is that these errors are the primary drivers of dispersion, and dispersion makes cannon artillery an area fire weapon. But what if these errors could be controlled? What if errors are no longer "impractical to measure" because of advancements in measurement technology? Increasing the number of measureable data points associated with the firing of a conventional artillery round could provide data scientists the means for using big data technology to reduce the size of dispersion patterns.[12]

Although the FDC already accounts for data associated with criteria such as powder temperature and projectile weight, refining these measurements to more precise metrics would improve the predictive capability of big data technology. Instead of measuring propellant temperature to the nearest degree, measurements should be taken to the tenth or the hundredth of a degree. Moreover, cannon artillery units should seek to improve their ability to measure components of the firing system that are not taken into account in fire mission processing. Capturing real-time measurements of tube wear, tube temperature, gun displacement, and powder burn rates would assist in the analysis to further reduce dispersion. Advancements in measurement technology for cannon artillery

platforms and munitions are necessary to accomplish these tasks, but the fundamental design of the platform should not require alteration.

In addition to capturing more data from the firing platform and associated munitions, combining the data points from all the Army's platforms should yield a massive amount of data to infer more accurate probabilities. Combining data points from all cannon units requires the creation of an information network. This network should permit cannon units across the entire Army to send and receive information to and from one another. The Army should establish FA-specific data storage facilities that constantly upload data from this network of cannon units. When processing fire missions, all AFATDS should network to this central storage facility so they can account for the vast amount of firing data from other units. If AFATDS are given enough pro-

cessing power, they should be able to mine this large trove of data to improve gunnery solutions. As more and more data uploads to the network, the ability of AFATDS to produce better gunnery solutions should improve over time.

AFATDS software should incorporate machine learning technology, so that it can begin to self-correct its own gunnery solutions. In a hypothetical scenario, an AFATDS produces a gunnery solution that results in rounds impacting on the exact target location. The AFATDS software should inform the system that this result is the "desired result." Over time, the AFATDS will have access to increasing numbers of gunnery solutions that produce more "desired results." As the "desired results" database increases in size, the AFATDS should recognize that this specific database employed the best gunnery solutions. Ideally, AFATDS would be able to refine its own fire mission processing algorithms as it identifies the gunnery solutions that achieve the operator's 'desired result.' Rather than requiring software updates every few months, the AFATDS software should be programmed to self-learn and self-adjust by analyzing the vast troves of data that will exist on its network.[13]

In addition to inherent errors, human error in fire mission processing contributes to inaccuracy. Human error often centers on the inputting of incorrect data into the

Figure 3. An example of an urban map in 3-D. (Janwillemvanaalst/Wikimedia)
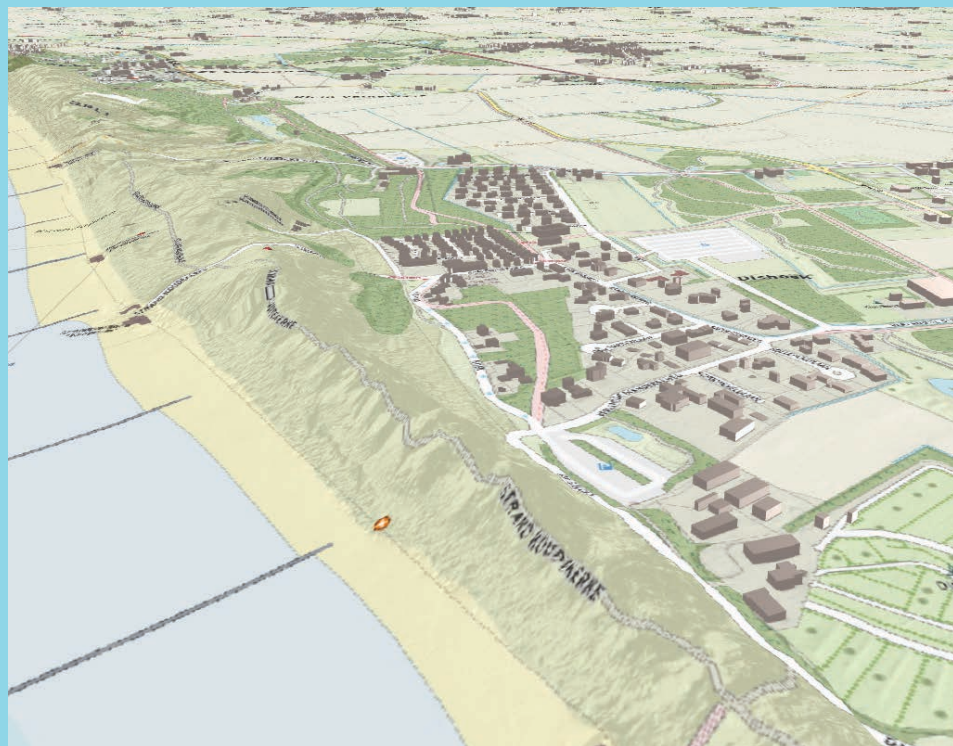
10TC 3-09.81, 3-15.
11TC 3-09.81, 3-14.
12Viktor Mayer-Schonberger and Kenneth Cukier, Big Data, 78.
13Trevor Meier and Robert D. Wilson, "Advanced Field Artillery Tactical Data System Gets Dramatic Upgrade," RedLeg Update, Sep-Oct 2016. http://sill-www.army.mil/USAFAS/redleg/archive/2016/sep-oct-2016.pdf

AFATDS computer. If the AFATDS could identify such outliers before processing fire missions, firing incidents should be reduced dramatically. In an FDC, a human operator who types in an incorrect grid location for a firing platform will cause that firing platform to shoot out of sheaf for a multi-gun mission.[14] Noticing such an error usually happens after the firing of that mission. When such an incident occurs, a manual troubleshooting process initiates that requires FDC personnel to examine each aspect of the fire mission to identify the inconsistency. This can often be a time-consuming and laborious process, and sometimes no one can identify the inconsistency, resulting in the continuous firing of rounds that don't impact the designated target area. With a database of troubleshooting errors, big data technology could facilitate analysis of all the different errors associated with fire mission processing. In a best case scenario, the AFATDS would inform the operator whenever it detects an inconsistency in a fire mission. Through predictive capability, AFATDS could identify when an input appears to be an outlier, without having to wait for the actual processing of the fire mission.

At present, the AFATDS produces gunnery solutions that place impact points on the horizontal plane. In built-up areas, however, commanders need to affect targets on the vertical plane (for example, an enemy fighter standing in the fourth story window of a 10-story apartment building). In order to target on the vertical plane in the given scenario, AFATDS would need to process information from 3-D maps that account for the entire urban infrastructure in a given area (See Figure 3). AFATDS software currently incorporates 3-D mapping technology, but not to the extent required to target on the vertical plane. The maps would have to include the geographic location of each building so AFATDS could account for it. The use of such maps could allow AFATDS to target on the vertical plane. Three-D maps with geolocation information would add a massive amount of data to the AFATDS database, since every building, window, door, etc. would require datafication. AFATDS could analyze this data to produce gunnery solutions for the

vertical plane.[15] Commanders could employ cannon artillery to strike the sides of buildings, or suppress a floor of windows. Vertical plane targeting would add a new tool to the GFC's kit bag in the urban fight.

Improving responsiveness

The delivery of timely surface-based indirect Fires requires rapid deconfliction of airspace. Unfortunately, airspace deconfliction is often a time consuming process that precludes the timely use of cannon artillery platforms. Joint aircraft platforms often stack at multiple altitudes above target areas, and the proliferation of UAS on the modern battlefield only complicates efforts to clear airspace for artillery munitions. In order to gain visibility of all aviation systems in a given AO, units have to submit a query to their higher headquarters (HQ) and then wait for higher headquarters to respond. Sometimes, units have to submit queries to multiple HQs before firing units can receive confirmation that the airspace is clear.

With the latest version of AFATDS software, FDC operators can plug airspace coordination measures (ACMs) into the computer.[16] When AFATDS processes a fire mission, it will verify that the ballistic trajectory of the rounds do not violate any of the active ACMs in its database. This is one way to execute airspace deconfliction. However, airspace deconfliction measures can be fairly restrictive since they often account for a large buffer area to reduce the risk of collision between an aircraft and an artillery round (see Figure 4). A much more effective method for de-conflicting airspace could focus on the probability of intersection of aircraft and artillery trajecto-

ries. Big data technology could predict the likelihood of an intersection between two fast-moving objects in the same airspace. In this manner, artillery rounds could be shot through airspace in vicinity of aircraft. With big data technology, aircraft and artillery could share the same airspace. In order for this to work, AFATDS computers would have to tie into a network that provides information about the real-time location of all aerial platforms in a given area. If the AFATDS could monitor specific aerial platform locations, it could de-conflict its own fire missions. If the possibility exists for a collision, then the AFATDS could delay the fire mission and thus de-conflict by time. Ultimately, this manner of deconfliction could prove much more effective than blocking off huge chunks of airspace as no-go areas for artillery munitions.

If modern battlefields will predominate in urban areas, then such battlefields will be crowded. Discriminating between combatants and non-combatants in urban areas is a challenging, dangerous and time consuming process. Traditionally, Soldiers monitor video screens linked to sensors to identify combatants for targeting. This takes time and often the Soldier is not 100 percent effective in identifying targets even when the sensors are cued to look in the right area. Enemy combatants have become much more adept at concealing their locations. Sometimes, Soldiers confuse non-combatants for combatants, and vice versa. Moreover, the human and physical terrain of the modern battlefield complicates efforts to provide continuous surveillance.

Artificial intelligence (AI), in combination with big data technology, could assist

Figure 4. Formal airspace coordination area. (Field Manual 3-52)
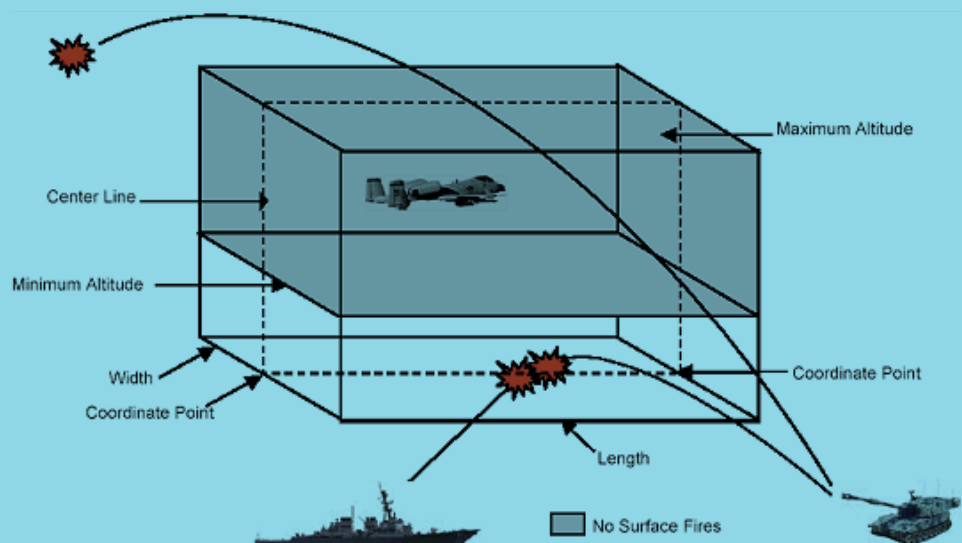
14 Jim Collins and Joshua Herzog, "Every Mil Matters: One Battalion's Fight Against Error," *Fires*, Sep-Oct 2016. http://sill-www.army.mil/firesbulletin/

15 Trevor Meier and Robert D. Wilson, "Advanced Field Artillery Tactical Data System Gets Dramatic Upgrade."

16 Trevor Meier and Robert D. Wilson, "Advanced Field Artillery Tactical Data System Gets Dramatic Upgrade."

A

50 Meters

B

Point at which speed and direction are determined.

1,000 Meters
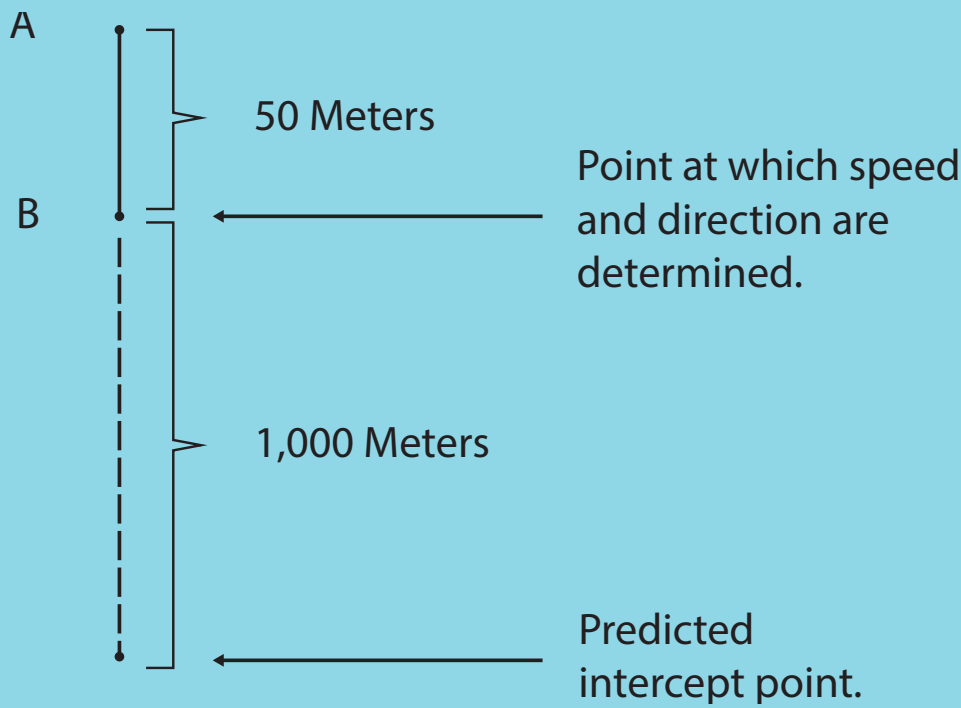
Predicted intercept point.

Figure 5. Traditional method of determining intercept point of moving target. (Army Techniques Publication 3-09.30)

commanders with target identification.[17] The Army is already procuring machines that can identify the human form from video images. In addition to the human form, they can also discern various types of combat vehicles and equipment. This form of AI can certainly assist the FA community in speeding up the targeting cycle. If UAS and other aerial platforms with digital video capabilities can pre-program to identify targets, then individual service members would no longer have to tie themselves to video screens and wait for targets to appear. Upon identification of a possible target, the sensor would immediately transmit the target location data to an FDC. In addition to the target location data, a screen shot could transmit to the FDC for the operators to verify that the target is worthy of engagement. Rapid target identification through AI would accelerate the 'detect' phase of the Army's Targeting Methodology (decide, detect, deliver, assess) since it relies less on human attentiveness and human observation to identify well-concealed targets.

To take this scenario further, numerous aerial and ground sensors with digital video capability network together and link in with FDCs. A common database accessible to all components on the network maintains target information data that includes images of the targets from various angles. A central computer continuously downloads images from the various sensors on the network to compare the sensor images to pre-existing target images in its database. If that specific target begins to move out of range of a given sensor, the central computer automatically directs another sensor to key in on the target location. When the central computer confirms a match between sensor and pre-existing images, it sends a message to a human for target engagement approval. Upon approval, the platform communicates the target location information to an FDC with howitzers in range of the target. The FDC sends a fire mission to the guns. After firing, the sensor observes the rounds in relation to the target and provides battle damage assessment (BDA) data to the FDC. Using the same AI to identify the target, the sensor determines the distance between the target and the impact point, and then communicates this information to the FDC.[18] The FDC can re-process the information and re-attack, or merely record the BDA if the fire mission produces the desired effect.

Improving effectiveness

On modern battlefields, targets are often fleeting. Small windows of opportunity exist to engage targets, especially during counterinsurgency and counterterrorism operations. Upon identification, firing platforms must rapidly engage targets. This requires well-established sensor-to-shooter links and the rapid communication of target data between sensors and delivery platforms. Identifying numerous targets simultaneously requires prioritization. Engaging numerous targets at the same time necessitates the allocation of various delivery platforms to each target. Decision aids exist to assist commanders in this process, but crowded battlefields may overwhelm a commander's ability to prioritize and engage targets in a timely manner.

During highly kinetic operations in which numerous sensors request fire missions, the fire direction officer (FDO) can struggle in choosing the most efficient method for employing the battalion's firing platoons to execute fire missions. When a battalion FDC receives a fire mission request from any of the various sensors on its fire support communication net, the FDO must decide which of the firing assets is in the best position to execute the fire mission. Upon making a decision, the FDO directs the AFATDS operator to transmit the request to one of the platoon FDCs. The platoon FDC must then process the same fire mission. The process may result in delays and prevent certain howitzer platoons from performing at their maximum capacity. In applying big data to the problem, algorithms could identify inefficiencies in the employment of each firing platform. For example, big data could identify the correlations between target engagement times and the usage rates of certain firing platoons. Upon identification of these correlations, AFATDS could learn to make recommendations to the FDO to maximize the ability to service all the fire mission requests with the number of firing platoons available. Big data technology would not replace the FDO, but empower them in their duties.[19]

Furthermore, AFATDS operators must manually input "method of attack" information into their computers when they process fire missions. When determining the method of attack, the AFATDS operator considers the number of howitzers to fire, the type of round, the number of volleys, and other information related to how the

17Benjamin Jensen and Ryan Kendall, "Waze for War: How the Army can Integrate Artificial Intelligence," War on the Rocks. September 2016. ttp://warontherocks.com/2016/09/waze-for-war-how-the-army-can-integrate-artificial-intelligence/

18Kevin Murray, Che Bolden, Scott Cuomo, and James Foley, "Manned/Unmanned Teaming to Transform the MAGTF," Marine Corps Gazette100 (2016): 70-75. http://search.proquest.com.lomc.idm.oclc.org/docview/1793868254?accountid=14746

19Benjamin Jensen and Ryan Kendall, "Waze for War: How the Army can Integrate Artificial Intelligence."

cannon crewmembers employ their platforms to achieve the desired effect on a target. This is all important information, but it is time consuming to input and relies on imperfect human judgment. An improvement to this system would be the use of big data technology to discern the best possible method of attack. Data scientists would need to produce algorithms that compare successful BDA to specific method of attack data to determine what methods of attack were most successful against specific target types. Subsequently, AFATDS programmers could design software to automatically recommend method of attack guidance for various targets on the battlefield. This change would save time, and ensure targets were attacked in the most effective manner.

One aspect of targeting that remains a challenge for cannon artillery units is the engagement of moving targets. Methods exist for FDC crewmembers to produce target data for moving targets, but it relies on math steps and a cooperative enemy that maintains a steady rate of advance toward a single point on the ground (see Figure 5). Instead of relying on a singular target location to engage a moving target, it would make more sense to create a target area that comprised possible locations that a vehicle or troop formation might occupy at a given point in time. As an example, AFATDS would designate a firing battery of six guns to fire at a moving target. Incorporating 3-D mapping technology, the AFATDS could predict aim points for each gun along the route of march to account for the possibility of the target slowing down or speeding up. Rather than the FDC operator having to compute math steps, the AFATDS computer would calculate the probable vehicle locations, and then communicate separate firing information to each howitzer in the battery. Although this may not be a perfect solution to the moving target problem, it would certainly be an improvement to the current method for engaging moving targets.

Implications for organization, materiel

Improving cannon artillery's precision, responsiveness and effectiveness through the application of big data technology will require new equipment and infrastructure in FA organizations. A server will need to be built to store and maintain the enormous amounts of data produced by the operating force. This server will act as the central storage location for all the data produced by the cannon artillery community. The server will require network connection with all of the Army's cannon artillery units so that it can continually retrieve all the data produced by the various sensors and FDCs throughout the operating force.

The digital network used to connect each cannon artillery unit with the central server is another key piece of infrastructure that requires development. Currently, digital communication networks exist to connect a unit's firing platforms with the AFATDS in their platoon FDCs. Also, the AFATDS in platoon FDCs can communicate with the AFATDS in both battalion FDCs and brigade fire support cells. The Single Channel Ground and Airborne Radio System is presently used to facilitate the digital networks that connect the various AFATDS computers. However, there is no overarching network that connects all of the Army's cannon artillery units. Besides just connecting AFATDS computers to the central server, the network would require connection with all sensor platforms that are organic to a brigade combat team. The central server would need access to all digital video and imagery produced by brigade sensors to ensure that information is available for processing and analysis. To enable the airspace deconfliction procedures already mentioned, AFATDS would require access to the radar networks that aviation units employ to monitor the locations of their aircraft. The groundwork is being laid for this access, considering the latest version of AFATDS incorporates improved connection capabilities, such as the Link 16 protocol.[20]

The AFATDS computer itself would require significant updates to accommodate the other changes listed above. The computer would need much more processing power to sort through and analyze the increasing amounts of data transmitting on the network. It would need new hardware to facilitate digital connectivity with a central server. It would also need new connections to link in with any BCT sensor capable of producing target location data. AFATDS software would need to be capable of receiving real-time updates from the central server. For example, server managers should be able to push new fire processing algorithms down to firing unit FDCs to improve gunnery solutions. The software should update automatically anytime improvements are sent from the central server. Furthermore, AFATDS software should automatically upload the data it produces from processing fire missions to the central server. All these activities should occur without active involvement from FDC personnel. The transfer of data between the AFATDS and the central server should be transparent to the operator.[21]

The management of a central server would require the hiring of additional personnel. These new personnel would have several different functions. Not only would they need to manage the server and the network that connects the server to the Army's FA units, but they would need to analyze the data consolidated on the server. Specifically, the Army would need to hire data scientists who can find creative ways to mine the data for correlations that will assist the cannon artillery community.[22] Upon finding these correlations, the data scientists would need to work hand-in-hand with computer and software engineers to produce newer versions of AFATDS that incorporate the lessons learned from the data analysis. The data scientists would need to remain in constant contact with the operating force to stay abreast of the most pressing battlefield challenges. Since the job of the data scientist is exceedingly specialized and technical, it would likely need to be a contracted position.

Challenges ahead

Two major challenges exist:
1. The reliance on a digital network during combat operations to apply big data solutions.
2. The vulnerability of the network to enemy attack.

The creation of a central server in CONUS with the ability to connect to operating units around the world assumes a viable network that is always up and running. Network operations would require access to electricity and the ability to send and receive signals over some type of communications network. However, operations in austere environments may preclude access to electric energy. Moreover, enemy capabilities may prevent the use of any equipment that runs on a digital platform. An electro-magnetic (E-M) attack would force Army units to rely solely on mechanical

20Trevor Meier and Robert D. Wilson, "Advanced Field Artillery Tactical Data System Gets Dramatic Upgrade."
21Trevor Meier and Robert D. Wilson, "Advanced Field Artillery Tactical Data System Gets Dramatic Upgrade."
22Viktor Mayer-Schonberger and Kenneth Cukier, Big Data, 125.

Soldiers from the 2nd Armored Brigade Combat Team, 1st Infantry Division, participate in an electronic warfare exercise at the National Training Center, Fort Irwin, Calif. Led by the U.S. Army Cyber Command, the cyber electromagnetic activities performed during the exercise demonstrate the integration of cyber warfighting into U.S. Army capabilities. (U.S. Army)

warfighting systems. Any warfighting system that relies on a digital capability would immediately become obsolete in an environment where E-M weapons persist.

Even if the Army is able to establish and maintain a digital network that connects numerous cannon units, sensors and radars, that network may become a highly lucrative target for our enemies. The expansion of the network implies that a tremendous amount of operational information becomes consolidated on that very network. If an adversary develops the capability to penetrate the network, they would have immediate access to firing unit locations, aircraft flight paths and a myriad of other data points that would give them a significant intelligence advantage. In addition to the intelligence value, the enemy could execute a cyber-attack on that network that would have far-ranging implications for many joint warfighting systems.

Large-scale conventional conflict, as seen in World War II or the Korean War, favored massive artillery bombardments with little regard for damage to the host nation's infrastructure. In the information age, smartphones can depict collateral damage from a battlefield just moments after it occurs. These images can sway entire populations in a matter of hours. Moreover, targets on the modern battlefield are rarely static. They constantly move, and find ways to blend in with the population or urban infrastructure. If the trend from the past 15 years continues, the majority of adversaries would not be easy to identify. They would not wear recognizable uniforms or operate traditional military platforms. Engagement windows would be small, and would require the delivery of desired effects on the first strike. Opportunities for re-attack would be few, or non-existent.

The modern battlefield will require the United States Army to deliver effects that are precise, responsive and effective. In order to remain relevant, the Army's cannon units must tackle these challenges head on. Although big data is no panacea, the technology could be a stepping stone to better position cannon units for future conflict. Indeed, new equipment and additional personnel are required to incorporate the changes recommended throughout this paper. Engagement and coordination with other services and intergovernmental organizations is also necessary. But these changes do not require a fundamental redesign of force structure or organization. Rather, the changes will rely mostly on innovative Soldiers to determine the best way to operationalize this existing technology. This notion ties in neatly with the Department of Defense's Third Offset Strategy, which focuses on the ability of individual service members to apply their critical and creative thinking skills to maintain an edge on the battlefield.

The addition of precision weapons to the cannon unit's arsenal was a boon for the FA community, since it met a major requirement for GFCs in Iraq and Afghanistan. If the cannon artillery community can achieve similar effects with conventional munitions, while simultaneously updating its other processes, then the King of Battle will have a renewed sense of importance amongst its maneuver brethren and keep its edge on the 21st century battlefield.[23]

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MULTI-DOMAIN OPERATIONS
COMMUNICATE FIRST, SHOOT, THEN MOVE

By 2nd Lt. Daniel Osika

As the United States military moves past a decade of counter-insurgency operations, service members sit in a state of strategic limbo. Confronted by an enemy with minimal electronic warfare abilities, artillery or aviation assets, the United States has struggled to modernize tactics for future conflicts against a near-peer adversary. While current military doctrine and technologies have left shortcomings exposed, the country has been fortunate that groups such as ISIS have not had the capability to exploit those weaknesses. However, future wars will most likely evolve into a combination of military engagements on land, sea, in cyberspace or from the air, resulting in what is known as a multi-domain operation.

Adversaries who have the ability to leverage such assets are the same nations who would be able to identify and target the aforementioned weaknesses in U.S. systems. As other nations now possess modernized tactics and equipment on par with the U.S., the tactical capability between them has narrowed significantly. In order for the artillery to widen this gap, it is vital to analyze the communication methods the United States is exploring to more successfully integrate Fires into multi-domain warfare.

As participation in the War on Terror continued, nations around the globe have analyzed the strengths and weaknesses of U.S. field artillery. Conducting fire missions from well emplaced forward operating bases has been the norm for most artillery units throughout the majority of fighting in the Middle East, which is an advantage that cannot be relied upon during a near-peer conflict. With counter-battery operations presenting a much more prevalent threat from developed nations, stable communication methods have never held a more vital role. The M119A3, M777A2 and M109A6 howitzer platforms have gotten progressively more mobile, accurate and efficient, making communication the focal point of improvement for the artillery community.

Unfortunately, the current criticisms of procurement of a next generation battlefield network are mainly coming from individuals who do not entirely understand the technologies involved, as well as from users who are not sufficiently trained on it. Loren Thompson, an expert contributor for Forbes

who focuses on the strategic and economic implications of defense spending, explains the danger in this frequent acquisitions phenomenon:

"The depressing part is that the critics don't understand the systems they are attacking, and unwittingly contributing to a longstanding pattern in which the nation's premier land force can't seem to stick with a plan when it comes to modernizing."[1]

It is essential for those in charge of funding these communication systems to fully understand their capabilities in a wartime environment. The subsequent congressional review of the current military communication programs in 2017 raised valid concerns regarding the sustainability of the network in a near-peer conflict. But it did not specifically distinguish which parts (of an extremely multifaceted system) were at fault. The Warrior Information Network-Tactical (WIN-T), the only system currently able to provide mobile wartime communication and online connectivity down to key leaders at the company level, was deemed the sacrificial lamb for opponents in sweeping criticisms. With no replacement currently being fielded for testing, it is a dangerous proposition to condemn the WIN-T prematurely.

In a perfect world, the WIN-T would act as a secure and intuitive network that connects land, sea, cyber and air assets under one system, yet that is simply not possible. Unfortunately, it is just one strand in the intricate web of military communications. While a singular system is ideal in theory, the limitations of current technologies force a solution that is not the answer most users want. Whereas most envisioned a new interconnected network supported by one modular piece of equipment for different platforms, the best solution actually exists as one vehicle with the ability to utilize all the existing systems based off the scenario the user faces. This variant of the Mine Resistant Ambush Protected (MRAP) is called the MRAP All-Terrain Vehicle (M-ATV), and is currently being issued to units across the Army to help fulfill this requirement. The intent, more specifically to the Fires community, is to utilize these vehicles as fire direction centers (FDCs) so battery leadership can successfully connect with higher headquarters while continuously moving around the battlespace.

In order to succeed in a multi-domain battle, it is imperative for Soldiers to knowledgably choose between assets and decide which one can be best used to complete the task at hand. In the following anecdote, Gen. David Perkins, Training and Doctrine Command commanding general, explains how Soldiers of today have a predisposition to trouble-shoot communication issues in a multi-domain operation.

"When I was growing up, if we wanted to contact somebody, we really had one way to do it: get on the phone and dial them. Now, if I say I have to pass information to somebody or I have to contact them, do I use my cell phone? Do I send them an email? Immediately when they see a problem, they have five or six ways to solve it. They will try one way, and if that's not working, they will quickly move to another one."[2]

The same flexibility is vital for fire direction personnel at the battery level as they transition to the new vehicles to provide accurate and responsive Fires. Each communication platform included in the M-ATV Capability Set 17 can no doubt perform its intended function, however, each method has inherent faults due to the limitations of the type of technology used. For instance, the Single Channel Ground and Airborne Radio System (SINCGAR) radios work well over short distances through ground wave propagation between the surface of the Earth and the ionosphere, however they are limited by line-of-sight capability. Unfortunately, this leads to terrain features such as mountains or valleys acting as a serious detriment to line-of-sight communication. Satellite communication essentially makes transmission range a non-issue, although any variations in weather conditions can affect it. High frequency radios can support very clear transmissions at extreme distances, but short-range communications are generally unsupportable. Ideally when Soldiers face a communication issue while using an M-ATV, they should be able to seamlessly transition from one method to the next and continue to trouble shoot the problem until it is solved.

The M-ATV's Capability Set 17 gives service members access to a plethora of options, starting with four mounted SINCGARs radios in the rear of the vehicle, and space next to the driver to mount two additional SINCGARs or a Harris high frequency radio. In the front passenger seat, the fire direction officer (FDO) also has access to the Blue Force Tracker 2/Joint Capabilities Release interface. This is a system which displays all friendly unit locations, and gives Soldiers the ability to open secure chat rooms to quickly send messages through free texts, as well as the ability to create and send geometries such as routes or possible improvised explosive device sites. Behind the FDO sits the Advanced Field Artillery Tactical Data System operator with the WIN-T interface using a tactical internet connection. This Secret Internet Protocol Router connection allows Soldiers to have secure access and facilitates mission critical information being sent up to higher in real time. Finally, the Combat Net Radio gateway uses satellite communication, where the WIN-T acts as a network converter through which a satellite phone routes itself via SINCGAR radio to transmit to an individual Soldier. Placing these options at the Soldier's fingertips has increased their ability to coordinate fire missions, from any number of different assets across multiple domains, which is a tactic that will play a vital role in the future conflicts that America expects to engage in.

The success of that future fight also depends on the flexibility of Soldiers and their ability to think critically. With these technologies, key leaders can stay better connected to what is happening on the battlefield, and fire direction personnel specifically can better maintain their ability to provide accurate and timely Fires. In order to bring this vision to reality as systems get more and more complicated, Soldiers need to be willing to invest in learning how their technology works to trouble shoot issues as they arise. Communications will continue to be an integral warfighting function, and the future looks bright for the artillery as units take the next step to become more efficient, but more importantly, staying better connected across land fire weapon systems, naval gunfire platforms and aviation assets.

Second Lt. Daniel Osika is a 1st Platoon, B Battery, 2nd Battalion, 11th Field Artillery Regiment, fire direction officer stationed at Schofield Barracks, Hawaii. Significant portions of his time in the field have been spent developing and testing smaller, and more consolidated methods of tracking his responsibilities while operating the fire direction center out of the MRAP All-Terrain Vehicle.

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FIRES

IN LARGE SCALE COMBAT OPERATIONS

04.30.2018 – 05.03.2018

What is old is new again

Field artillery in megacities

By Capt. Geoff Ross

"In the future, I can say with very high degrees of confidence, the American Army is probably going to be fighting in urban areas. We need to man, organize, train and equip the force for operations in urban areas, highly dense urban areas, and that's a different construct. We're not organized like that right now."

— Gen. Mark Milley

In 2014, 54 percent of the world's population lived in urban areas. That number is growing 1.84 percent per year between 2015 and 2020, 1.63 percent per year between 2020 and 2025, and 1.44 percent per year between 2025 and 2030.[1] Milley is correct in his assessment that large urban areas are a looming challenge for the United States Army. In the future it will fall upon Soldiers and their equipment to close with and destroy the enemy in this new dimension the Army currently has failed to address in military operations on urbanized terrain training. This article contends that the field artillery, as a core component of the combined arms force, must train and address the unique challenges created by city-fighting. The argument entails a return to one of the least trained arts of American artillery, direct fire.

Throughout 2016 and 2017, coalition field artillery provided the assist to advise and assist, with American M777A2 and M109A6 units. They fired precision and near-precision rounds in support of Iraqi Security Forces fighting to liberate Mosul from ISIS. The precision M982 and M982A1 Excalibur (EXCAL) projectiles provided outstanding, limited collateral damage munitions to target everything from vehicle-borne improvised explosive devices, to snipers, to command and control nodes. EXCAL provides flexibility, scalability, and all-weather responsiveness in support of ground force commanders (GFCs).

1 http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/

Soldiers from C Battery, 2nd Battalion, 82nd Field Artillery, conduct direct-fire training at Udairi Range, Kuwait, during Operation Spartan Shield. (Courtesy photo)

Near-precision Precision Guidance Kits (PGKs) allow the GFC to use a wider suite of artillery projectiles, specifically the M795 High Explosive and M549A1 High Explosive Rocket-Assisted rounds. PGK is a more cost effective option to EXCAL in situations where a low-trajectory round will achieve the desired effect instead of the high trajectory offered by the EXCAL. With indirect Fires and close air support, the coalition has destroyed, neutralized and suppressed hundreds of ISIS positions and destroyed critical enemy equipment. The capabilities precision and near-precision munitions provide will continue to be required as the Army fights in megacities. However, there is a gap in doctrine and equipment which the field artillery can address against what could be called urban mountains, the buildings which dominate the skylines of major cities around the world.

C Battery, 2nd Battalion, 82nd Field Artillery encountered this issue in June 2017 while attached to 2nd Brigade, 82nd Airborne supporting Iraqi forces fighting in western Mosul. The Jamouri Hospital Complex, located on the west side of the Tigris River in the northern half of the city, was one such challenge 82nd Airborne and their Iraqi counterparts faced. The centerpiece of the complex was an eight-story, reinforced concrete building standing on 50-meter high bluffs above the river. ISIS fighters had

commandeered it as a command and control node with robust fighting positions and the Iraqi Army was locked in an intense, uphill-fight to rid the building of enemies. To help the Iraqis break through their defenses, C Battery conducted a reconnaissance, selection and occupation of position artillery to determine the feasibility of conducting a direct fire raid with two M109A6 Paladins into the fields north of the complex. The purpose of the raid was to fire 155 mm rounds into specific windows, marked on a grid reference guide, as fighters appeared and engaged friendly forces. The Paladin crews staged in hidden locations out of enemy observation (i.e., "hides") behind concrete buildings and move to firing points before engaging targets identified by U.S. advisors operating in concert with Iraqi forces. Though the raid was cancelled following a change in the friendly scheme of maneuver, it provided the battery leadership a view into the future of urban warfare and the problems inherent in using artillery as a direct fire weapon system.

The first concern was the range-to-target for the guns. Direct fire optics for artillery are designed for the defense of the guns from a direct attack while positioning area artillery at targets less than 1,000 meters. Because of this, they lose resolution at the ranges which they were tasked to engage, mainly 1,500 to 1,800 meters. Additional-

ly, the optimum engagement range for 155 mm artillery direct fire is 800 meters. The acceptable engagement range is 800 to 1,200 meters, and the least preferred range is out to 2,000 meters. Talking with experienced noncommissioned officers in the battery, the command assessed with high probability that as range-to-target increased, the chance of dispersion of rounds increased as well, necessitating walking rounds onto the target, potentially losing the surprise effect of an accurate round.

The second issue was brought by the advisor teams based on their on-the-ground, situational awareness. Concerns were raised that the building may be degraded internally to the point that a large caliber round, such as a 155 mm, fired from the north could pass through the building and continue to its ballistic impact point beyond – a point potentially occupied by civilians or friendly forces. Consequently, C Battery, looking to the fire direction center (FDC), computed the minimum time settings to ensure that the rounds would function on the target face, inside, or immediately beyond the building. To estimate the time fuze settings required, the FDC used range-to-target referencing the trajectory charts in the back of the tabular firing table (an imprecise science), to find the approximate range at altitude of the target, and extracted the time fuze setting. Since time fuzes

default to point detonation, the leadership assessed that should a round fail to impact a surface of the building, a maximum time setting would ensure it did not continue forward. Variance between target altitudes and ranges from the howitzer would result in different settings; they would need to be changed by section chiefs, between rounds, based on spottings on the target. Fire direction is an exact science, but in this operation the time settings would have been adjusted based on approximations and best guesses.

The final issue, and most concerning to commanders at all levels, was force protection. To get within range to engage the complex, the guns needed to be within 1,500 to 1,800 meters, well within the threat bubble of known ISIS anti-tank guided missiles (ATGMs) which were assessed as being present in the target structure. The guns could not have moved into positon, stopped, found their target, fired and displaced to cover before being engaged by ISIS ATGMs. Paladins are tough, but they are not main battle tanks (MBTs) and a hit from an ATGM would have likely resulted in a catastrophic kill. Limited by their optics and the lack of long-range firing tables, C Battery was at high risk of casualties to accomplish this mission. The adjusted scheme of maneuver and the Iraqis' motivation to liberate Mosul meant the battery did not conduct the raid.

As President Dwight D. Eisenhower said, "Plans are worthless, but planning is everything."[2] Using the planning for the C Battery direct fire raid as a case study leads to other questions on the nature of field artillery training from the crew to staff levels to plan and execute such operations, and to the development of equipment (including munitions) to mitigate issues of urban warfare while increasing mission success.

Currently, the Army fields three howitzers, the M119A3 105 mm towed howitzer, the M777A2 155 mm towed howitzer, and the M109A6 155 mm self-propelled howitzer. Each piece brings different capabilities and limitations to the battlefield. The M119A3 and M777A2 are easily transportable by air or ground, and can rapidly move to new locations hundreds of kilometers away, while the M109A6 Paladin can be driven across a myriad of terrain, carry ammunition, provide a level of protection, and a degree of organic, on-the-move defense. The greatest limitations when providing di-

rect Fires into a megacity is that howitzers have to be towed into position and, once in place, have no organic protection from small arms or fragmentation for the crews. Other combat forces must be allocated for their defense, limiting the GFC's offensive close fighting capabilities. The M109A6 in contrast lacks easy mobility without heavy equipment transports and must be driven into the vicinity of its firing location before being put into action. With these factors in mind, it is reasonable to state that the preferred megacity direct fire artillery system is the venerable M109A6 (in the future, the M109A7) because of its organic protection. However, light, airborne or air assault infantry—those units most suited to urban combat—are the very units lacking in armored, self-propelled artillery support. Without exception, the organic artillery elements in these light infantry units consists of towed artillery pieces.[3] Before addressing the tactics and equipment required to successfully direct fire artillery into tall buildings it is important to address the need for direct-fire artillery support. Currently, the joint force has at its disposable a variety of air and ground-delivered munitions. Despite all of these, there is an inherent complexity to engaging a specific floor or group of windows with weapons, particularly if the fire needs to be continuous or repeated. For the last 16 years of conflict, the United States military has become proficient at dropping bombs and firing artillery to impact at a vertical or near-vertical angle. This is effective against buildings with a few floors, but it loses its punch as buildings grow taller with increasing space between the roof and the target. Simply put, the resiliency built into modern megastructures to resist natural disasters, such as earthquakes, toughen them as well against vertical or near-vertical attacks by conventional munitions.

For example, an enemy firing down from the 20th story of a 50-story building can be engaged in multiple ways. Bombs can be dropped or artillery fired to hit the roof, but there are plenty of floors between the impact and the target to protect them from the effects, much like sandbags protect the top of a field bunker from fragmentation. An aircraft could glide a bomb into the side of the structure, guided by either GPS coordinates or laser, and cause potentially serious damage to the building and

its integrity. However, air attack with precision munitions has its drawbacks: if a re-attack is needed, if the bomb is off target, if the enemy moves to a new floor, or if there are non-combatants in the area, it would require an aircraft with a limited payload to make a second pass. This becomes a problematic proposition in any airspace contested with purpose built anti-aircraft weapons.
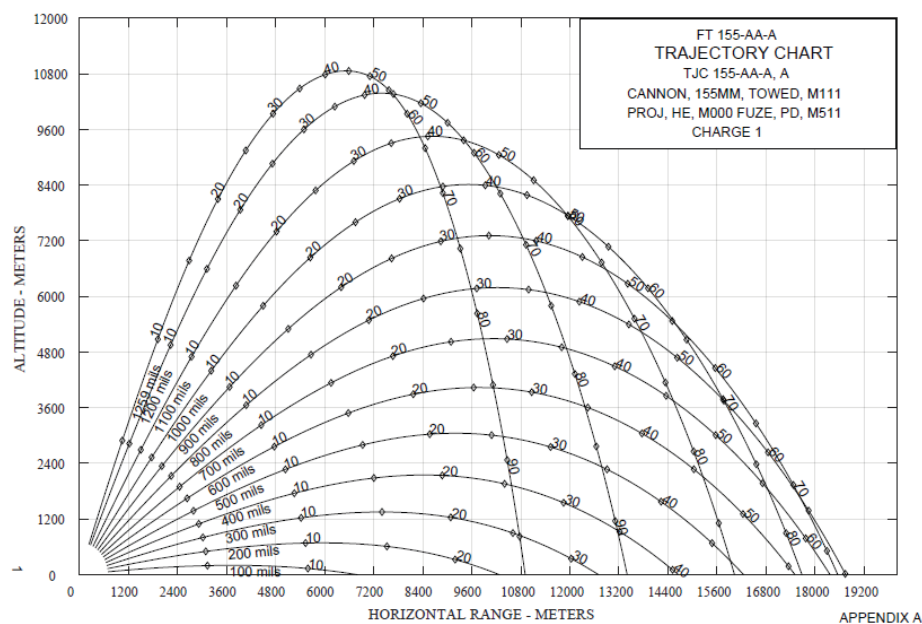
MBTs or infantry fighting vehicles can shoot direct fire into buildings, but limitations on the maximum weapon elevation and the fact that many current weapons are designed for engaging vehicles reduces these systems' effectiveness against an enemy occupying one or multiple floors of a tall building. Additionally, the widespread proliferation of cheap ATGMs and even traditional weapons (anti-tank grenades, mines/improvised explosive devices, and the century-old Molotov cocktail fuel grenade) in urban environments means heavy losses should be expected for armored forces operating at close range in cities. As the Russian Army discovered while fighting in Gronzy on New Year's Eve, 1994, determined defenders can easily make an armored force suffer extreme casualties in a short time with easily available infantry anti-tank weapons. It is estimated the Chechnyan defenders killed between 1,500 and 2,000 Russian soldiers while the Russians "lost more tanks in Grozny than they did in the battle for Berlin in 1945."[4] This paper proposes the use of self-propelled artillery in a similar fashion to how it was employed by the Soviets on the Eastern Front during World War II, where guns in urban and near-urban environments see the target and engage it with direct fire. A 155 mm projectile can have devastating effects on an enemy inside of a building, from an extended range while not causing severe structural damage. Unlike the munitions of the 1939-1945 war, modern artillery munitions are more accurate and dependable, capable of hitting targets even in a closely packed urban environment. The key to meeting this challenge is in the evolution of U.S. Army Field Artillery tactics, techniques and procedures (TTPs), and developing equipment for specialized urban fighting.

Fortunately, the basis for the field artillery's evolution exists inside of published manuals and training. All howitzer crews are assessed on their ability to conduct

2   http://www.presidency.ucsb.edu/ws/?pid=10951
3   https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/atp3_09x23.pdf
4   https://archive.nytimes.com/www.nytimes.com/books/first/g/gall-chechnya.html

A generic 155 mm, low charge trajectory chart produced for this paper by the United States Army Armament Research, Development and Engineering Center, Firing Tables and Ballistics Division. It can be extrapolated that by firing higher charges and using rocket assisted projectiles the quadrant elevation can continue to be lowered while achieving greater ranges. (Courtesy illustration)

direct fire drills as part of their Artillery Table V and VI crew certifications and qualifications. However, this is designed to assess their ability to engage targets on the ground at ranges out to 2,000 meters and at similar elevation in terms of altitude above the ground from the gun. The Paladin Digital Fire Control System (PDFCS) is an amazing computer and can generate direct fire firing data for the gun, but only provides assistance to the crew in engaging same-level targets. In a megacity, it can be reasonably expected for targets to be dozens or hundreds of meters above the gun and potentially thousands of meters away.

The last appendix of the 155 mm firing tables, the often neglected "trajectory charts," may provide an answer. It is a visual representation of the flight of a projectile in terms of altitude (in meters) over the horizontal range to target. Looking at the apogee, the point at where a round ceases its vertical flight and begins to descend, it shows a 155 mm cannon can gain considerable standoff from a target and fire rounds to strike at a variety of altitudes, allowing the rounds to be walked up and down a structure to achieve the desired effects. Though this chart is generic and for reference only, it can be inferred that a 155 mm projectile fired at less than 200 mils of quadrant elevation (QE) with a low charge (while not accounting for non-standard

variables) will have an apogee occurring between 3,000 and 7,000 meters from the gun and at an altitude of about 500 meters. Though the vast majority of buildings around the world are shorter than 500 meters, it can be seen that by adjusting the QE and increasing the charge, a round can be fired into a variety of building altitudes at a ranges which give a degree of protection to the crew and vehicle.

Two minor upgrades and changes to doctrine can be done to allow Paladins to successfully direct fire artillery into buildings in a megacity. First, the Army should introduce a direct fire firing table which has QEs for various ranges to and heights of buildings. In addition, time settings for fuzes need to be listed so they are set to either detonate immediately in front of the building to maximize fragmentation into the structure, or to delay the detonation to have effects inside of the walls. This ensures the round explodes before fully passing through a building reaching the ballistic impact point beyond the target. This table should have the entry argument of range to target and subsequent columns with quadrant and time settings for various altitudes based on 10-meter increments in building height.

Second, Paladins need to receive equipment which allows them to identify and engage targets rapidly with existing mu-

nitions. Most importantly, the vehicles will require an optic which provides a reasonable level of detail at ranges at and beyond 10,000 meters so a crew can quickly reference a target card to engage specific portions of a building. For example, "20th story, five windows in from the western face," would be one such entry. With an integrated laser range finder, similar to the one found on an M1 Abrams MBT, the howitzer would be able to tell the crew the exact grid, altitude and range to the target, allowing the system to compute the proper QE and time settings to achieve the desired effects. The PDFCS provides the framework which, with some coding, could bring all this data in and output a good firing solution.

Self-propelled howitzers can provide a unique capability to future maneuver commanders conducting operations inside of megacities. They can fire traditional indirect fire with precision, near-precision and conventional munitions from outside the cities, destroying targets of opportunity, and denying the enemy key infrastructure. Additionally they can, if TTPs and equipment evolve, provide effective Fires to high-rises and skyscrapers from outside the threat envelope of a vast majority of anti-tank weapons. Self-propelled howitzers are not tanks. Their armor is designed to protect against small arms and fragmentation, but they have the mobility and firepower which commanders of the future will need to win in megacities. If adapted, these simple changes to current doctrine and training can minimize the risk to friendly armored forces and provide the overwhelming and accurate fire superiority that is the heritage of the field artillery.

Capt. Geoffrey Ross is a field artillery officer and former commander of C Battery, 2nd Battalion, 82nd Field Artillery while supporting combat operations during Operation Inherent Resolve. He has completed three deployments to Afghanistan in support of Operation Enduring Freedom and one deployment to Kuwait and Iraq in support of Operation Spartan Shield/Operation Inherent Resolve.

The future of Fires software

AFATDS and JADOCS

By Chief Warrant Officer 3 Christopher Thompson

"If everybody is thinking alike, then somebody isn't thinking."

–Gen. George S. Patton

Abstract

Current tensions within the global operational environment, and the state of the U.S. military's global posture has generated the need for review of the improved coordination, synchronization and execution capability within the Joint Automated Deep Operations Coordination Software (JADOCS) and the Advanced Field Artillery Tactical Data System (AFATDS). The joint community is experiencing an increased requirement for improved coordination, synchronization and execution capabilities to successfully enable global requirements. However, current procurement mandates are attempting to incorporate JADOCS capabilities into AFATDS. This is not suitable, feasible or acceptable considering AFATDS does not have the processing capability to account for JADOCS current strategic responsibilities. The following effort described will streamline the service components within the Department of Defense and the procurement process when acquiring Fires coordination, synchronization and execution software.

Today's world of software-based devices and the increasing complexity of the operational environment can create austere conditions to predict system failures. It is not a question of if a failure is possible, but how often it can be detected and whether the mission can be completed. Some leaders within the U.S. Army Fires community believe the current Fires digital infrastructure is redundant and that incorporating JADOCS and its planning, coordinating and processing capability under the digital architecture of AFATDS would be a more feasible, suitable and acceptable approach. This could not be further from the truth.

What seems to have been missed or lost in translation are these systems, high availability. At the most basic level, availability can be defined as a probability that a system is operating successfully when needed. Availability is often expressed mathematically or as a percentage.

Availability (A) is calculated using the formula A = MTBF (MTBF + MDT), where MTBF is mean time between failure and MDT is mean down time. MDT is often assumed to be the same as MTTR, the mean time to repair. MTTF, mean time to failure, is often considered interchangeable with MTBF, although there are subtle differences. The term high availability has been used to encompass all things related to productivity, specifically reliability and maintainability. So let's take a closer look at these terms.

Reliability

Reliability can be defined as the likelihood that a device will perform its intended function during a specific period of time (often called the mission time). It is a measure of system success over a time interval. To help make sure that products meet customer expectations, reliability can be designed using efficiency models and techniques and enabling system diagnostics in order to detect faults and when faulty hardware needs replacing. This helps achieve high availability.

However, even the most robust and reliable system may not be the most available. To be available, a system must also be easy to troubleshoot, modify and repair during the mission time.

Maintainability

Maintainability of a system significantly impacts the user's perception of availability. For example, AFATDS 6.8.1 and JADOCS under their current, not projected, operational mandates have diagnostics that can improve availability. The key to keeping a system maintained is to make sure there are qualified and trained personnel. Less obvious – but just as important – are physical characteristics that affect maintainability. Modules and components should be capable of being removed, replaced or added to system without interrupting the mission. Features like online edits, partial downloads, adding input/output online and removing and inserting modules (e.g. 1 or 2 disk) under power help make maintainability successful.

Understanding the components above, is it feasible to assimilate two systems that operate effectively under their current mandates? Is it suitable to increase AFATDS command and control (C2) responsibilities as the Fires direction manager for the tactical and operational levels? Is it acceptable to require JADOCS, the joint coordinator and managing system at the operational and strategic levels, to assimilate its joint

Staff Sgt. Nicole Mayberry completes a practical exercise using an Advanced Field Artillery Tactical Data System at a field artillery military occupational specialty course hosted by the Wisconsin Army National Guard's 426th Regional Training Institute at Fort McCoy, Wis. (Capt. Joe Trovato/U.S. Army)

responsibilities into a system that does not currently have the same processing power?

These are all questions that should bring an impetus of review in order to effectively enable the Fires warfighter. The remainder of this paper will highlight background information, findings, supporting information and conclusion, with a recommended way forward to support the effort of this document.

Method

In 2013, TRADOC Capabilities Manager Fires Cell briefed Operational Support Directive (OSD) that 90 percent of JADOCS Fires and targeting capabilities already existed in AFATDS. This was an inaccurate statement then and is an inaccurate statement now. However, TCM Fires was able to convince the OSD and Army G8 that a convergence made sense and would reduce the cost of maintaining two systems versus one. The OSD and Army G8 agreed with this concept and began the assimilation of JADOCS functionalities into AFATDS, starting with AFATDS 6.8.1 and potentially being completed with AFATDS v6.8.1.1.

In November of 2015, the Fires TCM briefed U.S. Central Command on a transition plan for JADOCS capabilities to AFATDS. CENTCOM representatives were

assured that several critical capabilities had been incorporated into AFATDS. Several CENTCOM attendees expressed concerns about the critical capabilities function and if the system could operate as required, to include being able to process the volume of information that is solely under JADOCS responsibility. During this time frame, the Fires TCM indicated absence of operational command to test the concept that AFATDS could or could not manage the planning, coordinating and processing responsibilities and capabilities of JADOCS. That was an inaccurate statement then and is an inaccurate statement now. United States Forces Korea provides the perfect platform to test any digital revisions, upgrades or concepts.

Findings

As of August 2017, one of the only operational commands that fully integrates and tests the full capabilities of JADOCS and AFATDS is the USFK. In the Korea operational environment JADOCS is utilized as a joint planning and coordination tool and most importantly as an archive for the AFATDS data base. As the senior targeting officer for 210th Field Artillery Brigade from August of 2015 to August of 2016 I had firsthand experience. I was a part of three readiness exercises that identified gaps in the AF-

ATDS ability to manage the high volume of Fires required to support USFK operations. This allowed for the recognition and understanding of the limitations within AFATDS, and validate JADOCS pre-established additional duty as an archive for AFATDS within the Fires digital architecture. In addition, these exercises re-enforced JADOCS prime purpose as the Fires C2 integration tool.

Currently, 210th FAB provides general support Fires to the Ground Component Command. Meaning that, on order, 210th FAB assembles and deploys in support of Combined Forces Command counter-provocation efforts, Fires shaping operations in support of the Air Force, conducts counter-fire operations, and fires time sensitive targets in support of GCC, Combined Joint Task Force-8, and the CFC. This is a massive requirement, and currently, 210th FAB is the only field artillery brigade with this level of responsibility. This mission requirement maximizes the full capacity of a field artillery brigade and provides a unique opportunity to integrate JADOCS and AFATDS to their fullest capacity.

However, the above examples are not the only situations of AFATDS inability to process the current responsibilities of JADOCS. In March of 2016, 197th Field Ar-
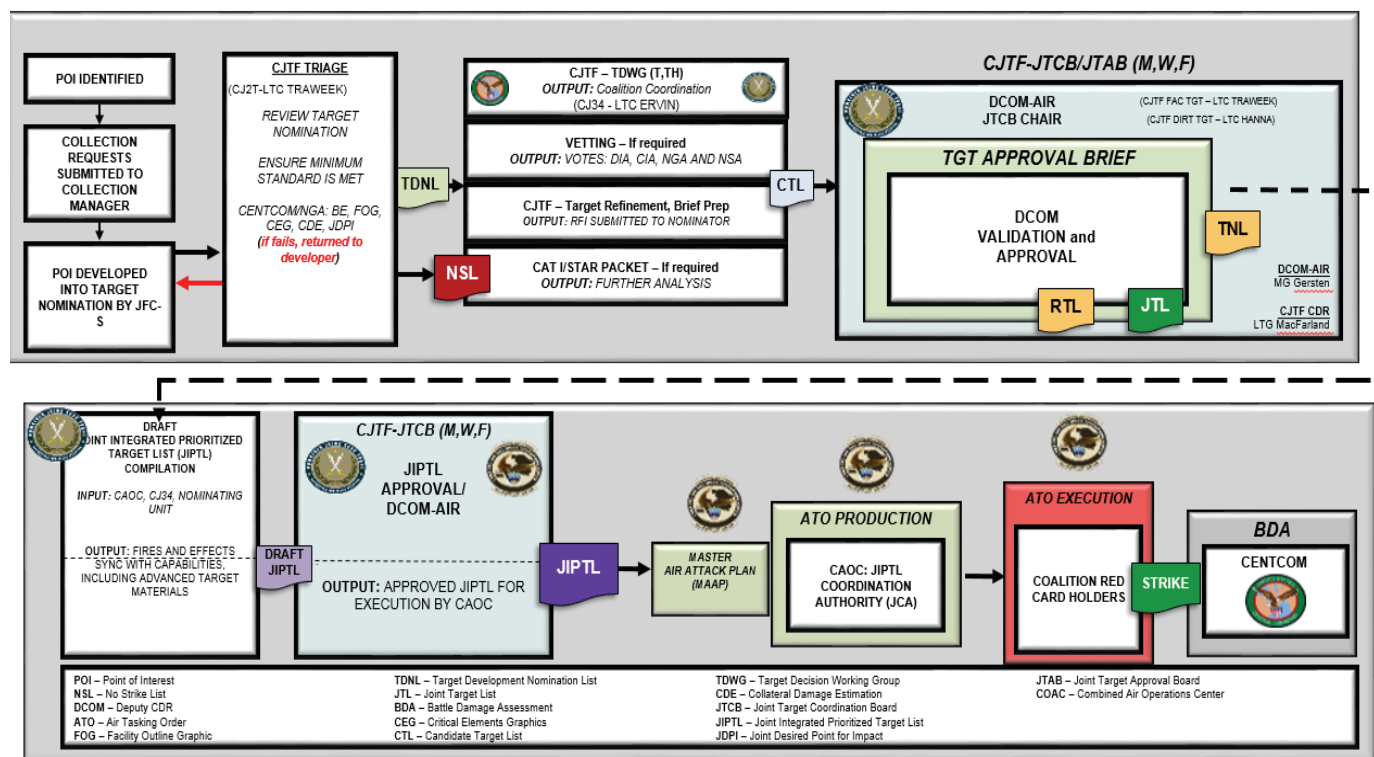
Figure 1. Joint Automated Deep Operations Coordination Software in support of deliberate/dynamic targeting. (Courtesy illustration)

tillery Brigade preformed a compatibility test to see if AFATDS could in fact support the robust requirements of JADOCS. As a whole, AFATDS could not (March 2016). Additionally, in November of 2016, the program manager for both AFATDS and JADOCS along with representatives from Fort Sill, Okla., conducted a review in order to validate 197th FAB's findings. These were the findings:

• AFATDS Fires manager, nominative candidate target list and collaboration list has limited permissions.
• AFATDS does not use the same abbreviations as JADOCS.
• There is not a clear requirement of how AFATDS pulls from the Joint Targeting Toolbox.
• There is not a comprehensive understanding of the Fires manager from JADOCS to AFATDS.
• Currently AFATDS managers are not suitable, feasible or acceptable to assimilate the JADOCS current responsibilities.
• AFATDS does not have a suitable approach to export mission fired report data to Excel. This will hinder commanders' ability to see real-time information and degrade the intelligence community's ability to conduct expedient Fires analysis.
• AFATDS weapon pairing solution is not as efficient as the Joint Munitions

Effectiveness Manual Weaponeering software, when generating feasible and suitable munition requirements.
• Fires Command Web (FCW, a client to AFATDS) is too liberal in its permissions.
• The FCW does not give a digital signature to its processes.

Supporting information

The previous information is not to discredit AFATDS capability, but to illuminate the need for both AFATDS and JADOCS separately. Below are multiple examples of this. The examples range from a vignette that took place with 197th FAB, to excerpts from the Joint Publication 3-03 (Sept. 16), Joint Publication 3-09 (Dec. 14) and Army Techniques Publication 3-60.1 (Sept. 15).

Recently while deployed in support of a combatant command, 197th FAB had some targets built that had between 15-22 aim points. They understood the 12 aim-point limitation and worked with that, but building 22 separate targets for a single mission with a time constraint was not feasible. Meaning that the AFATDS FCW requires that the target is built twice instead of once and this decreases high availability and increases a probability of error (March 2016).

Within the Combined Air Operations Center and also in Iraq, the 197th FAB has Navy and Air Force agencies in different locations building targets on JADOCS. Setting up FCW access is not simple due to firewall issues between networks, along

with the aforementioned doubling of the work for an FA target. Mortar Anti-Personnel/Anti-Material (MAPAMs) are being shot on a near-daily basis in Iraq right now. There is an operational need for JADOCS to support the sending of MAPAM missions up to the limit of the AFATDS capability and that needs and has to be communicated to the program manager and throughout the Program Office.

JADOCS is a software application and collaborative tool used for dynamic targeting and facilitates the integration of joint/multinational Fires. Digital integration of U.S. and multinational Fires systems enables timely execution of time sensitive targets (TST), component-critical targets and high-payoff targets. The joint management function provides the ability to change and display operational maneuver graphics, ACMs on the airspace control order, air tracks on the air tasking order (ATO) loaded on the air defense system integrator, and fire support coordination measures (FSCMs) while conducting joint fire support. The air interdiction (AI) planning and execution function provides more effective employment of AI assets through timely and improved information flow for the identification, assignment, and nomination of AI targets.

JADOCS is a software application consisting of managers' databases, and tables that present and manipulate command,
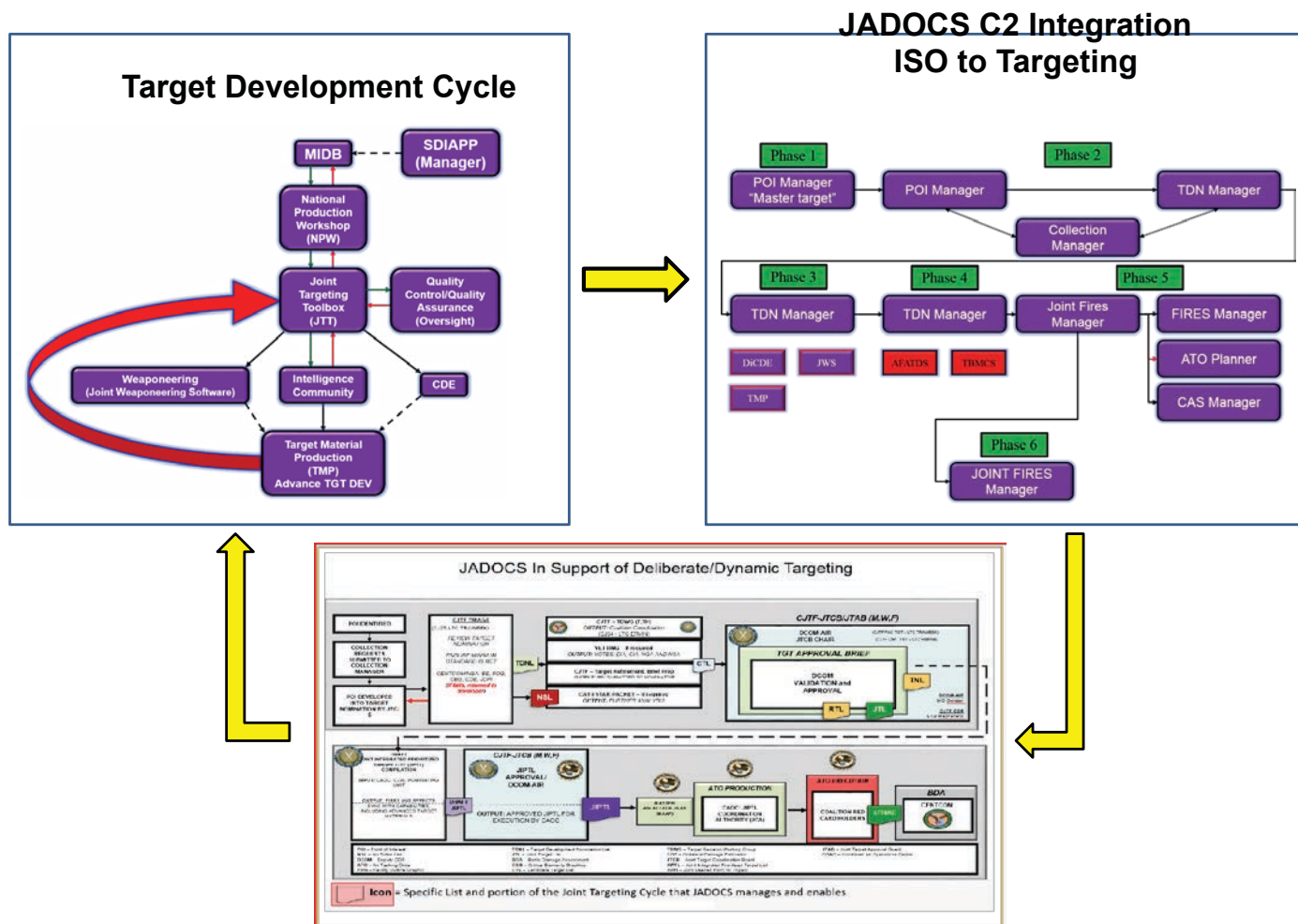
Target Development Cycle

JADOCS C2 Integration
ISO to Targeting

Figure 2. Joint Automated Deep Operations Coordination Software in support of targeting. (Courtesy illustration)

control, communication, computers and intelligence (C4I) information and communications interfaces to and from various C2 and C4I systems to obtain, coordinate and disseminate information. The JADOCS application can reside on any commercial off-the-shelf computer with a Windows operating system and connection to the appropriate theater networks.

Dynamic targeting use

In dynamic targeting (DT), JADOCS is the principle collaborative and force assignment tool. It provides the ability to nominate, vet, assign and plan cross-component DT missions. It interacts with other platforms, increasing situational awareness and provides immediate visibility to all staffs from the joint operations center to the command executing the DT mission.

Communication capabilities

JADOCS is a software application package and can reside on all classified networks. For DT purposes, JADOCS interacts with AFATDS, Modernized Integrated Database, Global Command and Control System Family of Systems, Naval Fire Control System, Theater Battle Management Core

System (TBMCS), and select coalition systems.

JADOCS is used at all levels of warfare, but its use varies by component, as follows.
1. Joint commands: geographical combatant commands and joint task forces.
2. United States Army: brigade and above.
3. United States Marine Corps: Marine Air-Ground Task Force Command.
4. U.S. Navy: maritime operations centers, ashore and afloat, aircraft carriers and amphibious assault ships.
5. U.S. Air Force: air operations centers.

JADOCS DT considerations.
1. The theater J-2 and J-3 are required to track, assign and monitor the engagement of TSTs, joint force commander critical targets and component-critical targets within their area of operations. During DT missions, this is accomplished using the Tactical Data Network (TDN) within JADOCS.
2. Throughout the planning and engagement processes, the managers within JADOCS are continuously updated with mission information and mission status by all managing stakeholders.

These managers provide the joint Fires element and component Fires coordinators with an executive-level update of the target, including the estimated and actual times on target. Components can control their unique mission manager without impacting the managers within other components or the joint operations center.

In the Army and Marine Corps, AFATDS is the primary automated fire support and fire direction system at the division level and below. AFATDS can communicate over a variety of networks, including frequency modulation, very high frequency, ultra-high frequency, Enhanced Position Location Reporting System and local area networks.

1. Internal communications: AFATDS is an automated system and communicates with other automated systems via the data distribution system. It can publish, receive and distribute information. Information types include target lists, FSCMs, ACMs, ATOs, airspace control orders, Department of Defense Form
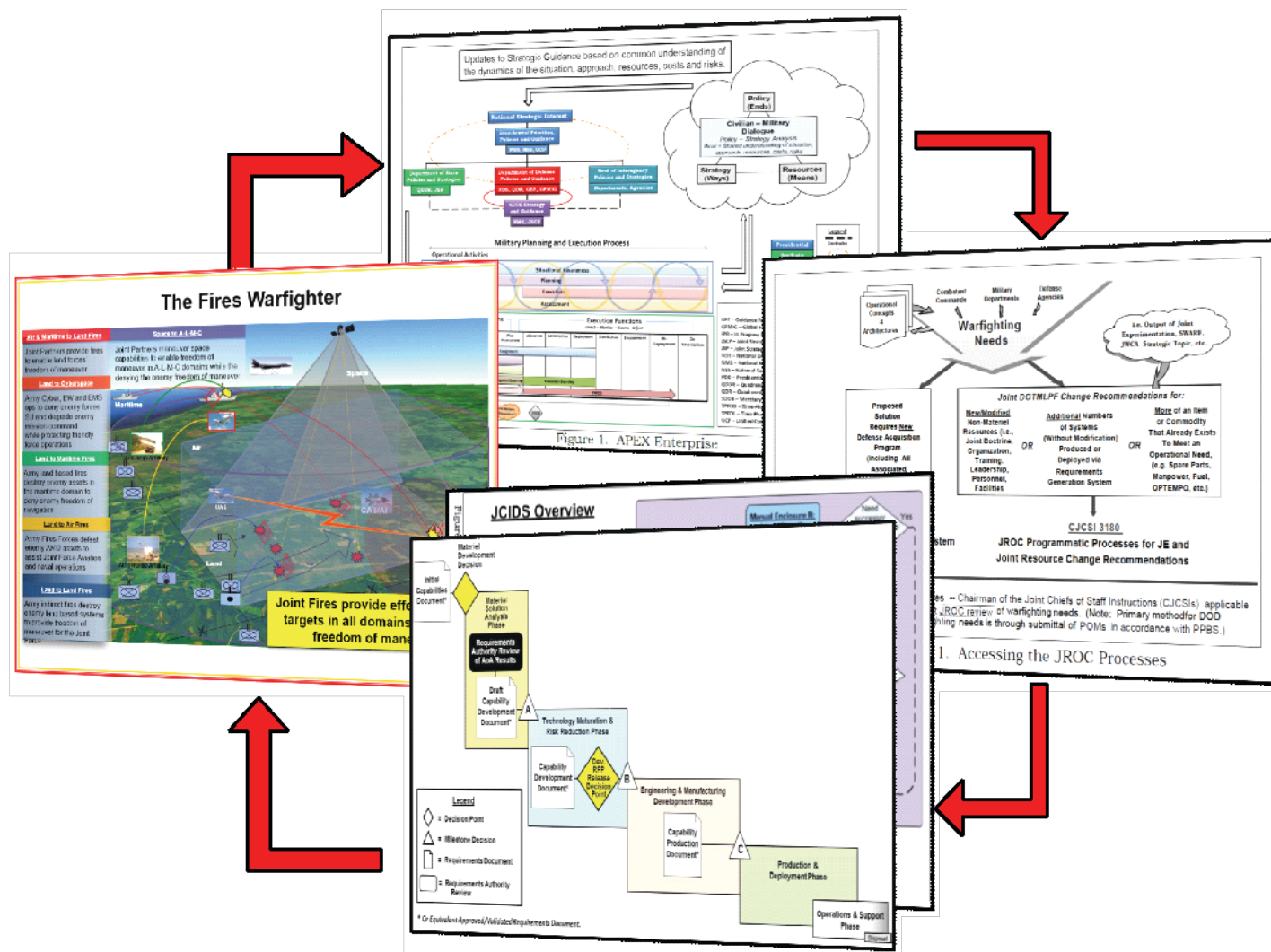
Figure 3. Joint Automated Deep Operations Coordination Software Integration. (Courtesy illustration)

1972s, graphic control measures, and unit locations.

2. External communications: AFATDS communication between the Army and Marine Corps is conducted via communications networks established within the joint master unit list. There are limited communications with the Air Force (DD Form 1972, ATO, etc.) via the TB-MCS. Cross-component coordination and information dissemination is best achieved through the data link between AFATDS and JADOCS.

AFATDS is a multi-service integrated fire support system that processes fire missions, air support requests and other related information to coordinate and maximize the use of all fire support assets (i.e., mortars, FA, attack helicopters, air support, naval gunfire and offensive electronic warfare). It meets the needs of the FA for planning the use of critical resources and for managing, collecting and passing vital fire support data throughout fire support

channels. AFATDS can create, store and check FSCMs/ACMs for violations during fire mission processing. AFATDS can send both preplanned and immediate air support requests through each echelon of command to the supporting AOC. It is fielded from echelons above Army corps or Marine expeditionary force to firing battery levels. With their AFATDS, the Direct Air Support Center is able to link digitally into the artillery and target acquisition channels to achieve a rapid counter-fire capability from either ground or air systems.

Joint Publication 3-09 Joint Fire Support: Joint Automated Deep Operations Coordination System (December 2014). JADOCS integrates communication, coordination, collaboration and execution of joint and multinational targeting and Fires. Digital integration of U.S. and allied joint Fires information enhances situational awareness to reduce friendly fire incidents and enables timely execution of TSTs and high payoff targets.

Discussion

In moving forward what we need to define is what is the end goal? Is it a single "one-stop-shop" system or two systems that operate efficiently under their respective, not projected/proposed, mandates? Currently JADOCS is a system of record which assists with knowledge management of entity-level target development, supports target list management; TDN submissions, candidate target list submissions, situational awareness to targets and status on the joint, restricted, integrated target list, and no-strike lists. Figure 3 illustrates this.

In addition, JADOCS allows organizations to work internal points of interest, providing situational awareness to external organizations to de-conflict targeting efforts within a given operational environment. JADOCS also enables the joint targeting process through capabilities analysis, commanders' decision and force assignment, and mission planning and force ex-
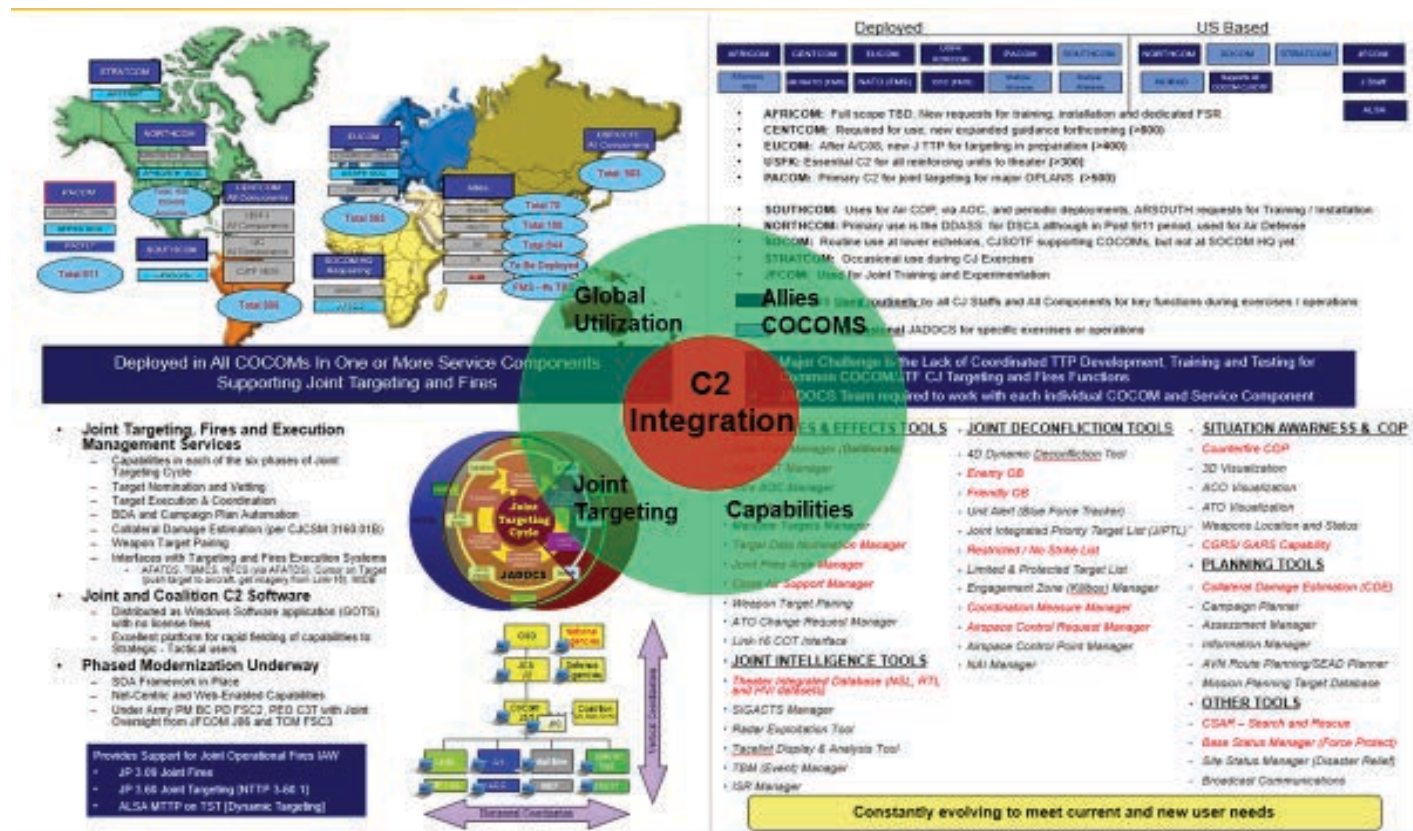
Figure 4. The Fires Warfighter. (Courtesy illustration)

ecution. Providing an integrated common operational picture and mission planning tools that allow for a range of capabilities against developing or approved targets, coordinating actions against targets approved by the Joint Targeting Coordination Board and conducting analysis of Fires within JADOCS to execute via appropriate managers. Figure 4 illustrates this.

However, the AFATDS is a reliable C2 system for the tactical and divisional levels, but JADOCS is the C2 integration system at the forefront of the corps and strategic (joint) levels. From face value, the idea of an AFATDS/JADOCS assimilation looks somewhat like JADOCS, but does not operate like JADOCS. Under the hood is not the same and the behind-the-scenes programming is completely independent of the logic of programming in JADOCS. We need to ensure that we are not wasting tax payer dollars on this vision of potential AFATDS/JADOCS assimilation with uneducated guesses as to how this is supposed to be implemented.

A way forward

A starting point in achieving functional resolution is to ask how we got here? It needs to be determined if, where, and when this plan was validated through the interdependent provisions of Chairman of the Joint Chiefs of Staff Manual 3130.03, Adaptive Planning and Execution overview and policy framework (APEX) (March 2015), Chairman of the Joint Chiefs of Staff Instruction 3180.01 Joint Requirements Oversight Council (October 2002), the Chairman of the Joint Chiefs of Staff Instruction 3170.01 Joint Capabilities Integration and Development System (January 2015), and the Joint Fires Warfighting community.

Finally, as Fires warfighters we should be asking where are the requirements that were written to put JADOCS into AFATDS? Training and Doctrine Command Capabilities Manager is unable to provide any current data to facilitate a comprehensive walk through on how AFATDS supposedly can integrate JADOCS (experts of these applications have proven it cannot), nor can the TCM clarify why we are at this point of chaos, and produce the written requirements to the AFATDS/JADOCS field engineers. Is the TCM going to re-write the operational test? Does this concept have high availability, and is it truly enabling the joint Fires community and warfighter? These are just a few questions and statements to initiate an effort to conduct an effective comprehensive review by actual users/programmers of both systems into whether JADOCS should or should not be assimilated into the AFATDS digital infrastructure.

Chief Warrant Officer 3 Christopher Thompson, U.S. Army, (retired), is a former targeting technician with an extensive background as a joint and service component targeting subject matter expert. He has an expansive background in integrating and managing joint Fires and targeting methodologies, hardware and software ranging from Joint Automated Deep Operation Coordination System, Advanced Field Artillery Tactical Data System, Joint Weaponeering Software, Joint Targeting Toolbox, Precision Strike Suite Special Operations Forces, ArcGIS and numerous other supporting systems. Throughout his career, Thompson devised technical plans and continuously refined processes to ensure high availability from the strategic to the tactical levels of operations in the Afghanistan, Iraq and Korea environments.

Multi-domain task force takes on near-peer operations

By Col. Christopher Wendland

Headquarters, Department of the Army recently identified United States Army Forces Pacific and America's I Corps as the lead for the Army's new multi-domain task force (MDTF) concept. Seventeenth Field Artillery Brigade, *Thunderbolt*, a separate brigade under America's I Corps, is serving as the executor of the ongoing pilot program. The new Army MDTF concept is focused on developing methods to counter a peer/near-pear adversary's ability to conduct anti-access/area denial (A2AD) operations against U.S. power projection capabilities.

The *Thunderbolt Brigade* is tightly integrated with America's I Corps. The brigade commander dual-hats as the corps fire support coordinator and the brigade is a corps separate, which is also known as a direct reporting unit, to the corps headquarters. As the corps prepares for decisive action operations to support any world-wide contingency, the 17th Field Artillery Brigade staff routinely synchronizes warfighting functions with corps staff and typically delivers a large portion of the lethal shaping that a corps provides for its subordinate divisions.

With two attached High Mobility Artillery Rocket Systems battalions, each with 16 launchers, one brigade support battalion and an attached signal company, the *Thunderbolt Brigade* has a great foundation to serve as a starting point for an MDTF. The Army is now deciding if/what other formations could be assigned or attached to the base foundation to expand the capabilities needed to counter a peer/near-peer adversary A2AD threat.

Since this is a "multi-domain" task force, the Army is looking to inform its evolving multi-domain operation strategy during the execution of the MDTF-Pilot Program. U.S. Army Pacific, U.S. Army Training Doctrine Command, and America's I Corps have a series of exercises planned to test the integration of new formations and technology to provide sensor-to-shooter agnostic capabilities to a joint task force (JTF) commander assigned the MDTF. To achieve the true "agnosticism," each of the upcoming planned exercises will integrate all service capabilities into the MDTF-PP. The end-state goal is to provide a JTF commander the ability to thwart a peer/near-peer adversary's A2AD capability by synchronizing lethal and non-lethal capabilities across multiple domains (air, maritime, ground, cyber and space) near simultaneously, to create multiple dilemmas for the enemy and create a position of advantage for U.S./allied/partner power projection. The pilot is also looking to discern how requisite authorities could/should be delegated since if the MDTF supports an echelon or headquarters (coalition) that is unable to quickly approve certain missions, or those authorities are not delegated to the MDTF headquarters, the MDTF role is limited for execution.

In December 2017, America's I Corps and the 17th FAB completed an inaugural MDTF-PP exercise together in conjunction with Japan's annual Yama Sakura 73 exercises.

USARPAC and TRADOC augmented the *Thunderbolt Brigade* with non-standard cyber, electronic warfare and space capabilities during the exercise. Lt. Gen. Gary Volesky, I Corps and Joint Base Lewis-McChord commanding general, identified a portion of the exercises where U.S./Japan power projection was at risk. He instructed the MDTF-PP to develop a plan and integrate that plan into corps shaping to mitigate risk, provide a window of opportunity for I Corps and Japanese Ground Self

Defense Forces, and achieve a foothold in a peer/near-peer adversary's A2AD environment from which they could advance future operations.

The MDTF-PP developed a convergence window of layered multi-domain effects that provided an umbrella of coverage for the U.S./Japan bilateral air assault and airborne insertion force during their greatest period of vulnerability. Considering most of the "task force" participants had not met prior to the exercise and were not fully aware of the capabilities each brought to the table, the exercise proved extremely insightful for future iterations.

USARPAC, America's I Corps, and the *Thunderbolt Brigade* have a full schedule of exercises planned leading up to the summer of 2019. Each exercise will develop and iteratively test linkages to various service-agnostic multi-domain sensors and shooters. Using a plug-and-play methodology, different formations and emerging technologies will be attached to the 17th FAB MDTF-PP headquarters for short periods of time. The MDTF-PP headquarters will then develop and test linkages and processes, and the Army will analyze the data and determine how to build the "true" MDTF when the pilot program concludes.

Challenges continue to emerge. Seventeenth Field Artillery Brigade's primary mission is to serve as America's I Corps Force Field Artillery Headquarters (FFA). The *Thunderbolt* staff is attempting to balance the role of corps FFA (a responsibility to synchronize multiple field artillery O6-level commands — both FA brigade and DIVARTY— for a corps decisive action fight), the role testing a MDTF headquarters (bringing together non-traditional units and processes under the FA brigade headquarters), and their requisite responsibility of training their organic subordinate battalions for future decisive action operations.

In addition, specific to the MDTF role, there are notable challenges associated with creating communications linkages between the various service capabilities back to the MDTF-PP. The *Thunderbolt* S6 continues to request exceptions to policy or develop work-arounds to mitigate interoperability issues. Each challenge continues to press against the status quo and will eventually open up new doors and improve interconnections between services and the efficiencies to leverage multiple domains near-simultaneously. The *Thunderbolt Brigade*

headquarters tactical operations center is the central node that each sensor-to-shooter capability must pass and is arguably the most critical aspect of the pilot program.

Seventeenth FAB is routinely reviewing mission command shortfalls to provide the corps with existing capability gaps that must be addressed to ensure the MDTF can accomplish the mission. In addition to looking at service-agnostic sensor-to-shooter linkages, the MDTF-PP headquarters is also ensuring the linkages that hold true from the brigade to America's I Corps will hold true for any joint task force headquarters.

Another challenge is the sustainment support for each of the new formations temporarily attached to the MDTF-PP. Although all field artillery brigades have an assigned brigade support battalion on their modified table of organization and equipment, the FA brigade support battalions are only comprised of a headquarters support company and are not sourced subordinate companies (no supply support activity, maintenance company, or Role II medical capability). These shortfalls require the FA brigade to look at sustainment augmentation for each of the Army plug-and-play units under temporary attachment for the various future exercises or to leverage corps assets to fill the gap. As the MDTF-PP becomes associated with non-standard units and deploys to exercises in austere locations, 17th FA Brigade is working to identify requisite sustainment requirements to ensure the MDTF will remain responsive to JTF counter A2AD requests.

Overall, the 17th FA Brigade is appreciative of the opportunity and privilege to serve as a pilot program for such an important joint force future capability. The *Thunderbolt Soldiers* and those attached Airman, Marines and Sailors are motivated to push the envelope on new technology integration and to challenge and re-negotiate authorities to allow more capability at lower echelons.

The *Thunderbolt Brigade* is proud to be the Army's MDTF-PP and will work tirelessly with USARPAC, TRADOC and America's I Corps to remain a learning organization and employ this opportunity to ultimately further the Army's multi-domain operation concept.

Col. Christopher Wendland is the 17th Field Artillery Brigade commander and is the fire support coordinator for America's I Corps at Joint Base Lewis McChord, Wash.

Challenges in NATO fire control and digital interoperability

By Lt. Col. Derek Baird

The North Atlantic Treaty Organization faces an increasing security threat with peer-level opposition forces possessing significant joint Fires capabilities that are highly interoperable, and capable of providing timely, accurate, massed Fires in support of maneuver operations. The alliance fire support community continues to focus on increasing its joint fire support interoperability, and synchronization of joint fire support to meet the challenge of a capable peer opponent.

Over the past few years, NATO's focus shifted from deter and assure, to deter and defend across the full spectrum of operations. To accomplish this, NATO took its training focus from a non-Article V scenario to an Article V, decisive action/major

Figure 1. The fire control exercise concept (Courtesy illustration)
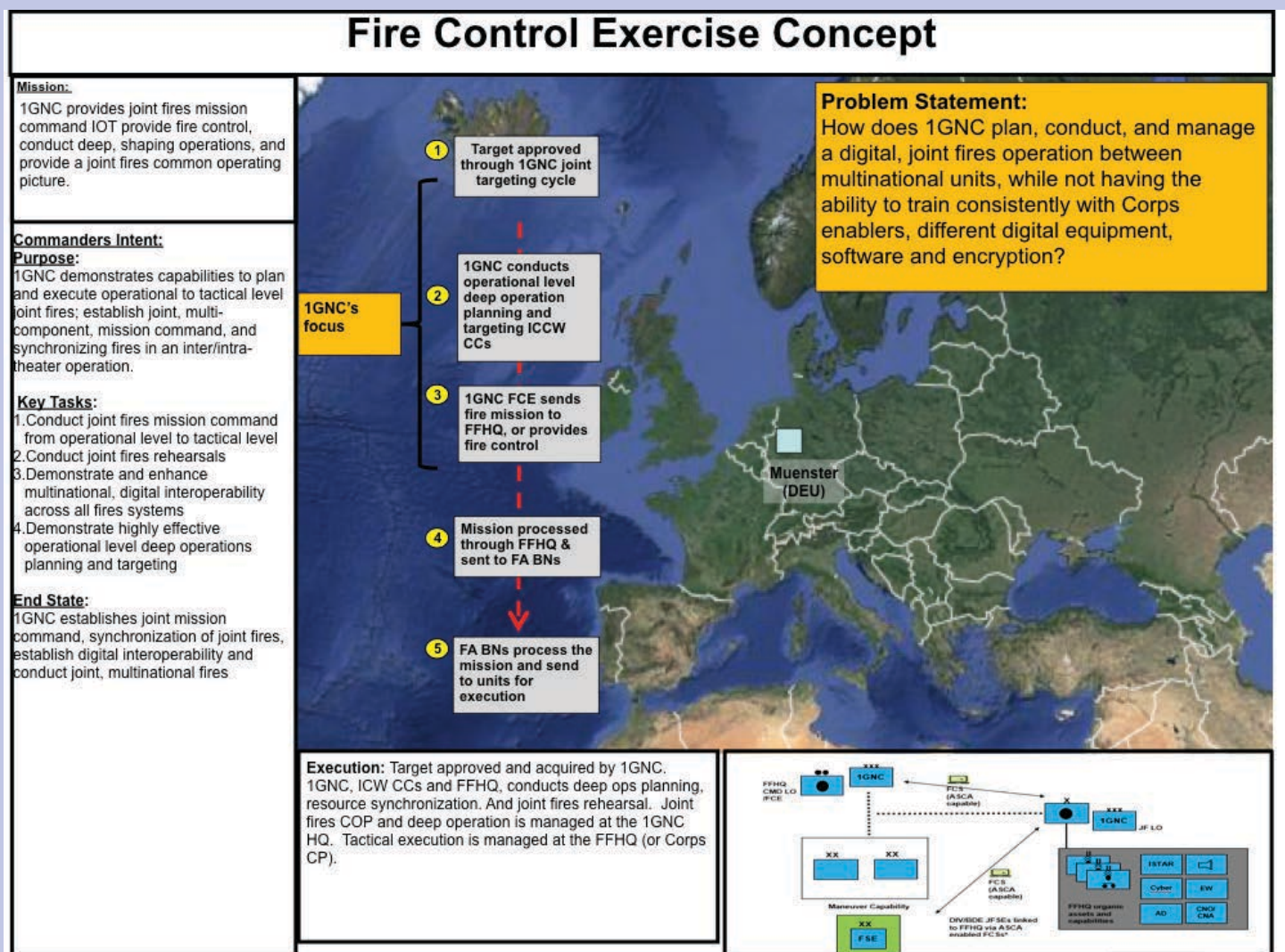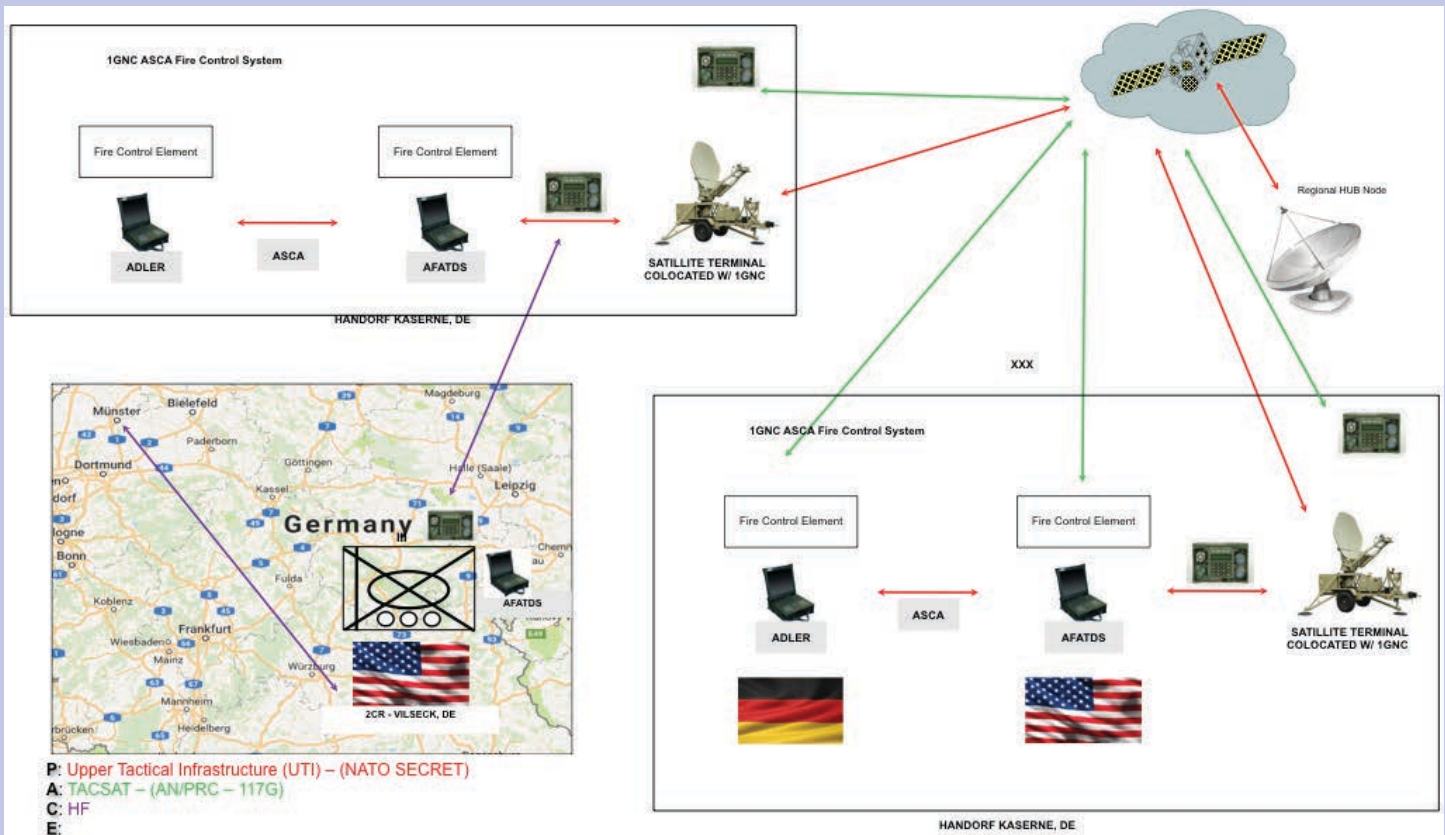
Figure 2. The Fires mission data flow. Center. (Courtesy illustration)

Soldiers from 4th Battalion, 319th Airborne Field Artillery Regiment, 173rd Airborne Brigade, prepare an M119 105 mm howitzer for parachute rigging at Aviano Airbase, Italy. (Antonio Bedin/U.S. Army)

combat operation scenario. The NATO fire support community is furthering NATO efforts by providing timely and accurate joint fire support to deter and defend against a peer opponent. The joint Fires support element (JFSE), per Allied ArtilleryPublication-5 (NATO Fire Support Doctrine), details corps-level requirements for joint fire support element to provide fire support command and control (C2), and manage artillery employment. Fire control requires a robust JFSE capable of providing C2. NATO Force Structures are not currently fully capable of providing fire control, necessary to engage peer-level opponents during an Article V, decisive action/major combat operation scenario. This is largely due to the lack of appropriate manning, training and existing equipment gaps that prevent responsive, deep, shaping fire support in order to shape the NATO Force Structure area of operations.

The 1st German-Netherlands Corps, a NATO Force Structure, is supporting NATO's efforts to provide digital Fires interoperability and enhancing its own Fires warfighting capabilities to meet its military objectives. To accomplish these tasks, 1st GNC's Fire Support and Air Space Management (FSAM) developed and executed a fire support interoperability exercise

Figure 3. The 1st German-Netherlands Corps interim joint fire support element/fire control element. (Courtesy illustration)

demonstrating 1st GNC's capability to provide fire support interoperability, fire control and a fire support common operating picture (COP). The aim of this event was to demonstrate long-range, digital, multinational interoperability between fire support systems, with a future goal to include joint Fires interoperability. The 1st GN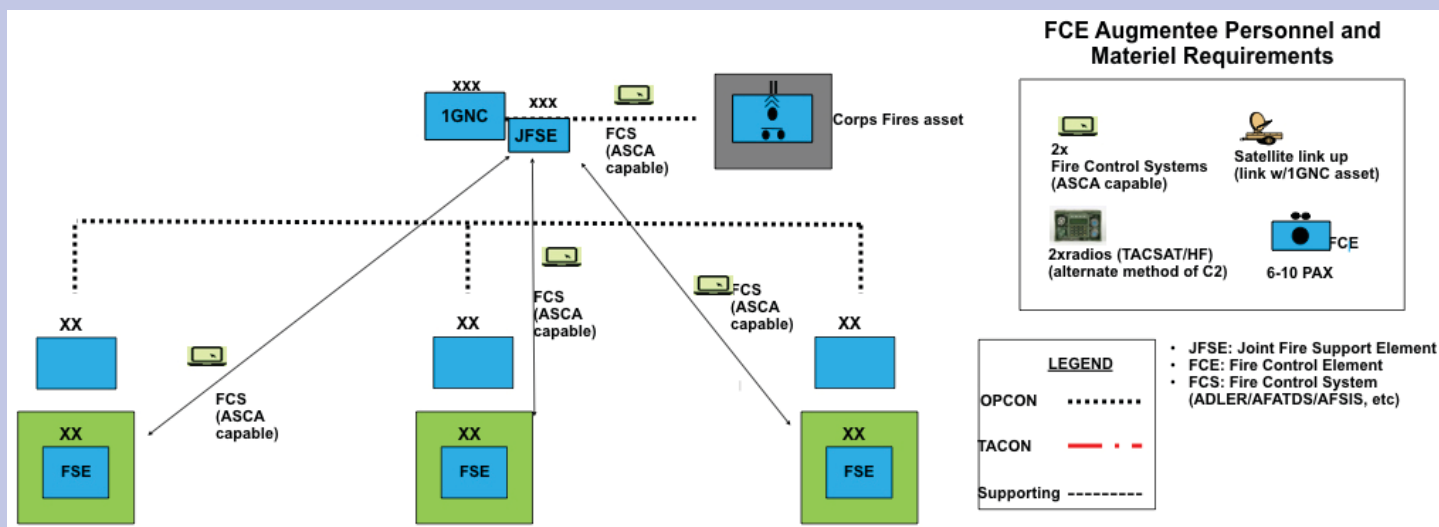C fire support team incorporated digital fire control systems (the ADLER and Advanced Field Artillery Tactical Data System) from the German Army Concept and Capabilities Division and the United States Army Europe into 1st GNC's organic and the 2nd Cavalry Regiment's communications systems to provide fire support mission command. The German ADLER and U.S. AFATDS fire control systems use the Artillery Systems Cooperation Activities (ASCA) program (an internal program to each of the systems) to pass digital traffic between the two systems. This exercise contributed to the ongoing efforts of the NATO fire support community to provide corps/Land Component Command/joint task force multinational, joint, deep, shaping Fires in support of NATO Force Structure military objectives.

The 1st GNC fire control exercise, see Figure 1, occurred January 2018 at the Luetzow-Kaserne Muenster - Handorf Barracks, near Muenster, Germany. We used a classroom setting to conduct our fire control exercise (FCX) and test our problem statement:

"How does 1st GNC plan, conduct and manage a digital, joint Fires operation between multinational units, while not having the ability to train consistently with corps enablers, different digital equipment, software and encryption?"

To answer this, we spent five days testing our primary, alternate, contingent, emergency (PACE) communications architecture, conducted interoperability testing, and further developed the corps fire control element task organization. The communications architecture, see Figure 2 opposite page, included upper tactical infrastructure i.e., internet via tactical satellite (organic 1st GNC asset), and lower tactical infrastructure (LTI) such as tactical satellite (TACSAT) and high frequency (HF) radios. The German ACCD, and USAREUR Fires cell provided personnel and fire control boxes; the German ADLER fire control system and the U.S. AFATDS respectively, to support our efforts. Communications equipment, and expertise were provided by the 1st GNC (satellite and AN/PRC-117F TACSAT radios), and 2nd Cavalry Regiment (AN/PRC-150 HF radio). Additionally, we refined our proposed future corps Fires troop concept (task organization and equipment) that will enable the 1st GNC to provide fire control organically (with augmentation), or through an attached force field artillery headquarters (FFHQ). This exercise allowed us to derive several lessons learned and set conditions for future fire control exercises.

Overall, the 1st GNC FCX was a success, validating proof of concept, but falling short of achieving maximum test results. First GNC designed and executed the FCX to verify the validity of our digital interoperability and Fires common operating picture; however, equipment challenges prevented us from fully testing the communication's architecture. Although we did not realize our end goal, the test highlighted oppor-

tunities for improvement and provided an improved starting point for our next FCX.

The corps' primary means of sending digital traffic is to pass data between fire control systems on two separate Local Area Networks (LAN) via 1st GNC organic tactical satellite connections in order to create a Wide Area Network (WAN). First GNC established a network intended to simulate two separate physical locations in a classroom setting, see Figure 3. One of the lessons learned was to ensure all participating nations involve their information assurance personnel earlier on in the process to ensure appropriate system's security classification is not an issue. Although we believe the concept to be valid, we were unable to fully test the theory. However, we were able to pass digital traffic between ADLER and AFATDS via a local area network. The next step is to fully connect the fire control systems through a dedicated satellite network to verify digital interoperability. This is our focal point for the next fire control exercise. In the long term, NATO must adopt a mission partner environment (MPE), or a federated mission network (for this article we will use the mission partner environment naming convention) to share information across different system security classifications, see Figure 4. To accomplish this, NATO must identify information exchange requirements, using approved message formats (such as a variable message format), to pass information through a gateway using the multinational interoperability program, and agreed upon rule sets, to a mission partner environment. This MPE would allow all multinational partners to share Fires information, conduct fire control and provide a digital Fires COP at every echelon.
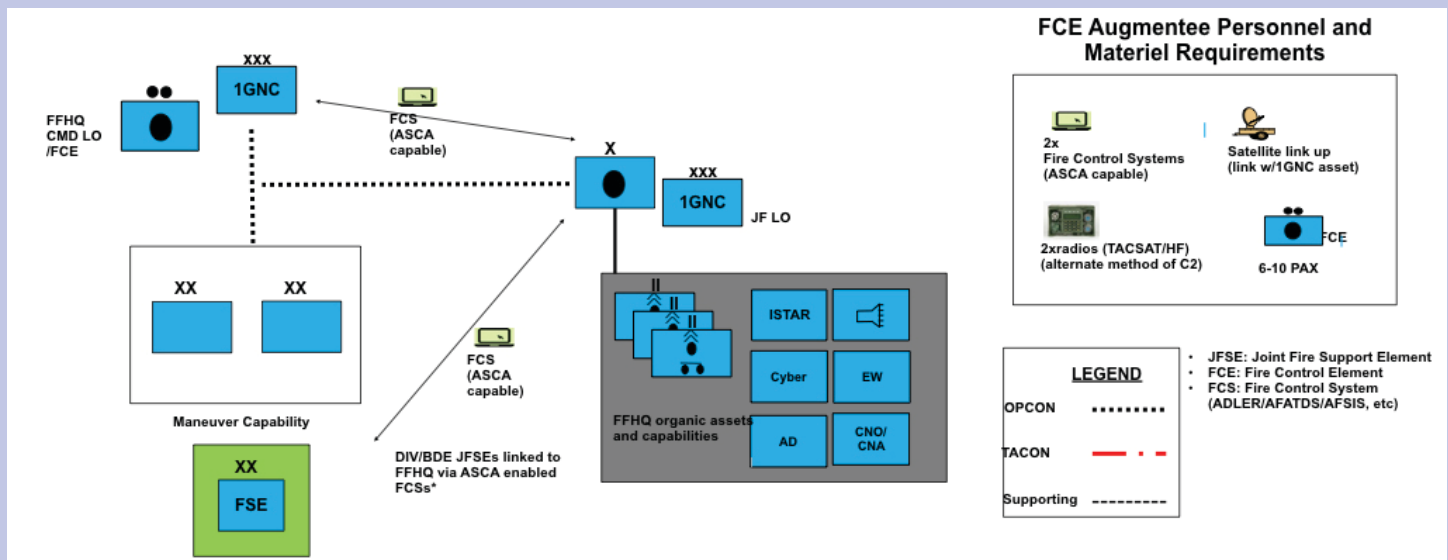
Figure 4. Joint fire support element/fire control element with a field artillery headquarters. (Courtesy illustration)

Our next step was to test our alternate means of communication: passing digital Fires data through a TACSAT radio. The assumption going into the exercise was that we would have challenges connecting the ADLER and AFATDS through TACSAT radio due to the model TACSAT (2x ANPRC-117F) radios we had available. The ANPRC-117F radio does not support TCP/IP protocol enabling the connection between the different fire control systems (ADLER, AFATDS). The upgraded AN-PRC-117G model supports the TCP/IP protocol enabling the TACSAT connection between the AFATDS and ADLER (and any additional multinational fire control system), thus enabling digital interoperability. We will integrate ANPRC-117G model TACSAT radios into our next FCX in order to confirm TACSAT radio digital Fires interoperability.

The final interoperability test (testing our contingency plan) was the integration of a high frequency radio into the digital communications architecture. Our assumption was that the AFATDS to AFATDS connection to the AN/PRC-150 HF radio would be successful since U.S. units do this on a consistent basis, but our research showed there might be a challenge for the ADLER to connect to the U.S.-provided HF radio. The 2nd Cavalry Regiment provided the HF radio, established a HF link from Handorf to Vilseck, Germany, and maintained a strong connection all week. The intent was to test an AFATDS to AFATDS link, and an ADLER to AFATDS link via HF radio. However, the ADLER was unable to recognize the U.S.-provided HF radio, but could pass data through a LAN to an AFATDS,

which in turn passes data to another AF-ATDS over the HF radio. We intend to go a step further during the next FCX by linking an ADLER (or other multinational fire control systems) to the AFATDS via a wide area network and then pass digital traffic over HF. Additionally, we continue to research a workaround that would allow the ADLER (or other multinational fire control boxes) to connect directly to a U.S.-provided HF radio, thus eliminating the need for the additional WAN, or LAN connection.

NATO Force Structures are not ideally suited to conduct fire control in their current manning configurations. During our FCX, the FSAM section further refined a proposed task organization that addresses current fire control, and interoperability gaps. Figures 3A and 3B illustrate the proposed 1st GNC task organizations without a FFHQ (Figure 3A), and with an attached FFHQ (Figure 3B), the necessary equipment and personnel to conduct fire control, and manage a digital Fires common operating picture. Ideally, the 1st GNC would have an attached Force Field Artillery HQ capable of providing corps-level fire control while also providing personnel and equipment to the corps HQ to enable Fires command and control between the corps, and the FFHQ. This would also provide a robust corps digital Fires COP; enhance the targeting process; and enable more synchronized corps-level deep shaping operations. In a best case scenario, this FFHQ would be multinational in composition to better incorporate the diverse Fires capabilities found in the alliance, and help bridge the gap in human and technical interoperability. The future for NATO Force Structure

and the 1st GNC is to continue testing corps troop concepts for Fires in future exercises to demonstrate a corps' ability to provide robust interoperable network architecture (satellite, TACSAT and HF), plan and execute corps shaping operations, conduct corps-level fire control (ideally with an attached FFHQ), and manage a digital Fires common operating picture.

As stated earlier, the 1st GNC fire control exercise was a resounding success. We validated our problem statement, and the fire control and interoperability concept. Additionally, we established a future gated strategy to close the Fires interoperability gap with respect to personnel, equipment and training. We knew going into the exercise that there would be interoperability challenges, since this was the first time in over a decade that the corps, and a NATO Force Structure in general, attempted to bridge multiple network gaps in support of Fires interoperability. This exercise, and future exercises will establish a path for NATO and allied partners to further develop and improve fire control at all echelons. Digital Fires interoperability between multinational fire control systems via satellite, TACSAT, and HF radios are feasible, but must be trained and exercised on a regular basis to ensure the capability is present should the need arise. NATO, along with multinational partners, realizes the need to share information across different networks and systems, with different security classifications, to a mission partner environment that provides a Fires COP, and enables rapid Fires planning, synchronization and execution at all echelons. Exercises such as the Dynamic Front series, and home sta-
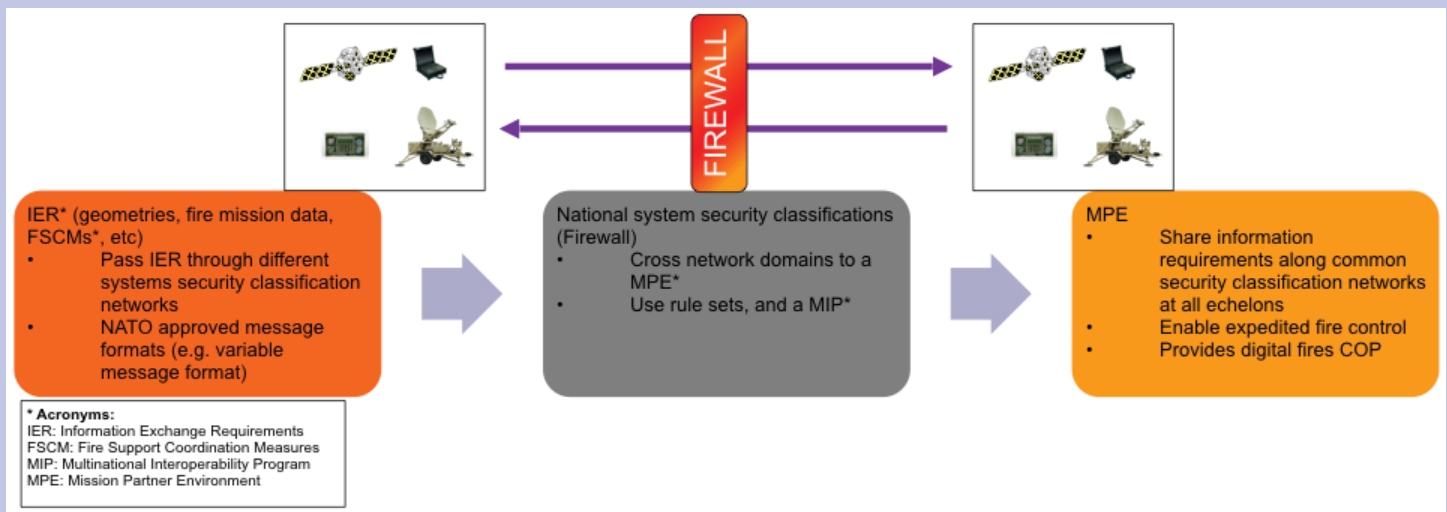
Figure 5. The mission partner environment. (Courtesy illustration)

tion training are excellent opportunities for macro (large multinational exercises) to micro (home station training) level testing of systems and digital sustainment training. The 1st German-Netherlands Corps intends to continue to conduct future fire control exercises with our multinational partners, to include other NATO Force Structures, USAREUR, and the Royal Netherlands Army Fire Support Command in order to increase the corps' ability to manage a Fires COP, and conduct digital fire control using fire control systems that have the ASCA protocol. Partnered training allows the 1st GNC, and by extension NATO, to plan, conduct and manage digital joint Fires operations between multinational units, and directly contributes to NATO's expanding Fires warfighting capability. Additionally, NATO must expand Fires interoperability to the joint realm, ensuring all component commands are able to share information, synchronize joint Fires and provide a common understanding for commanders and staffs at all levels. The push to increase digital Fires interoperability enables NATO to continue to provide the competitive edge required to assure deterrence and provide effective multinational fire support during potential future major combat operations.

Lt. Col. Derek Baird is the 1st German-Netherlands Corps (a NATO Force Structure) joint fire support officer. Baird has participated in numerous multinational NATO exercises from 2015-2018, and is working with a NATO team to develop a mission partner environment enabling digital Fires interoperability.

Sailors Arleigh Burke-class guided-missile destroyer USS Donald Cook (DDG 75) fire a standard missile 3 during exercise Formidable Shield 2017. Formidable Shield is a U.S. 6th Fleet led, Naval Striking and Support Forces NATO-conducted exercise which will improve allied interoperability in a live-fire integrated environment, using NATO command and control reporting structures. (1st Class Theron J. Godbold/U.S. Navy

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PCS LIKE A PRO

By Rickey Paape, Jr.

One constant during military service is the eventual reassignment and clearing of your current duty assignment. The excitement of knowing your assignment will be changing soon, quickly becoming anxiety as you realize the daunting tasks ahead of you. Below is a compiled guide to help make the transition as smooth as possible.

When to begin

Typically, you are notified of your upcoming change of station, this may be through an e-mail, phone call or from a supervisor. It is important to note this notification is not official and physical orders are needed to begin the transition process. However, early notification gives you the opportunity to learn about the community you will be joining. Research the local area, schools and daycares if you have children, as well as any social organizations that you would like to be involved in. Narrow down the areas you may want to live, but do not make any commitments (i.e. home purchase, lease agreement, etc.).

Orders received

It may take some time from when you are originally notified to when you get your orders. Your orders are an important document, so verify the accuracy of the information. Report any inaccuracies to your administration section.

With orders in hand, it is time to start working on your move, begin with the "Scheduling the move" section below for more detailed information. Place your name on the wait lists for services your family may need, contact your new duty location's housing office, even if you do not plan on living on base, they will be able to provide you with reputable realtors and property owners. Contact local daycare centers, many have wait lists and it will be

better to get on it early. For school-age children, communicate with the local schools to get a list of required information from their current school to help with the transition.

Contact your new unit for a sponsor, who will be able help you in-process. If possible, plan on taking a temporary duty assignment at your new duty station to search for family housing and meet with your sponsor.

Regardless of whether you are taking leave or not, during your move you will need to have an approved Department of the Army Form 31, Request and Authority for Leave, during your transit between duty locations. Submit your form to your unit personnel office for approval. Remember the end date of your leave cannot exceed your report date.

Before you start the process of actually clearing your current duty station, you should prepare for the process. Create an inventory of the items assigned to you from the local Central Issuing Facility. Make sure you have all the items, they are in working order and clean. This will avoid a statement of charges. If you are leasing your home or apartment, notify your landlord 30 days prior to leaving.

Clearing your duty station

Plan to attend your local out-processing brief. These are typically held 14 business days before departure, confirm this with your local out-processing office. Be prepared to take notes and have a list of questions prepared. Make appointments for any offices you need to clear. Not all offices make appointments.

It is your responsibility to clear all of the agencies and organizations at your installation during the clearing time provided. Failure to complete the process may result

in a statement of charges, withheld pay or disciplinary action under the Uniformed Code of Military Justice.

Scheduling the move

As soon as you receive the official orders, begin by gathering the information you will need. The following information will be needed: estimated weight (https://www.move.mil/resources/weight-estimator), pick-up and delivery locations and dates (the exact location is not needed, just include the new installation for now), special items (boats, guns, large electronics) and any professional equipment. You should also have an emergency contact in the event the movers cannot reach you. Once you have all information collected, schedule your move through the Electronic Transportation Acquisition system at https://go.usa.gov/xQDxN.

Before the move

Begin preparing for the move immediately. Start by staying organized. Create a portable filing system and store important documents such as your orders, birth certificates, social security cards, housing paperwork, etc.

Make an inventory of all items, particularly those to be packed and transported. Take this opportunity to clean out items, discarding what is not used or needed. Hold a yard sale, donate or throw out excess belongings. Organize like items, this will make things easier for unpacking. Take photos of your high-dollar items from every angle and include photos of your house as well, this will help if there are any damage claims later.

The moving company will call you and conduct a pre-move survey and identify any special items or requirements. Place anything you will take or keep with you

PCS CHECKLIST

PCS Notification
- ☐ Research new community
- ☐ Identify schools/daycares
- ☐ Review housing options

Orders Received
- ☐ Review the orders
- ☐ Report inaccuracies
- ☐ File important documents
- ☐ Begin the moving process
- ☐ Wait lists for new location
    - ☐ Housing office
    - ☐ Schools
    - ☐ Day care offices
    - ☐ Get a sponsor at your new unit
- ☐ TDY to find new housing
- ☐ Complete a DA Form 31, leave form
- ☐ Inventory items and prepare for turn into CIF
- ☐ Attend local out-processing brief
    - ☐ Take notes
    - ☐ Make appointments if possible
    - ☐ Clear all agencies as required

Your Move
- ☐ Gather information
    - ☐ Contact info
    - ☐ Estimated weight
    - ☐ Pick-up and delivery dates and locations
    - ☐ Any special or professional items
- ☐ Submit your move info: https://go.usa.gov/xQDxN

- ☐ Inventory your household
- ☐ Sell, donate or discard any unnecessary items
- ☐ Organize your belongings
- ☐ Take photos of all valuable and specialty items
- ☐ Take photos of your home
- ☐ Pre-move survey
- ☐ Mark items you are keeping with "Do Not Pack"
- ☐ Fill out USPS change of address form

Pack day
- ☐ You must be there
- ☐ Have family and friends help
- ☐ Take photos of box contents
- ☐ Contact the personal property office for any issues

Move day
- ☐ Driver will handle any issues that arise
- ☐ Conduct walkthrough
- ☐ Annotate any disagreements on the inventory sheet
- ☐ Sign the inventory sheet

Delivery day
- ☐ You will be provided an inventory sheet
- ☐ You must check off the box numbers
- ☐ Direct the crew where to put boxes
- ☐ Check inventory for any missing boxes
- ☐ Annotate any discrepancies on the inventory
- ☐ Sign the inventory sheet
- ☐ Complete the Notification of Loss/Damage AT Delivery Form within 75 days
- ☐ File a claim for damages within nine months

aside so the packers will not mistakenly pack these items. Label this area with a sign saying "Do Not Pack." Roughly one week before your move day, fill out the change of address form for the U.S. Post Office.

Pack day

The moving company will typically send a few people to pack your items for shipping. This is can be different from your move day, which is when the movers load your packed items onto the truck. The packers will contact you ahead of time to give you specific dates and times they will be available to pack your items. It is critical you are available during this time. If the moving company fails to show, quickly contact your local personal property office. During pack day, the packers will pack as much as possible in boxes. Invite family and friends to help keep an eye on all the activity. It will help make sure your inventory is accurate and potentially they could take photos of the inside of the boxes so unpacking at your new place is easier. If you find yourself uneasy about any situation during this process, you should contact your local personal property office.

Moving day

The driver is in charge. The driver is responsible for the crew and ensures everything is properly loaded for the move. If you have any issues, discuss them with the driver first and they should address them. If the driver is unable to resolve the issue, contact your local personal property office. The moving company will be taking inventory of boxes, furniture, large appliances and any other large items. They will also note if there is any pre-existing damage to your household goods in their inventory. Annotate any disagreements you may have with their assessments on the inventory sheet, including any damage to the residence. Do a final walk-through with the driver to make sure everything has been loaded. Finally, you will need to sign the inventory, but annotate any disagreements with the inventory before signing.

Delivery day

Before the crew can start unloading boxes, you will be provided the inventory sheet. You will need to check off the numbers from each box to ensure everything

has been delivered. Do not let a member of the crew check off the numbers. As the boxes are unloaded, direct the crew where to place each box. Decide whether you want the crew to unpack the boxes or only specific ones and whether they will be reassembling the furniture. Once the truck is unloaded, verify the numbers on the inventory sheet. Mark any discrepancies on the inventory sheet before you sign, including any damage to the residence during the move. You will be responsible for any trash or unpacking once the moving crew has departed.

If you need to make a claim, you must notify the moving company in writing within 75 days of any damages or missing items. This notification is not a claim but it is required. Once the moving company has been notified, you have nine months to file the claim. If the claim is filed after nine months, you will only be reimbursed for the depreciated value of the item up to two years.

Rick Paape is an award-winning graphic designer. He has also served seven years in the U.S. Army as an air defender.

Increasing multi-domain capability

Joint force training approach to third offset strategy

By Maj. Rich Farnell, Maj. Shane Williams and Capt. Chandler Rochelle

One of the unique characteristics of Joint Base Lewis-McChord is that a major airlift wing is stationed alongside several combat brigades, including an expeditionary sustainment command. Given all these forces are geographically co-located, exclusive training opportunities present themselves which set conditions for joint force utilization and overlap of training objectives.

One such instance is the 62nd Airlift Wing's Rainier War Exercise. This event includes joint planning between 62nd Air Wing and 17th Field Artillery Brigade, which prepares them to rapidly deploy and provide deep-strike capabilities through HIRAIN operations. The High Mobility Artillery Rocket System (HIMARS) Rapid Infiltration (HIRAIN) is a forcible entry capability that extends the operational reach of a combatant commander. Soldiers in 17th FAB strive to synergize this capability in a joint manner leveraging the tenants of multi-domain operation to sustain efficient joint training.

Early in the process, planners from the 62nd Airlift Wing Ground Liaison Detachment recognized the opportunity to extend invitations to units that could also benefit from United States Air Force lift assets. Further perpetuating the impetus of sustained readiness, multiple units on JBLM were able to turn the 62nd Airlift Wing's Rapid Mobility Exercise into a joint base-wide operation that reaped tremendous benefits to all who participated.

The focus for the 62nd Airlift Wing was the facilitation of Joint Full Spectrum Readiness Training. This involved a methodical move forward with scenario-based training to enhance joint deployment readiness for the entirety of Joint Base Lewis-McChord. The 62nd Airlift Wing planners developed a complex scenario in which multi-domain capabilities were needed for mission success. Within this context, air and ground assets would have to coordinate hand-in-hand to fuse their tactics, techniques and procedures. The overall objective for the 62nd Airlift Wing was for this integration to occur within the training environment.

The overarching training objective for 1st Battalion, 94th Field Artillery Regiment during Rainer War was to execute the HIRAIN. Nesting the employment of the HIMARS within the tactical scenario so that all joint partners could see the HIRAIN firsthand was another step in increasing multi-domain capability. The Joint Precision Air Drop System (JPADS) facilitated constant GPS coverage for the fire control panel while it was in flight. This capability on the C-17 allowed the launcher to expeditiously egress the aircraft and deliver precision Fires while minimizing the time the launcher spent at the raid location. Long-range communications were tested as well, further demonstrating that a fire control node offset of the launcher location could in fact pass fire mission data via high frequency (HF). The HIMARS off-loaded the C-17 aircraft at Schoonover Air Strip at Fort Hunter-Liggett, Calif., and the battalion

fire direction center (FDC) passed fire mission data via HF from JBLM, Wash., within minutes of the launcher being in position ready to fire. The rapid loading, offloading and firing of a six-round fire mission in a matter of minutes demonstrated the ability to provide a unique capability to exploit windows of opportunity to open access for friendly forces with precision Fires.

The platoon involved employed a medium HIMARS package of two HIMARs, one FDC and a HUMVEE carrying maintenance support. Two C-17s were allocated to the battalion. One aircraft carried a launcher and FDC while the second aircraft was loaded with a launcher and a HUMVEE. This tandem package allowed for redundancy in the case of maintenance issues and technical difficulties in the launchers.

To meet mobility requirements, both packages underwent inspections at the base Installation Transportation Division, followed by a joint inspection (JI) by the 62nd Air Wing load masters. Concurrent to the JI, the platoon leader and platoon sergeant gave a mission brief to the launchers inside the troop holding area. Per standard operating procedure, a three-day window was allocated to meet these mobility requirements.

Overall, the exercise highlighted the importance of joint training and a common operational picture. By utilizing local unit training, 17th FAB capitalized on locked-in resourced that was mutually beneficial training for all involved. Multilateral plan-

ning and integration is essential in ensuring the success of any joint training event. By following the Rainier War model, plenty of installations can leverage host units to further enhance individual readiness, and when tied into a nested common operational picture, significant gains can be made in increasing multi-domain capability across the services.

Maj. Rich Farnell is the 1st Battalion, 94th Battalion, 94th Field Artillery Regiment operations planner. He has also served as the 17th Field Artillery Brigade's fire support planner for key exercises in the Pacific such as Ulchi Freedom Guardian and Yama Sakura. Previous assignments include 2nd Infantry Division, fire support planner; National Training Center observer coach/trainer, and multiple battery commands. Farnell is a graduate of the Command

and General Staff College, and holds a bachelor's degree from the University of Tampa in Business Management, master's degree from the University of Oklahoma in Organizational Leadership, and is pursuing a doctoral degree in Organizational Leadership from Northeastern University.

Maj. Shane Williams is the 62nd Operations Group chief executive officer. He holds a Bachelor of Science in Electrical Engineering from the United States Air Force Academy and a Master of Arts in Organizational Leadership from Gonzaga University. Williams attended Specialized Undergraduate Pilot Training at Columbus Air Force Base, Miss., prior to serving as the 8th Airlift Squadron, assistant weapons and tactics flight commander at Joint Base Lewis-McChord, Wash., and as the 97th Air Mobility Wing, chief of wing weapons and tactics, at Altus Air Force

Base, Okla. Williams is a Distinguished Graduate of the United States Air Force Weapons School and is now stationed at Joint Base Lewis-McChord, Wash.

Capt. Chandler Rochelle is the 1st Battalion. 94th Field Artillery Regiment, 17th Field Artillery Brigade, assistant operations officer. He holds a Bachelor of Arts in History from the University of San Francisco. Rochelle attended Field Artillery Basic Officer Leaders Course at Fort Sill, Okla., prior to serving in the 4th Infantry Division as B Battery, 4th Battalion, 42nd Field Artillery Regiment fire direction officer and B Battery, 2nd Battalion, 12th Field Artillery Regiment platoon leader and 2nd Battalion, 12th Field Artillery Regiment battalion fire direction officer. He attended the Captains Career Course at Fort Sill and is now stationed at Joint Base Lewis McChord, Wash.

A High Mobility Artillery Rocket System (HIMARS) crew from A Battery, 1st Battalion, 94th Field Artillery Regiment, 17th Field Artillery Brigade fires a rocket off of the Fort Hunter Liggett, Calif. dirt landing strip, June 7, 2017. The 62nd Airlift Wing flew a HIMARS from Joint Base Lewis-McChord to Fort Hunter Liggett, Calif., to off-load and fire a six-round mission. (Sgt. Jacob Kohrs/U.S. Army)

FIRES

Knowledge Management

Fires Knowledge Network: gathering and organizing actionable knowledge to successfully accomplish the mission.

"Today's Army is much less about the knowledge you have so much as the knowledge you can share."

A Mark 45- 5-inch gun fires off the port side of the Ticonderoga-class guided-missile cruiser USS Lake Champlain (CG 57) during a naval surface fire support exercise. Lake Champlain is part of the Carl Vinson Strike Group who will report to U.S. 3rd Fleet, headquartered in San Diego, while deployed to the Western Pacific as part of the U.S. Pacific Fleet-led initiative to extend the command and control functions of 3rd Fleet into the region. (Mass Communication Specialist 2nd Class Nathan K. Serpico/U.S. Navy)

Thunder from the sea
Naval surface fire support

By Col. Brian Duplessis

"One major gap was a class and exercise on naval surface fire support. The instructor did cover the standard weapon systems on the destroyers and cruisers but it really lacked the employment methods, delivery munitions, and general considerations on why NSFS is the right option ... Generally most fire supporters can speak intelligently between [Laser Guided Bombs], [Joint Direct Attack Munition], [High Mobility Artillery Rocket System], artillery, mortar, etc. but most do not really have a solid understanding of NSFS capabilities."
—USMC Major, Command and Staff College Distance Education Program

In response to the statement above and the edition's theme - Fires in support of major combat operations - this work will provide a brief background on the history of Naval Surface Fire Support (NSFS), current and future capabilities, the NSFS training and qualification continuum, and cover employment considerations and dif-ferences with land-based surface Fires, to include terminology. As we shift focus to major combat operations against near-peer competitors, fire supporters across the joint force may find themselves employing NSFS and would do well to better understand this capability.

Brief historical background

"Because of the high rapid-fire capacity of naval guns they play an important part in the battle ... The movement of tanks by day, in open country, within the range of these naval guns is hardly possible." German after-action report on
—Normandy Landings, June 6, 1944

Naval Surface Fire Support came of age during World War II where a portfolio of light (5 inch), medium, (6 inch), heavy (8 inch) and super heavy (12-16 inch) weaponry supported global amphibious and littoral operations.[1] This system remained largely intact and acquitted itself well in Korea and Vietnam. Despite this proven track record, missiles began supplanting

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1   *The littoral is comprised of two segments. The seaward portion is that area from the open ocean to the shore that must be controlled to support operations ashore. The landward portion is the area inland from the shore that can be supported and defended directly from the sea.*

guns with the last big gun vessel decommissioned in 1975, leaving only 5-inch weaponry available, with the exception of 1983 – 1991 when four Iowa-class battleships were recommissioned. These leviathans fired their last rounds in anger during Operation Desert Storm and now serve as floating museums never to see action again.

Current and future capabilities

"Anzac and the British frigates then steamed right into Khawr Abd Allah waterway, sailing to within four kilometers of the Iraqi coast. After "strategically removing" set targets, Anzac continued to provide fire support to the British as they fought their way through the Iraqi forces on Al Faw to seize the town of Umm Qasr. More action took place on Saturday, when Anzac fired more than 20 more rounds to help the British advance, including destroying an Iraqi 155-millimeter medium artillery gun that was firing on the commandos."
—Account of UK and Australian NSFS, OIF I 2003

"Fight tonight" NSFS consists solely of 5-inch guns with a maximum range of 13 nautical miles (24 kilometers) and Tomahawk Cruise Missiles, theater-level weapons with significant launch preparation time and cost-prohibitive for use against all but the most critical targets. Projects in development include the Advanced Gun System (AGS) and electromagnetic rail guns. AGS, a 6.1-inch (155 mm) gun, was designed to fire a guided long-range land attack projectile (LRLAP) 74+ kilometers. Unfortunately, fiscal woes ended LRLAP fielding with costs per round reaching $800K; alternatives considered included an Excalibur 155 mm guided projectile derivative. AGS was the intended main armament for three Zumwalt class destroyers with two single mounts per vessel with 600 rounds per mount. The first of this class is in fleet service albeit without a main battery round in combat quantities. Alarmingly, the Navy recently moved forward to do away with AGS altogether and outfit the Zumwalt class with anti-ship vice land attack weaponry removing it from its originally intended mission, NSFS. Rail guns promise heretofore unimaginable ranges through the use of electricity vice chemical propellant. Rail gun armed vessels will also be able to carry more projectiles due to additional available magazine space previously required for propellant. For example, a destroyer could store up to 2,400 solid

USS Iowa (BB-61) fires a full broadside of nine 16/50 and six 5/38 guns during a target exercise near Vieques Island, Puerto Rico, July 1, 1984. Photographed by PHAN J. Alan Elliott. Note concussion effects on the water surface, and 16-inch gun barrels in varying degrees of recoil. (Photo courtesy of U.S. Navy)

shot railgun projectiles vice the current capacity of 600 conventional rounds.

Why NSFS?

"For the small team of commandos in northern Somalia ..., it must have seemed like history repeating itself... Fourteen years earlier a similar situation had resulted in the deaths of 18 U.S. service members. To escape.., the commandos called in some surprising assistance: ...A few shells from the Chafee's 5-inch gun covered the commandos' retreat."
—USS Chafee, DDG-90, supports Troops in Contact, 2007

Despite the challenges detailed, NSFS has utility in littoral combat where commanders can leverage naval Fires to com-

pensate for a lack of cannon artillery to support initial forcible entry operations and to also counterbalance a shrinking artillery park and limited amphibious/aerial lift, both of which conspire to limit the amount of artillery available. The chief limitation of field artillery in forcible entry operations is inability to support the initial entry (amphibious, airborne, air assault or any combination) unless established on an expeditionary advanced base during advance force operations. NSFS can partially offset this initial lack of medium-range surface Fires and - for subsequent operations ashore - support units operating along the littorals as was commonplace in Korea and Vietnam. NSFS can also temporarily supplant field artillery when batteries displace across challenging terrain thereby maintaining operational tempo and avoiding unnecessary pauses to allow the artillery to catch up. Additionally, as we divest field artillery we can use NSFS to fill the gap. This complementary employment was aptly executed in the Falklands War when 3rd Commando Brigade augmented the Fires of five light cannon batteries with

7,900 medium-caliber NSFS rounds. Lastly, a lack of amphibious shipping and surface connectors can significantly limit the landing force's artillery complement with commanders potentially embarking other capabilities leaving NSFS as the primary means of surface Fires, less infantry mortars. In order to properly employ this underutilized weapon system, we must first understand the training and qualification continuum.

Training and qualification continuum

"In the end, the level of NGS (Naval Gunfire Support) provided was sufficient and the performance of the ships was highly commendable, although both could have been enhanced through a greater focus on the capability in the decades preceding the Falklands War"
—Dr. Stephen Padget, "Old but Gold: The Continued Relevance of Naval Gunfire Support for the Royal Australian Navy."

Destroyers and cruisers are required to qualify and maintain proficiency in NSFS as a subset of the strike warfare warfighting area. Qualification is also a component of multiple awards and honors a ship may earn and is required prior to overseas deployment. Permanently forward deployed vessels re-qualify every two years approximately.

NSFS teams, similar in duties and composition to a cannon battery fire direction center, conduct two shore-based training sessions, followed by live-fire qualification. The training and qualifying agency for East Coast and Europe-ported vessels is Expeditionary Warfare Training Group Atlantic (EWTGLANT). Expeditionary Warfare Training Group Pacific (EWTGPAC) is responsible for West Coast ships with detachments in Hawaii and Japan covering the Mid-Pacific and Far East.

Qualification is a five (in some cases six) event sequential series. These events are:
1. Administrative self-review;
2. Administrative/material external review;
3. NSFS Focused Team Training (FTT);
4. NSFS Mobile Team Training (MTT);
5. Naval Fires Control System (NFCS) MTT for NFCS-equipped ships; and
6. Live-fire exercise (FIREX) qualification.

As the name implies, administrative self-review is an internal event the gunnery liaison officer (GLO)[2] uses to ensure his/her team is properly prepared for all follow-on training. Upon conclusion, team members should have basic skills and fundamental knowledge of their rates.[3] The GLO will be familiar with capabilities and limitations of the ship's gunfire control system and Gunnery/Combat Systems Doctrine and basic gunnery procedures. Team members gain basic skills and fundamental knowledge of their positions and read all applicable sections of their ship's Gunnery/Combat Systems Doctrine. Gun fire control system operators are also qualified. Administrative/Material External Review is largely a repeat of the internal event under cognizance of the qualifying entity.

NSFS Focused Team Training (FTT) is the first major training event, lasts three days, and is conducted pier side or in a shore-based training lab for Norfolk-based vessels. This initial training event focuses on fundamentals and previously-identified team weaknesses. The FTT also locks the NSFS team down key billet holders must remain constant throughout all further training events and deployment; if key team members depart, training must be repeated.

Scheduled within 90 days prior to qualification FIREX, the NSFS Mobile Team Training (MTT) is the culminating shore-based training event. Five days in duration, the MTT reinforces concepts and fundamentals covered during FTT concluding with a dry-fire qualification rehearsal to validate and refine tactics, techniques and procedures. Naval Fires Control System (NFCS)[4] equipped vessels undergo an additional three-day MTT designed to develop proficiency to maintain the digital common tactical picture, respond to digital calls-for-fire, and plan and execute a schedule of Fires; approximately one-third of the fleet is NFCS equipped.

The qualification live-fire exercise is the culminating event consisting of a practice and calibration fire (PACFIRE) to ensure the ship is meeting the requirements for accurate predicted fire before engaging targets. After PACFIRE, six tactical missions are evaluated: 1) Area target; 2) Suppression of enemy air defenses; 3) Re-fire target; 4) Counter-mechanized series; 5) Danger close; and 6) Coordinated illumination. These may be fired in any order and one mission is fired with reduced charge. Scores are calculated against established accuracy and timeliness criteria. In order to pass, a score of 80 percent and no more than one failed mission must be achieved. Failure results in MTT remediation and qualification repeat.

After qualification, ships are expected to conduct sustainment training, but this often proves daunting as there are few live-fire ranges, limited ammunition and higher priority competing training requirements. On average, cruisers live fire once every 1.8

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2   The Gunnery Liaison Officer (GLO) is the shipboard equivalent of the Fire Direction Officer (FDO) in Field Artillery Units
3   In the Navy, one's rate is synonymous with one's Military Occupational Specialty (MOS) in the other services.
4   NFCS is interoperable with AFATDS; non-NFCS equipped vessels are not.

Members of the naval surface fire support team work through a training scenario in the combat information center aboard the Arleigh Burke-class guided-missile destroyer USS Curtis Wilbur (DDG 54). Curtis Wilbur is on patrol with Carrier Strike Group Five in the Philippine Sea supporting security and stability in the Indo-Asia-Pacific region. (Mass Communication Specialist 3rd Class Ellen Hilkowski/U.S. Navy)

years and destroyers once every 2.4 years. This state of live-fire training is similar to what was seen in the field artillery during the height of Iraq combat operations when most field artillery battalions conducted multiple, consecutive in-lieu-of missions before resuming core mission training.

Employment considerations

"So here's this perfect platform [naval 5" guns] sitting out on the coast unable to be used by us because the initial planning didn't envision the need for it and because the right people didn't get to the right place in the pre-deployment phase."
—Gen. (ret) John Abizaid reflecting on his experiences as a Ranger Company commander during Operation Urgent Fury (Grenada, 1983)

Most fire support courses of instruction touch on NSFS covering basic capabilities and limitations to include flat trajectory, elliptical shot dispersion pattern and hydrographical considerations. While these

factors are critical, there are numerous other considerations to facilitate effective NSFS employment. These include, but are not limited to: 1) Limited time on station and ammunition capacity; 2) Multi-mission role of surface combatants; 3) Ammunition types and employment; 4) Vulnerability; 5) State of crew training and ship proficiency.

Surface combatants assigned to NSFS are limited in time on station and ammunition available. Due to a lack of depth in the NSFS team, surface combatants are not

able to sustain ongoing 24-hour operations in the same manner as an artillery organization. Furthermore, they will likely not last longer than 24 hours due to their sparse magazines - 600 rounds per mount[5] - some of which must be retained for self-defense. Due to these limitations, assigned NSFS ships should be used early in the same manner we use allocated armed aircraft sorties within time-on-station parameters; it is largely a "use or lose" proposition. Given this constant rotation of ships, long-term habitual relationships, such as those between direct support (DS) cannon battalions and infantry regiments, are difficult to establish and require more effort and outreach between supporting and supported commanders. Also, unlike a cannon battery of six to eight weapons, ships are limited to one or two weapons. If one goes down, there are not five others to continue delivering Fires.

All modern surface combatants are multi-role ships capable of anti-air, anti-surface, and anti-submarine warfare in addition to shore bombardment utility. As such, there is always the risk an assigned NSFS ship may be reassigned to a higher priority mission with little to no warning. Fire support planners must recognize this and designate alternate platforms/means to achieve essential fire support tasks, which is yet another reason assigned ships should be used early.

Unlike field artillery, NSFS does not boast a wide variety of munitions. Basic types are limited to high explosive and illumination.[6] Given this limitation, fire support planners should not expect ships to deliver the full gamut of Fires to include smoke and sub-munitions. Furthermore, due to high muzzle velocity, illumination rounds often malfunction due to ripped parachutes in much the same manner as artillery illumination fired at high charges. If possible, plan NSFS illumination within reduced charge range or allot an alternate platform to deliver. The inherent flat trajectory is another limitation rendering naval guns incapable of engaging targets in defilade at full charge; consequently, plan defilade targets within reduced charge range or designate other agencies to service. The inherent high velocity and flat trajectory can, however, prove useful when firing upon fortified targets with penetration desired. In this scenario, naval guns are best employed against targets offering a vertical face such as bunkers, buildings, cliffs and cave openings. Naval guns' high velocity and minimal deflection probable error are ideal for destruction missions particularly when the ship can take the target under direct fire. Also, this low, flat trajectory makes integration with aircraft more manageable when compared to mortars with their inherent high angle fire. The final consideration is the inability of naval guns to provide massed, surprise fire. While a single 5-inch gun can match the explosive weight a howitzer battery can deliver in a minute, it is incapable of delivering the initial surprise of six or more rounds simultaneously impacting. This high rate of fire does, however, make naval guns useful for sustained suppressive fire within limits of the ship's ammunition magazine capacity. Furthermore, the 5-inch HE round is a reliable anti-personnel and light material solution.

Within the current United States Navy, every ship is a capital ship unlike the World War II era where commanders were willing to risk destroyers and even light cruisers while judiciously guarding heavy cruisers, battleships and aircraft carriers. As such, do not expect the maritime commander to risk a high-value, multi-mission combatant in the performance of NSFS under high-risk conditions. First and foremost, the threat will need to be attrited to acceptable levels before commitment. If the threat returns to an unacceptable level, expect ships to leave the line until conditions have been met for (relatively) safe NSFS operations. Finally, unlike field artillery, cruisers and destroyers will not man their guns to the last man standing; to expect anything else is unrealistic.

As previously discussed, training is adequate, if not optimal, particularly in terms of live fire - much less integrated live fire in support of maneuvering forces ashore. For these reasons, it is not recommended to employ naval Fires in close proximity to advancing troops or other detailed schemes of fire where the risk for fratricide is high; optimal employment is flanking, enfilade fire down the long axis of a linear target or group of targets - parallel to friendly lines - to take advantage of the elliptical dispersion pattern combined with minimal deflection error. This is not a knock on our brothers and sisters in blue, but a realistic assessment of the likely state of training and proficiency early in a conflict. Ten years ago, I would have said the same about field
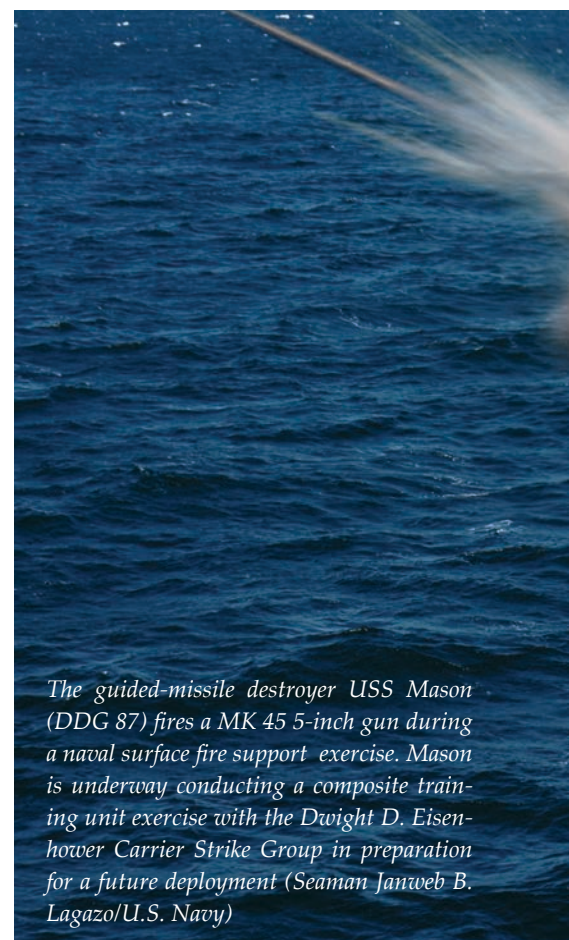
The guided-missile destroyer USS Mason (DDG 87) fires a MK 45 5-inch gun during a naval surface fire support exercise. Mason is underway conducting a composite training unit exercise with the Dwight D. Eisenhower Carrier Strike Group in preparation for a future deployment (Seaman Janweb B. Lagazo/U.S. Navy)

artillery units (including my own) resetting to their core mission after years of in-lieu-of combat missions. For these reasons, early detailed coordination is advisable; all destroyers and cruisers have helo facilitating face-to-face planning and coordination. During execution, spotters and fire support coordinators should plan to talk directly with the GLO and possibly the ship's captain to ensure close coordination and shared understanding and, if possible, include ship personnel in Fires/combined arms rehearsals and rehearsals of concept. Furthermore, ships are limited to two tactical missions: DS and general support (GS) simplifying C2 relationships and coordination of Fires. In addition to detailed coordination, forces not accustomed to working together need to use a single set of mutually understood terms and commands to ensure interoperability and ultimately mission success.

Common Lexicon

"Once when one of these observers was calling in a mission to us, we asked him if he wanted 'three guns, three salvos, fire for effect.' The Army man, used to artillery

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5   Current cruisers sport 2 x 5 inch mounts with a single gun per mount; destroyers have a single mount with a single 5-inch gun.
6   Some allied navies do carry smoke and/or WP.

talk, thought it over and said, 'yeah, that sounds like what I want.'"

—Capt. Hugh Knott, CO USS
St Paul, CA-73 1971

The entry point for shared understanding and seamless integration is a common lexicon of doctrinal terms. While NSFS and field artillery share much in common, each has its own distinct language and terms. While we can use workarounds to achieve success, as demonstrated in the anecdote above, we are a much more capable and agile force when operating with shared understanding and practices from the outset. While not all inclusive, equivalent NSFS and field artillery terms are compared to the terms in the figure to the right.

While the vision of NSFS largely remains one of capital ships pummeling hostile shores for "Saving Private Ryan" style amphibious assaults, nothing could be further from reality. In a joint force faced with dwindling resources and intense competition for those remaining, NSFS is a welcome addition to the commander's portfolio of Fires and effects, but only if employed wisely and within capabilities and limitations. As we come out of 15+ years of landlocked, counterinsurgency operations, we

NSFS	Field Artillery
Salvo	Volley
Number of guns/salvos	Method of fire
Guns up ready to fire (GURF) report	Fire capabilities report (FIRECAP)
Pre-fire report	Message to observer
Bearing (ships do not lay on an azimuth of fire)	Deflection or azimuth of fire
Summit	Maximum ordinate (MAXORD)
Gunnery liaison officer (GLO)	Fire direction officer (FDO)
No true equivalent; the weapons officer is somewhat analogous	Battery commander
Ship captain (regardless of actual rank)	Battalion commander

Common terms and their equivalent counterpart between the U.S. Navy and U.S. Army. (Rick Paape/Fires Bulletin, courtesy information)

would do well to remember the vast majority of potential adversaries are susceptible to influence from the sea to include, in many cases, NSFS.

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lery officer, he has commanded cannon and rocket artillery at battery and battalion levels to include combat service. He is joint-qualified having served as Fires and Effects Branch chief, Deployable Training Division, Joint Staff J7. Prior to his current assignment, he served as Current Operations Officer III Marine Expeditionary Force, Okinawa Japan/Combined Marine Component Command, Combined Forces Command, Korea.

Integrating offensive and defensive Fires to defeat indirect fire attacks

By Capt. Mary Jocelyn

The aircraft carrier USS Theodore Roosevelt (CVN 71) fires its Phalanx Close-In Weapons System during a live-fire exercise. Theodore Roosevelt is on a deployment to the U.S. 5th and 7th Fleet areas of operation in support of maritime security operations and theater security cooperation efforts. (Mass Communication Specialist 3rd Class Alex Perlman/U.S. Navy)

With warfare evolving into a multi-dimensional battlefield, there is an increased demand for innovation to counter enemies' creative uses of tactics and weaponry. Technology has played a major role in developing offensive weapons cheaply and providing ease-of-access to anyone seeking to use violence as a means to achieve their objectives. Cheap, readily available offensive weapons (i.e., tactical ballistic missiles and rockets, artillery and mortars) are an increasing threat to the force due to adversaries' superior numbers within their stockpiles. To combat this evolving threat of guided and ballistic munitions, the U.S. military and its allies rely heavily on the active air and missile defense weapons systems. However, the over-reliance on active defense limits our ability to provide the most comprehensive defense to friendly forces. Improvements in tactics and Fires integration must be implemented to combat the evolving threat. The only way to effectively defeat an adversary with superior numbers of offensive weapons is through a comprehensive defense of integrated offensive and defensive Fires.

Rear Adm. Edward Cashman, Joint Integrated Air and Missile Defense Organization director, Joint Staff J-8, concepts of comprehensive integrated air and missile defense to combat the growing risk of precision guided munitions through attack operations (offensive Fires), active defense (defensive Fires) and passive defense matches the innovation required to seize, retain and exploit the initiative to gain and maintain the relative advantage.[1] Comprehensive defense solutions can shape the joint force's power projection against regional tactical ballistic missiles and cruise missiles without the need to solely rely on active defense.[2] These defense architectures must be considered when designing defenses against local threats of rockets, artillery and mortars, as the U.S. military and its allies are also faced with the same challenges of finite resources. With the growing demand for counter-rocket, artillery and mortar (C-RAM) system of systems at forward operating areas, commanders must consider the effectiveness of integrated offensive and defensive Fires with passive defense.[3]

Attack operations, preferably left of launch and immediately responsive and

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1   ADRP 3-0, *Unified Land Operations, Headquarters, Department of the Army,* May 2012.

2   *Rear Admiral Cashman, Edward B. A2/AD OPERATIONAL CHALLENGE RESPONSE Integrated Air and Missile Defense: Critical Enabler of Joint Force Power Projection. Joint Staff, J8, Force Structure, Resources & Assessment*

3   *Ibid.*

Spc. Ramiro Ramirez, a field artillery firefinder radar operator with A Battery, 2nd Battalion, 44th Air Defense Artillery Regiment, puts away the Land-Based Phalanx Weapon System's ammo during the battalion's live-fire exercise on Fort Campbell, Ky. (Spc. Alexes Anderson/U.S. Army)

accurate counter Fires, is a critical component of defeating indirect fire (IDF) attacks. In the case of defending key sites from IDF, sufficiency can be achieved by rehearsing and integrating available offensive weapons to utilize data readily available from C-RAM's plentiful high-quality sensors as part of the time sensitive targeting process. Active defenses alone are insufficient and were never designed to provide consummate protection for extended periods. They are intended to provide a short-term limited capability to protect the force and commander's critical assets until offensive force application can be initiated to fix and kill the enemy.

By applying aviation, field artillery and air defense with joint and allied forces, integrated comprehensive defenses will ultimately be achieved. These components of Fires shape the operating environment by denying opportunities for enemies to target friendly forces by aggressively achieving the commander's desired effects.[4] Joint forces must be integrated to exploit the mutually beneficial effects of synchronized offensive and defensive operations to destroy, neutralize or minimize air and mis-

sile threats.[5] Through this integration and the evolution of tactics, the Fires warfighting function is able to provide commanders with a comprehensive defense capability.

The required integration can be provided by air defense artillery's active defense systems and field artillery and aviation's indirect and joint Fires. The Army's defensive Fires weapon systems have evolved to provide commanders capabilities against creative enemies. The U.S. military has matched innovation through the use of the Navy's Phalanx Close-in Weapon System on land to combat the growing indirect fire threat. The Land-based Phalanx Weapon System (LPWS) is a component of the Army's C-RAM system of systems, which is designed to defeat enemy IDF. Sense and warn (S&W), a component of C-RAM, detects incoming IDF and disseminates an audible warning, therefore, protecting friendly forces by enabling personnel to take appropriate cover. The LPWS component of C-RAM destroys or deflects IDF away from the commander's critical assets within the ground defended area.[6] Indirect and joint Fires can deliver timely and precise counter munitions to destroy the ene-

my and deny them opportunity to launch future IDF. Collectively, the elements of the Fires warfighting function, when operating in concert through comprehensive defense, provide commanders a comprehensive capability to defeat IDF.

The synchronization of attack operations, counter-Fires, and active defense serve as a powerful defense and show of force to the enemy. However, they alone cannot be solely relied on to provide a comprehensive defense to the Soldiers, Airmen, Marines and Sailors forward deployed. Passive defense provides the missing link to comprehensive defense. Fortifying fighting positions with site hardening materials (i.e., T-walls and HESCO bastions) and disguising aids such as camouflage nets limit the enemy's ability to target and achieve their desired effects on the friendly forces.

To accomplish the level of readiness required to support the multi-dimensional battlefield, units must implement realistic mission-focused training that challenges Soldiers, organizations and leaders. This training must stimulate innovation and develop the skills required for integration. Key collective training events for units in

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4   ADRP 3-09, *Fires*, Headquarters, Department of the Army, August 2012.
5   JP 3-01, *Countering Air and Missile Threats*, 21 April 2017.
6   FM 3-01.11. *Air Defense Artillery Reference Handbook*. Headquarters, Department of the Army, October 2007.

the Fires community must incorporate attack operations and active defense integration to best prepare its Soldiers and leaders for the complexities of battle.

The 2nd Battalion, 44th Air Defense Artillery, a C-RAM and Avenger battalion, designed a training exercise that challenges its Soldiers to become more innovative and build their integration skills. In November 2017, 2-44th ADA conducted the first C-RAM live-fire exercise at Fort Campbell, Ky., integrating the 101st Airborne (Air Assault) Division Artillery (DIVARTY) 105 mm cannon artillery and the 101st Combat Aviation Brigade Grey Eagle. This Combined Arms Live Fire Exercise (CALFEX) enabled Soldiers in both organizations to conduct their individual weapon systems gunnery, rehearse battle drills and battle information flow and refine integration procedures required for real-time targeting. The exercise defense design and data link architecture consisted of simulations integrated with live hardware to create a comprehensive and realistic threat environment while allowing for live-fire operations. The 2-44th ADA C-RAM assets were operated in both a simulation and live environment while DIVARTY and artillery assets were located within the simulation proportion of the C-RAM defense design, targeting a simulated point of origin (POO) located at a different training area on Fort Campbell. The use of Grey Eagle to confirm targets prior to counter-battery and conduct battle damage assessments was the plan, but due to weather it was not incorporated. After the completion of over 100 counter-fire missions executed during the CALFEX, kill chain execution was refined, increasing the delivery of lethal effects by 85 percent.

During the CALFEX, network sensors from 2-44th ADA and DIVARTY detected hostile IDF, hydra rockets and inert 120 mm mortars. The 2-44th ADA C-RAM command and control (C2) systems would analyze the data and process engagements for IDF threatening the defended assets. Simultaneously, POO data was transmitted to DIVARTY's Air Defense and Airspace Management (ADAM) Cell for distribution via Air and Missile Defense Work Station to the fire direction center (FDC) and Counter Fire Advanced Field Artillery Targeting and Direction System. The FDC was able to queue counter-fire missions, aimed at simulated POO locations within a live-fire target safety box. C-RAM POO data was passed to the ADAM cell by both Rajant radios and

Enhanced Position Location Reporting System (EPLRS) over the Intra-Forward Area Air Defense Network (IFN), proving the ability to integrate C-RAM data into static or maneuver forces. C-RAM engagement operations center Soldiers witnessed active defense and attack operations in concert on their C-RAM C2 system, when IDF was destroyed by the LPWS and counter fire was launched toward the simulated POO near simultaneously. Second-44th ADA and the 101st DIVARTY demonstrated offensive and defensive Fires integration is achievable and effective.

Integrating attack operations and active defense for responsive and synchronized counter fire requires data links and analog battle drills between organizations. During the 2-44th ADA and 101st DIVARTY CALFEX, there were two data links and an analog battle drill that enabled responsive Fires to destroy enemy points of origin. While only cannons were available at the time of the CALFEX, future training must include additional Fires assets from across the joint forces to more closely replicate the deployed operating environments. The event served as a precursor for both units' upcoming deployments in support of Operation Freedom's Sentinel, where 2-44th ADA will be under the operational control, administrative control and direct support to 101st DIVARTY. Together, the organizations will work to shape the battlefield by deterring IDF attacks through the violent

enforcement of respect for U.S. and coalition counter-fire assets.

With the evolution of enemy IDF weaponry and TTPs, commanders must consider innovative techniques and weapon system integration to seize, retain and exploit the initiative to gain and maintain the relative advantage. The 2-44th ADA and 101st DIVARTY CALFEX was the first step toward developing the skills required for comprehensive defense. Future training events must incorporate the aviation, field artillery and air defense artillery to create the most realistic combat environment to mature these capabilities and employment techniques. Elements of comprehensive defense at all echelons must be afforded the opportunity to train collectively in order to remain at the tip of the spear to fight tonight should units be called upon to defend our nation's and coalition partner's Soldiers, Sailors, Marines and Airmen by defeating IDF threats.

Capt. Mary Jocelyn currently serves as 2nd Battalion, 44th Air Defense Artillery, assistant S3, at Fort Campbell, Ky. Her previous assignments include the battalion standardization officer, fire direction center officer in charge, tactical director, and platoon leader at 3rd Battalion, 2nd Air Defense Artillery, Fort Sill, Okla. Her military education includes the Air Defense Artillery Captain's Career Course, Patriot Top Gun and the Air Defense Artillery Basic Officer Leadership Course.

Spc. Alexander Jones, a field artillery firefinder radar operator with A Battery, 2nd Battalion, 44th Air Defense Artillery Regiment, checks the ammo on the Land-Based Phalanx Weapon System. (Spc. Alexes Anderson/U.S. Army)

ADAM/BAE keys to success at National Training Center

By Capt. Abbey Carter

When BCTs create strict firewalls following enemy cyber attacks, cells frequently spend significant periods of time troubleshooting self-inflicted losses of service.

Spc. Brise Gilbert assigned to A Battery, 1st Battalion, 204th Air Defense Artillery Regiment, inspects the horizon while providing perimeter security for the battalion May 30, 2017, at the National Training Center, Fort Irwin, Calif. (Spc. Justin Humphreys/Mississippi National Guard)

I have served at the National Training Center for nearly two years. I first worked as the division air defense officer and now work as a brigade-level observer coach/trainer (OC/T). The leadership in rotational unit air defense airspace management/brigade aviation element (ADAM/BAE) cells often ask my team what they can do to best prepare for NTC. Below are descriptions of common challenges ADAM/BAE cells face at NTC and suggestions for meeting these challenges in an effective manner.

Plan for mission command node transitions

During NTC rotations, most ADAM/BAE cells competently manage airspace and conduct air defense operations from the brigade combat team's (BCT's) main command post, formerly known as the tactical operation center. However, transitions between mission command nodes pose problems for many units. ADAM/BAE cells frequently fail to identify personnel who will conduct operations from the BCT's tactical command post, or TAC, and additionally fail to identify the equipment that these individuals will utilize. When the main command post of an unprepared unit jumps and the TAC "has the fight," air defense and airspace management capabilities are significantly degraded or nonexistent.

Consider the following in developing a plan for TAC operations and mission command node transitions:

- Is the individual slated to lead ADAM/BAE operations at the TAC self-starting, motivated and capable of advocating for cell concerns with the BCT's most senior leadership in a tactically sound, effective manner?
- Will the TAC move with a tactical internet capability that will enable the use of an air picture on a Tactical Airspace Integration System (TAIS) or Air and Missile Defense Workstation (AMDWS) through Joint Range Extension Application Protocol C?
- If not, is the individual at the TAC trained and proficient in analog tracking methodologies?
- Are very high frequency radio nets clearly identified for air defense and airspace management?
- Are VHF radio operations clearly understood and rehearsed?
- Is there a redundant communications plan in place at the TAC that effectively utilizes different backbones? For example, Transverse and Voice Over

Staff Sgt. Christopher Reeves, the team chief for A Battery, 1st Battalion, 204th Air Defense Artillery Regiment, discusses plans with Spc. Brise Gilbert, his fellow gunner for the Avenger Air Defense System, while training at the National Training Center, May 29, 2017, at Fort Irwin, Calif. (Spc. Justin Humphreys/Mississippi National Guard)

Secure IP both use the tactical internet backbone, and should not be used in the same primary alternate contingency emergency plan.

• What is the plan to validate and exercise equipment at the TAC prior to roll-out?

By addressing these concerns, ADAM/BAE leadership can ensure that the BCT's ability to clear air for Fires, disseminate local air defense warnings, and manage rotary wing and unmanned aerial system (UAS) air operations remain seamless as the main command post repositions. Training and Evaluation Outline 71-BDE-5201 addresses mission command node transitions and TAC requirements in great detail.

Educate UAS request procedures, seek buy-in from leadership

Many ADAM/BAE cells struggle with incorrect or incomplete requests for UAS operations from subordinate units. Common shortcomings include incorrect center grids, untrained operators and excessively large operational radiuses requested. Addressing these deficiencies significantly eats into the time of ADAM/BAE operators, causes stress and frustration and additionally decreases the amount of time UAS platforms fly in support of BCT operations. The majority of UAS program managers educate maneuver battalions in appropriate UAS procedures prior to NTC rotations,

and utilize a simple and clear process. However, without continual leadership emphasis, significant deficiencies often remain. ADAM/BAE cell operators need to clearly articulate to subordinate battalions why shortcomings exist in submitted UAS requests and suggest potential corrections. If significant issues persist, the BCT operations officer is uniquely situated to serve as the "hammer" correcting subordinate units that consistently resist improvement. By educating the brigade S-3 in the UAS process prior to an NTC rotation, and reporting shortcomings to him throughout operations, ADAM/BAE cells can avoid the headaches that come with incorrect requests, and increase the brigade's capabilities.

Ensure functionality of ADAM/BAE "big four" prior to rotation

Command and control and datalink systems are vital to an ADAM/BAE cell's ability to maintain situational awareness of air defense threats and manage airspace. Unfortunately, an NTC rotation is often the first time an ADAM/BAE cell fully exercises its assigned equipment upon receiving it from reset or redeployment. Although certain challenges are inevitable, an aggressive 140A can greatly mitigate equipment concerns. Verifying Air Defense Systems Integrator software builds, building back-up hard drives, and signing for an additional TAIS from a sister unit are all steps 140As can take to prevent disruptive equipment outages and to enhance capability at a TAC. 140As should take care to build relationships with the brigade S-6 section, and ensure that BCT network managers fully understand the extent of ADAM/BAE-related services.

When BCTs create strict firewalls following enemy cyber attacks, cells frequently spend significant periods of time troubleshooting self-inflicted losses of service. In the event of equipment failures or shortages, units can plan to use the Dynamic Airspace Collaboration Tool internet browser capability to build airspace requests, and utilize Tacview to receive an air picture on most standard laptops. Unquestionably, rotational units struggle the most with utilizing NTC's radio frequency (RF) Link 16 network. 140As must ensure the functionality of their Multifunctional Information Distribution System (MIDS) radio prior to arrival at NTC. This includes acquiring a MIDS antenna if necessary, obtaining spare MIDS batteries, obtaining appropriate crypto, and verifying systems through successfully entering a local RF network. As NTC replicates a realistic, near-peer threat, redundant information systems become more and more critical to a BCT's success.

OC/Ts, NTC network operations, and the NTC joint interface control officer will extensively assist units struggling to connect to any Link 16 network. However, even the most extensive support cannot compensate for a lack of preparation or planning.

Prepare for air defense planning, operations prior to rotation

All rotational units at NTC train in air defense planning and operations. Units arriving without live Sentinel radar and/or Avenger support are assigned a construc-tive Avenger platoon and/or a constructive Sentinel radar at the BCT level. In the absence of air defense battery or platoon leadership, the brigade air defense officer (ADO) conducts all planning related to the employment of air defense assets. NTC is not a "closed book" test. ADOs can and should use the time prior to an NTC rotation to become comfortable with the defense design planning capabilities of the AMDWS. In particular, using Digital Terrain Elevation Data (DTED) maps enables a planner to determine ideal emplacement positions for Sentinel radars and Avengers. Units should contact NTC with any concerns regarding obtaining appropriate DTEDs.

Emplacement concerns are not the only aspect of air defense planning ADOs should address prior to NTC. The most successful units at NTC educate subordinate battalion commanders regarding Avenger capabilities and limitations, retain operational control (OPCON) of air defense assets at the brigade level, and extensively coach combined arms for air defense. Retaining OPCON of air defense assets at the brigade level ensures that weapons systems are emplaced on the battlefield to effectively defend identified assets on the brigade's defended asset list. Air defense planners consider employment guidelines such as early engagement and defense in depth when emplacing weapons systems. This enables multiple air defense engagements of a hostile air threat before it has negatively affected defended assets.

When maneuver battalions without a thorough understanding of these guidelines are granted OPCON of air defense weapons systems, there is a tendency to emplace the systems directly on top of friendly formations as a kind of protective "woobie." The emplacement of air defense systems directly on top of friendly forces limits engagements of hostile threats to "revenge shots" following the release of enemy ordnance or completion of other hostile effects. Rather than delegating command support relationships, units should integrate maneuver battalions into air defense operations through continually emphasizing combined arms for air defense.

Maneuver direct fire capabilities can significantly bridge gaps in air defense system coverage. Correct employment of passive air defense measures such as camouflage, glare elimination and dispersion significantly reduces a unit's susceptibility to at-tack by enemy air or artillery. Army Techniques Publication 3-01.8, "Techniques for Combined Arms for Air Defense," addresses these concepts in detail.

Design, implement an effective cell battle rhythm

Even the most tactically proficient cells cannot operate for extended periods of time without an effective battle rhythm. To quote the current commander of Operations Group, NTC is designed to exhaust individual Soldiers and teams alike so that "the hardest day they face will be in the desert."

By Training Day 3, OC/Ts can readily identify teams that have implemented effective work/rest cycles, and teams that have not. In building a battle rhythm, cells should identify planning meetings and key military decision-making process events that require leadership attendance. Strong officer and noncommissioned officer leadership and continual assessment of battle rhythm events is necessary throughout the entire course of a rotation. Units can build on the experiences and lessons of past field exercises in determining an initial battle rhythm for an NTC rotation.

The aforementioned recommendations are not intended to dictate any one approved solution to a tactical problem, but rather to identify aspects of ADAM/BAE cell operations that require thorough forethought and planning. Although NTC rotations are difficult, they should not be feared or dreaded. All members of Operations Group are fully committed to helping every unit learn and grow. OC/Ts and staff members will do everything in their power to aid units in this process. The only goal is for units to leave NTC better trained and prepared for combat operations than prior to rotation.

If you will be a member of an ADAM/BAE cell in an upcoming NTC rotation, don't hesitate to reach out to the Operations Group ADAM/BAE OC/T team with concerns or questions.

Capt. Abbey Carter is an air defense airspace management/brigade aviation element cell observer/coach trainer at the National Training Center. Her previous assignments include C Battery, 3rd Battalion, 43rd Air Defense Artillery commander; 3-43rd ADA assistant S-3; and 1st Battalion, 1st Air Defense Artillery tactical director. She is a graduate of the Joint Firepower Course, the ADAM/BAE Cell Air-Ground Integration Course, and the Air Defense Artillery Fire Control Operations.

A way to execute the brigade targeting process

By Lt. Col. Jonathan Shine

Soldiers assigned to A Company, 3rd Battalion, 29th Field Artillery Regiment, fire an M109A6 Paladin at enemy targets at the National Training Center, Fort Irwin, Calif. (Sgt. Richard W. Jones Jr.,/U.S. Army)

Every brigade combat team (BCT) arrives at the National Training Center with a plan to execute targeting and a battle rhythm of working groups and decision boards developed at home station. More often than not, however, BCTs conduct a process that is not valuable enough to survive the time constrained environment of an NTC rotation. The result is a lack of synchronization at the brigade level and very limited effects on the enemy prior to direct fire engagement with the BCT's main body. When executed effectively, targeting at the tactical level has the potential to focus the entire staff on the brigade's fight (as distinct from maneuvering companies and combined arms battalions onto their objectives) and to truly synchronize brigade and echelon above brigade (EAB) level assets to shape the enemy outside of direct fire range of maneuver elements.

Why it does not work: Starts with targeting working group

BCT targeting processes fail at the NTC for a combination of factors. Typically the first cycle is executed during reception, staging, onward movement and integration. The targeting working group (TWG) is led by the BCT targeting officer (TARGO) and attended by one or two of the critical members of the staff (BCT executive officer, operations officer, intelligence officer, fire support coordinator, fire support officer, air liaison officer and electronic warfare officer) plus junior representatives of the various staff and special staff sections. The TARGO presents a series of slides describing the air tasking order cycles and what they intend to request for close air support. This is followed by a description by the S2 (intelligence) representative of the enemy's general scheme of maneuver. In better units this is done over a map with the situational template or SITTEMP posted, but this is not common early in the rotation. Then the information collection manager (ICM) describes what EAB assets have or will be requested for the next day. The team then engages in discussion of which elements of the enemy order of battle should have which priority. At the end of the hour, the senior officer makes a decision on what the draft high payoff target list (HPTL) will be for presentation to the BCT commander in a deskside discussion later in the day. The targeting team then return to their sections in the main command post.

Following this meeting, the TARGO begins to produce a combined HPTL-target selection standards-attack guidance matrix (TSS-AGM) as an appendix to the operational order. No one in the headquarters refers to this product in execution and few members of the current operations (CUOPS) team understand how to utilize this tool. This combined product may be useful at EAB levels, but for the tactical level these four items need to be broken apart as stand-alone tools for common staff understanding. The ICM submits requests for collection for the same assets he or she was going to request prior to the meeting. The TARGO creates a DD Form 1972 to request close air support (CAS) to come on-station for as long as possible and "shape operations for the brigade at decisive points" by destroying anything the pilot can find between the coordinated fire line and fire support coordination line. This request is later denied by higher for lack of specificity. The fire support officer (FSO) huddles with the S3 to better understand the details of the close fight and begins to plan and rehearse priority targets to support it. If any high payoff targets (HPTs) are identified during the day, Fires are slow to respond as they are unprepared for the trigger and the CUOPS team struggles to dynamically clear ground and airspace.

The following day (or the day after), no senior members of the BCT staff are present for the meeting. They have made the very reasonable decision that their limited time is more valuably spent elsewhere. The targeting process has collapsed on itself because it has failed to provide any value. The only output is a well-discussed HPTL that is really just a re-writing of the enemy order of battle in order of importance to the BCT. Nothing about the BCT's plan has been changed and no assets have been allocated (or re-allocated) as a result of the meeting. No information has been generated either to focus BCT and EAB enablers or to analyze and communicate information to the commander to help him make decisions in the fight. By the end of Phase I, the TARGO has grown increas-
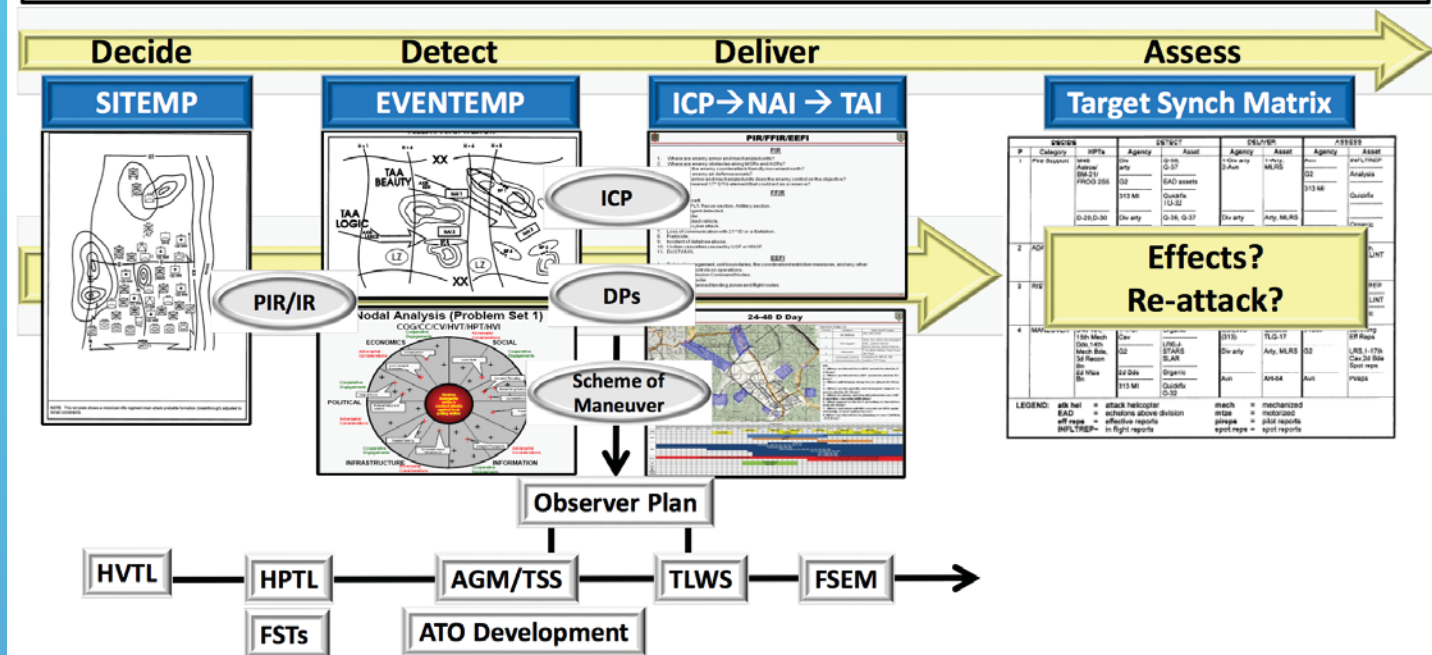
Figure 1. Targeting and applying the decide, detect, delivery and assess methodology. (Courtesy illustration)

ingly frustrated that no one will attend the meeting and eventually develops the HPTL-TSS-AGM-targeting support matrix and DD 1972s on their own; the BCT's targeting cycle is no more.

A way – D3A

There are several different targeting methodologies current in joint and Army doctrine, but for the tactical level fight the simplest and most effective remains decide, detect, deliver and assess (D3A). If the brigade staff can develop a disciplined staff process to deliberately and efficiently perform each step, D3A has significant potential to truly focus assets, shape the fight (beyond direct fire range of the maneuver battalions), and generate options for the BCT commander.

The targeting working group cannot be effectively run on slides. Soldiers brief on PowerPoint, but targeting is conducted on a 1:50,000 map, with notes captured on a white board. The TWG is a working group, not a briefing. Because of their expertise and span of control, the fire support coordinator (FSCOORD) chairs the TWG, the TARGO facilitates, and the BCT S3 and/or executive officer, the S2, FSO and the information collection manager (ICM) all participate, along with the air liaison officer, brigade aviation officer, electronic warfare officer, brigade staff judge advocate and the cyber electromagnetic activities chief. They come not because the meeting is on the battle rhythm, but because it is a proven process for increasing shared understanding and synchronizing assets. It is worth their time.

The TWG begins with a discussion of the proposed HPTL, but this is not truly very complex and does not require more than 10 minutes of discussion. The HPTL identifies three-to-eight specific enemy formations or systems whose loss to the enemy will significantly contribute to the success of the friendly course of action. HPTs must be acquired and successfully attacked for the success of the friendly commander's mission (Joint Publication 1-02). These are then listed on the white board.

The decide step is now complete. In draft form, decide is the BCT commander's responsibility. The balance of the TWG is spent addressing each of the HPTs in turn to define who, when, where and how the staff will "contribute to the success of the friendly course of action."

The detect step is the BCT S3 responsibility. Unlike the S2, the BCT S3 uniquely has the authority to task all BCT assets and the responsibility to ensure they are synchronized to accomplish the commander's end state. For each HPT, the group determines a primary and alternate asset that will be tasked to detect it. The first question should always be, "Why can't our organic, ground-based scouts detect it?" If they can, the S3 tasks them. The next question is, "What other organic assets can detect it?" Only when the staff determines they cannot detect HPT's should the ICM begin to request EAB assets to fill gaps in coverage. The discussion in the TWG helps to determine specifically when and where detection assets are required, based on the enemy situation template and event template.

Deliver is the FSCOORD's responsibility. Like the detect phase, the team identifies a primary and alternate delivery asset to strike each HPT as it is detected. If the answer is CAS, the TWG analyzes the detection plan, and then has enough de-

DECIDE (BCT CDR)	DECTECT (BCT S3)	DELIVER (FSCOORD)	ASSESS (BCT S2)
BCT EXMAT / SYNCMAT / EXCHECK, DSM/DST			
HPTL	**IC SYNCH MATRIX, ANNEX L**	**FIRE SUPPORT EXECUTION MATRIX**	**IC SYNCH MATRIX**
① **SA-8 (ADA)**	<u>P</u>: A/X-X CAV observing 1 NAI from 0600-100. IPRTO NLT 0600.	<u>P</u>: B/X-XX FA (HIMARS). IPRTF at 0600. Airspace pre-cleared 0600-1000 from PAA 10 to TAI 1. 6x M26A2.	<u>P</u>: A/X-X CAV observing NAI 1.
	<u>A</u>: EAB ELINT collecting vic NAI 1. Request on station 0700-0900	<u>A</u>: C/X-X (M109A6) IPRTF in PAA 20 at 0600. BTRY ⑥ DPICM.	<u>A</u>: Shadow 1 IPRTO in ACA GREEN from 0800-1200.
② **2S19 (FS)**	<u>P</u>: EAB GMT1 vic NAI 2 from 0200-0500.	<u>P</u>: CAS on station 0230-0430 vic TAIs 1, 2, 3, 4.	<u>P</u>: CAS on station 0230-0430 vic TAIs 1, 2, 3, 4.
	<u>A</u>: Q37 IPRTO at NV123456 NLT 0001. CFFZ 1 established over TAI 2.	<u>A</u>: A/X-XX FA (HIMARS) IPRTF at 0001 in PAA 30. Airspace pre-cleared from 2230-0530 from PAA 30 to TAI 2. 3x M26A2.	<u>A</u>: Shadow 2 IPRTO in ACA BLUE from 0400-0900.
③ **LP/OP (RSTA)**	<u>P</u>: X-X CAV observing NAIs 10,11, 12 from 0001-1200. IPRTO NLT 2300.	<u>P</u>: A/X-X FA (M109A6) IPRTF in PAA 30 at 2300. BTRY ⑥ HE/VT.	<u>P</u>: X-X CAV.
	<u>A</u>: EAB SIGINT Collecting vic NAIs 10, 11, 12. Requested from 0600-1000.	<u>A</u>: FM Jamming vic TAIs 10, 11, 12. Requested from 1000-1400.	<u>A</u>: A/X-XX CAV (AH-64) on station in ACA 3 from 0930-1130.

Figure 2. Decide detect deliver and assess. (Courtesy illustration)

tail for the DD Form 1972 to get the CAS request approved. Whether the delivery asset is artillery, CAS, aviation, electronic warfare or some other asset, the staff knows what to strike, when and where to find it (the trigger), and what effect to achieve. Individual sections then complete detailed planning required by their specific warfighting function. For example, the fire support element coordinates with the BAE and field artillery battalion to pre-clear airspace to enable responsive Fires.

The desired effect leads to the assess step, which is the BCT S2's responsibility. By definition, the destruction of an HPT is important to the commander's plan. Assessment implies reporting if, and when we are successful, which supports a decision from the commander (ie. We have destroyed 80 percent of the enemy's air defense assets. Commit the aviation exploitation force). If not, the target should be removed from the HPTL. As with previous phases, in this step the staff adds as much specificity as possible to synchronize.

The outputs of the TWG are the HPTL, information collection synchronization matrix and target synchronization matrix. Based on the TWG, during the military decision making process (MDMP) the staff can further (and more efficiently) develop the decision support template or matrix, fire support execution matrix, attack guidance matrix (AGM), target selection standards (TSS), and airspace coordination order. All of which will be combined into the BCT's execution matrix/checklist (EXMAT,

EXCHECK, SYNCMAT, etc., whatever the brigade uses to synchronize the fight) for the CUOPS staff to fight from.

Targeting, MDMP

One reason the targeting process collapses is that it contrasts with or duplicates staff work accomplished during the MDMP. To be effective, the two processes have to complement each other and should result in greater efficiency and better synchronization. The high value target list, TSS and AGM are tools that should be developed during the initial steps of the MDMP (specifically intelligence preparation of the battlefield and mission analysis). These products decrease extemporaneous discussion in the TWG. During the MDMP the commander and staff make the rules for how the BCT will operate. The staff follows those rules to get to the specifics of the situation during targeting. In the TWG, the BCT S2 has to identify the HVTs from the list that will affect operations or that can be removed from the battlefield during the identified timeline (24/48/72 hours). These items become the HPTL. The course of action decision brief is where the MDMP and the targeting process come together. This not only creates efficiency amongst the staff but also synchronizes the brigade plan (deep and close).

Target decision board

As the staff completes the various additional work from the TWG, the TARGO prepares the target decision board (TDB) for the BCT commander only if there is a decision to be made. In many cases, all necessary decisions will have been made during the MDMP. If a TDB is required, slides and charts are often effective, because this event is a decision briefing not a working group. There is better staff understanding and less duplication of work effort if provided over a map with all overlays utilized during the BCT planning process. The TDB reviews the results of the TWG and gains approval for the plan the staff has developed for the deep fight. The commander approves the HPTL and the concept for targeting each HPT, including asset allocation or provides additional guidance to refine the plan.

A disciplined and efficient targeting process has the potential to complement the MDMP, to better synchronize the staff, and especially the allocation of EAB resources to shape the battle as envisioned and described by the commander. This will only happen if targeting produces more than a cluttered HPTL and generic requests for Air Force support. Effective targeting requires ownership by the FSCOORD, BCT S3 and BCT S2 of their portion of the D3A methodology (and the BCT XO if he or she is responsible for the deep fight). Done right, targeting supports commander's decisions in the fight with well-planned and synchronized assets that provide maximum flexibility and options to react to and overwhelm the enemy.

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U.S. artillery on the Korean Peninsula then and now

Incorporating past lessons to posture future operations

By Capt. Joseph Schmid and Capt. Adam Wilson

> **"Due to recent challenges to U.S. security objectives in the Asia-Pacific Domain our [Pacific Command] Fires community must reach back and incorporate lessons learned during the Korean War in order to posture for the resumption of conflict on the Korean Peninsula."**
>
> -Col. Matthew N. Stader, 25th Division Artillery commander

Part I

Upon the conclusion of World War II, the Korean Peninsula has served as a physical and ideological battle ground between two drastically opposed systems of government that have both sought to assert influence throughout the Asia-Pacific domain.

Communism, today in the form of an increasingly disruptive China, has successfully propped up the North Korean regime enabling its nuclear and ballistic missile programs to challenge United States security objectives while creating massive regional instability.

Nicholas Eberstadt, a political economic specialist at the American Enterprise Institute, said in 2014 alone, China accounted for two-thirds of all North Korean exports valued at 2.6 billion dollars and almost as much of North Korean imports valued at 3.9 billion dollars.[1] The United States, a democratically led nation and the region's historically dominant security leader, currently has on or about 28,000 Soldiers, Marines, Sailors and Airmen stationed in South Korea. These men and women work closely with the Republic of Korea military during annual command post exercises and field training exercises such as Operation Ulchi Freedom Guardian, Warfighter, Operation Foal Eagle and Operation Key Resolve. Both the United States and South Korea profess all military drills are defensive in nature, a statement summarily rejected by North Korea who views all U.S./South Korean drills as aggressive invasion plans.

Recent events involving North Korea, South Korea, Japan, China and the United States as well as combative rhetoric from both North Korean and U.S. senior political leaders portray a sharp increase in the likelihood of military conflict on the peninsula. In 2017, North Korea, under Kim Jong Un's leadership, fired no less than 14 ballistic missiles. Of note, one of those was an intercontinental ballistic missile (ICBM) fired July 28, 2017, which traveled 45 minutes entering Japan's Exclusive Economic Sea Zone. A KN-17 Intermediate Range Missile flew over the Japanese mainland Aug. 28, 2017, sparking the country's emergency alert system. And finally, an unidentified missile entered Japanese airspace Sept. 14, 2017. Partially in response to increasingly aggressive North Korean missile tests, South Korea has allowed the U.S. to install a Terminal High Altitude Air Defense system. This has drawn sharp criticism from both China and North Korea. As we write this article, in a show of strength, the U.S. Navy has stationed three aircraft carriers in the western Pacific for the first time in the last decade. Tensions have exponentially increased with seemingly no diplomatic solution in sight.

In the following pages we'll outline why the U.S. is unable to extract itself from an Asia-Pacific Thucydides trap suggesting imminent conflict on the Korean Peninsula.

Consequently, we'll reinforce why U.S. Pacific Command Fires units must be able to fight and win tonight in the event of a military conflict with North Korea and possibly China. Relying heavily on "This Kind of War: The Classic Military History of the Korean War," a book Defense Secretary James Mattis recently urged "We all pull out and read … one more time," we'll seek out historical artillery challenges from America's first experience with limited warfare on the peninsula. Upon isolating those challenges faced by Redlegs during the Korean War, we'll then transition into how we can incorporate new technologies and concepts to posture for what we may face on the peninsula. However, prior to achieving this understanding, we will begin first with why our artillery's next challenge resides within the Korean Peninsula.

The Thucydides trap idea originated from the ancient Greek Thucydides himself who, in reference to the Peloponnesian War stated "What made war inevitable was the growth of Athenian power and the fear which this caused in Sparta."[2] Increasingly assertive Athenian political and economic interests projected across Greek city-states by the peerless Athenian Navy, inevitably clashing with historical Spartan regional dominance. Thus, the Peloponnesian War was the result of Sparta attempting to curtail a growing Athenian threat to traditional Spartan dominance over ancient Greece. The Thucydides trap concept portrays an established state reacting violently to halt the growth of a strengthening state who seeks to no longer be considered a near-peer. Graham T. Ellison, an American political scientist, first coined the phrase "Thucydides trap," while applying it to

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1   *U.S. News: Pyongang's China Connection, Michael Schuman, Sept. 19, 2017.*
2   *The History of the Peloponnesian War, Thucydides, 431 B.C., translated by Richard Crawley.*

U.S.-Asian security relations in the Pacific. Its common theme depicts the established U.S. Pacific bilateral security alliance system consisting of Australia, Japan, Republic of Korea, Philippines and Thailand being challenged by two nations: a near-peer China who has enjoyed explosive economic growth enabling it to project an expanding political, economic and military dominance throughout the Asia-Pacific and a North Korean rogue state who continues to develop its nuclear weapon and ICBM programs in the face of widespread world condemnation. Today, influential U.S. figures warn against the negative implications of a resurgent China and North Korea able to counter U.S. security objectives within the Asia-Pacific domain. Adm. Harry B. Harris, PACOM commander, appeared before the House Armed Services Committee April 26, 2017, and said, "China has fundamentally altered the physical and political landscape in the South China Sea through large-scale land reclamation and by militarizing these reclaimed features. Beijing continues to press Japan in the East China Sea, is stepping up diplomatic and economic pressure against Taiwan, and is methodically trying to supplant U.S. influence with our friends and allies in the region.

Furthermore, China is rapidly building a modern, capable military that appears to far exceed its stated defensive purpose or potential regional needs. China's military modernization is focused on defeating the U.S. in Asia by countering U.S. asymmetric advantages. China's military modernization cannot be understated, especially when we consider the Communist regime's lack of transparency and apparent strategy… China's near-term strategy is focused on building up combat power and positional advantage to be able to restrict freedom of navigation and overflight while asserting de facto sovereignty over disputed maritime features and spaces in the region."[3]

China has expanded its formidable military footprint within the Asia-Pacific domain causing justified unease amongst senior military figures. However, in today's complex world it's very difficult for a country's military to unilaterally change the global U.S.-dominated security hierarchy without a powerful national economy capable of sustaining a lasting political influence.

Numerous economic experts note how China's expanding economic influence empowers the country to further its political objectives within the Asia-Pacific. China's newly minted Asian Infrastructure Investment Bank and One Belt One Road policy are soft-power challenges to the West's Bretton Woods institutions, namely the International Monetary Fund and the World Bank. These new Chinese institutions have the potential to erode American security agreements as historical U.S. Asia-Pacific partners fall under the sway of Chinese economic influence. Along similar lines, China's robust economy directly translates into a more aggressive military stance in the Asia-Pacific. Upon realizing their economic might, People's Liberation Army commanders have found their government can "back their statements with timely displays of military firepower."[4] This instance mirrors how Athenian economic might fueled their ability to project power through the Aegon via its vast naval fleet. Today, China has leveraged its economy to develop a military capable of mounting an increasingly sophisticated response toward any foreign incursion into its perceived domain.

This Chinese posture is what makes the preemptive U.S. military invasion of North Korea so dangerous. North Korea's continued development of nuclear ICBM's is the lynchpin of the Asia-Pacific Thucydides trap. During a time of unprecedented simmering tension between the U.S. and North Korea, both countries are poised to re-enter into a war which technically never ended on the 38th parallel. During Mattis' recent trip to the Korean Demilitarized Zone he pointedly stated "I cannot imagine a condition under which the U.S. would accept North Korea as a nuclear power."

The U.S. would enter on the premise of disarming a rogue nation of its nuclear ICBM's. China, seeing a foreign power aggressively operating in its domain, would enter the war, similar to why it did in 1950, aiming to halt U.S. and ROK forces from unifying Korea, thus establishing a pro U.S. democracy on its border. The continuation of the Korean War could act as the catalyst for the world's two largest economies to enter into conflict on opposing sides. Consequently, the Asia-Pacific Thucydides trap would be sprung. In light of this potential occurrence, we will now pivot toward historical analysis of the Korean War in order to glean how our artillery of the past fared against North Korean and Chinese tactics within a mountainous peninsula during the Korean War.

The Korean War is commonly split into four distinct phases. Phase I was the initial invasion of South Korea by North Korea resulting in allied forces retrograding to a small foothold on the southeastern edge of the peninsula termed the "Pusan Perimeter." Phase II consisted of reinforced allied troops regaining the initiative as they broke out of the Pusan Perimeter decisively destroying North Korean forces and pushing them near the Yalu River along North Korea's northern border. China, recognizing the dangers of a united Korean Peninsula, entered the war beginning Phase III with brilliant deception tactics catching General of the Army Douglas MacArthur by surprise, pushing allied forces south of the 38th parallel. Phase IV introduced a stalemate between a numerically superior Chinese force, remnants of North Korean Army

Figure 1. Economic comparison between the United States and China. (Courtesy illustration)
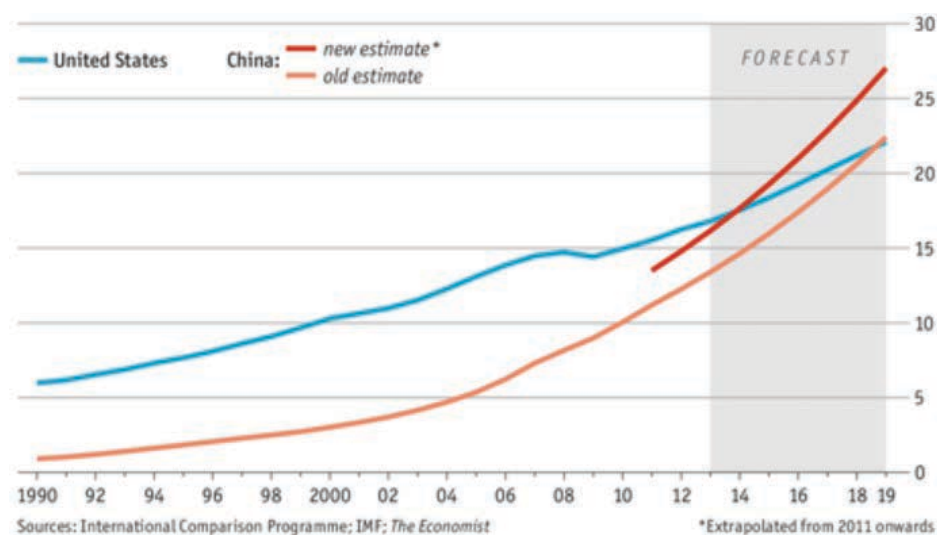
3   *Statement of Admiral Harry B. Harris, Jr., U.S. Navy Commander, U.S. Pacific Command before the House Armed Services Committee on U.S. Pacific Command Posture, Adm. Harry B. Harris, Jr.*
4   *Asia's Reckoning: China, Japan, and the Fate of U.S. Power in the Pacific Century, Richard McGregor, Viking Publishing, 2017, pg. 238.*

units, and fatigued allied troops around the 38th parallel resulting in the Armistice being signed on July 23, 1953.

During all four phases one factor continued to play a lasting role in America's inability to apply continuous combat power: that of mountainous terrain. The Korean Peninsula consists of roughly 70 percent mountainous terrain which immediately places wheeled, tracked and an offensive-minded brigade combat team at a disadvantage. Korean War experiences of the past show an American Army woefully unprepared for operating within this environment.

Sgt. James Daly, a forward observer for the 10th Field Artillery Battalion from 1950-51, recounted, "I remember the admonition 'lock your knees' as [I] trudged up a seemingly vertical mountain looking for a top I don't remember ever reaching … the hills in Japan were only mole hills compared to Korea."[5]

Soldiers and Marines like Daly were unaccustomed to the rigors of physically navigating the terrain. This sentiment is captured further in a monogragh published by Eighth Army Headquarters during the Korean War. The Eighth Army Headquarters found, "Troops arriving in Korea after performing administrative or caretaker duties in Japan were not physically prepared for the rugged terrain of Korea. The strenuous climbing required and the need to hand carry equipment, supplies, individual and crew-served weapons long distances over mountain trails demanded a high degree of physical fitness."[6]

During the war's first phase, the chaotic retrograde to Pusan, seasoned company and field grade leaders, who had previously served during World War II in the more unrestricted terrain of Western Europe, did not fully comprehend the vulnerabilities sharp peaks, long ridgelines and low valleys created for troops on the move. This fault is shown repeatedly during the onset of the Korean War.

T. R. Fehrenbach, an Army officer during the Korean War, said "Again and again, officers were simply not able to organize against the enfilading hills to clear the way. It wasn't that the men were afraid, they were simply unable to walk up the hills to engage the North Koreans."[7]

Today's artillery consisting of towed and self-propelled cannons as well as wheeled and tracked launchers will be limited to a small selection of improved and unimproved roads, making whoever is traversing them vulnerable to enemy fire from adjacent ridgelines. This vulnerability is best depicted by Fehrenbach's description of 2nd Division's catastrophic march through the six-mile long "Valley of Death." Following the advent of Chinese forces the 2nd Division commander, Maj. Gen. Laurence Keiser, recognizing the need to extricate his division from a Chinese envelopment, decided to retrograde south via the north-south running road between Kunu-ri and Sunch'on. The division's priority of movement was as follows: (1) 38th Infantry Regiment (2) 2nd Recon Company, Division Headquarters, Military Police Company, 2nd Signal Company, (3) Division Artillery (4) 2nd Engineer Battalion (5) 23rd Regimental Combat Team consisting of 23rd Infantry, 15th Field Artillery Battalion, and 72nd Tank Battalion. Reportedly tens of thousands of Chinese leveraged the high ridgelines paralleling the 2nd Division's route to enable a continuous linear ambush.

"The 2nd Division Artillery … was the last element of the division to come through the gauntlet on the south ... The first artillery battalions in the column came through best. The 17th leading, came out in good shape. The 37th following, lost ten guns. The 503rd fought most of the night to save its 155's, finally losing them. The 38th FA, at the end of the column, lost every gun and truck, and its men came out as stragglers over the hills, if they came out at all… the guns were undeniably lost," said Fehrenbach.[8]

During the march into "Death Valley," leaders had marginalized mountainous terrain resulting in a tactical catastrophe reducing nearly an entire division's worth of combat power. Seasoned Chinese leaders of a historically dismounted Army, recognized the capability gap in an enemy reliant on wheeled and tracked vehicles. This recognition enabled Chinese forces to seize decisive terrain and inflict massive casualties upon a retrograding foe. Along with restricting our battery's mobility, mountainous terrain constrains our firing point selection making the occupation force more vulnerable to counter fire.

With only 15 percent of the Korean Peninsula being categorized as lowlands, adequate battery firing points during the Korean War were scarce when compared to the large swaths of Western European grasslands available during World War II. Due to mountainous terrain, those positions that did exist were difficult to mass primarily because firing points were separated by multiple sets of valleys and ridgelines.

Furthermore, Capt. Ronald K. Kylel, Jr., an Ohio State post-graduate student who studied artillery performance within the Korean War, found mountainous terrain forced "units to position the guns closer to each other than desired to make room in a given area for the entire unit. These close formations made the unit more vulnerable to counter-battery fire."[9] Thus, in hindsight, mountainous terrain did present a challenge for America's artillery formations during the Korean War. However this is a challenge that remains to this day constant and unchanging. We as an artillery community can acknowledge, plan for, and train for the constraints mountainous terrain imposes on how we provide support to our maneuver brethren. This point proven, we'll now shift focus to how U.S. artillery responded to fluid North Korean and Chinese infantry tactics.

Perhaps the most defining aspect of North Korean and Chinese offensive tactics is what makes it so different from how the U.S. seeks to apply offensive combat power. Whereas U.S. offensive doctrine dictates a more straightforward approach; often fixing an enemy and then overwhelming him with a fast-moving flanking force. Chinese and North Korean infantry tactics during the Korean War championed flowing around and behind an opposing force in order to cut off lines of supply and envelope a semi-independent adversary. During Phases I and III of the Korean War, North Korea and China used this envelopment tactic to infiltrate thinly held United Nations forward line of troops (FLOT) with catastrophic results for U.S. Artillery. The Eighth Army Headquarters stated during 1952:

"Infiltration was a major enemy tactic and the constant threat to rear area units from guerrillas made it necessary for all units to be thoroughly trained in the use of

5   *Fire for Effect!: Artillery Forward Observers in Korea, Anthony J. Sobieski, AuthorHouse, Aug. 25, 2005, pg. 64.*

6   *Special Problems in the Korean Conflict, Eighth U.S. Army Korea, U.S. Army History Research Collection, Sept. 24, 1952, pg. 55.*

7   *This Kind of War: The Classic Military History of the Korean War, T. R. Fehrenbach, Open Road, March 1963, pg. 128.*

8   *Ibid.*

9   *Killer of Communists, Saver of Soldiers: U.S. Army Field Artillery in the Korean War, Ronald K. Kylel, Jr., The Ohio State University, 1995, pg. 4.*

arms … Artillery battalions were directed to train against enemy ground attack."[10]

The threat of infiltration tactics observed by Eighth Army Headquarters is brought to life repeatedly by Fehrenbach. He recounted one such instance that occurred during the 63rd Field Artillery Battalion's defense of the Kum River, "The NKPA [North Korean People's Army] regiment that had crossed the Kum hadn't wanted Joe Hicks and Company - their scouts had filtered to the American rear and located a far richer target, the 63rd Field [Artillery]… Mortar shells crashed into the Headquarters Battery area … Headquarters Battery disintegrated into chaos, with men running in all directions. Machine guns flayed them … A Battery, only 250 yards away [due to restrictive terrain no doubt] drew fire at the same time … Four hundred enemy infantry surrounded the B Battery Area … The 63rd Field [Artillery] had now lost all 10 guns and 80 vehicles. The five howitzers from A [Battery] had been abandoned intact. Many men were missing."[11]

North Korea's and China's ability to leverage terrain American forces considered non-trafficable resulted in thousands of successful infiltration raids and envelopments such as the one described above. Opposing forces sought to cut supply lines and destroy support formations. This tactic degraded U.S. frontline infantry and armor units' ability to close with and destroy a numerically superior adversary. Therefore, oftentimes battalions of maneuver formations and batteries of field artillery formations fought independent battles void of support from adjacent units. According to D. M. Giangreco, an acclaimed security speaker, author and 20-year veteran editor of Military Review, "The first nine months of the Korean War saw U.S. Army field artillery units destroy or abandon their own guns on nearly a dozen occasions. North Korean and Chinese forces infiltrated thinly held American lines to ambush units on the move or assault battery positions on the flanks or rear with, all too often, disastrous results."[12]

Consequently, if we, as an artillery community, wish to retain combat power while locked in conflict involving infiltration and envelopment tactics, we must harden battery defensive perimeters. Having ex-amined both terrain and infiltration tactics during the Korean War, we'll shift focus to the third and final challenge undergone by U.S. Artillery: that of artillery's available supply rate (ASR).

During the first three phases of the Korean War under Gen. Douglas MacArthur and Gen. Matthew Ridgway, a strict ASR was adhered to for two reasons. First, batteries found themselves acting semi-independently without support from adjacent firing units due to mountainous terrain, the sheer length of the FLOT assigned to them, and the relatively low number of field artillery units available. To counter the effects of firing semi-independently, a single battery would rapidly fire large amounts of ammunition at a single target. This resulted in acutely felt ammunition shortages during the opening phases of the Korean War, as well as smaller ASRs. The second reason for strict ASRs during the Korean War rests with strategic planners. They held a large majority of WWII artillery ammunition in reserve for a possible conflict in Europe against who they perceived to be the real enemy, the Soviet Union.

When rounds per tube per day are compared for the first and fourth phases of the war, there is a correlation to how U.S. forces fared against their adversaries. In September 1950, three months into the war, Lt. Col. Leroy Zimmerman, stated "Eighth Army was still rationing ammunition [resulting in] 50 rounds per tube per day."

He goes on to state during this time, "Gross ammunition shortages were experienced … Combat units had permanently stationed personnel at the ammunition supply point to spot ammunition needed."[13]

Maneuver units unable to stop advancing enemy formations stemmed from guns unable to provide shaping Fires which in turn stemmed from little to no ammunition per tube in support. A large factor contributing to our inability to halt the initial North Korean invasion rests with the lack of ammunition available to artillery units.

Now we'll fast forward to the final phase of the war during the Chinese attempt to seize Seoul with the First Step, Fifth Phase Offensive. Lt. Gen. Van Fleet, the new Eighth Army commander, recognized he was severely outnumbered by a vastly larger Chinese force. He leveraged "air attacks, naval and artillery indirect Fires to inflict approximately 75,000 to 80,000 enemy killed or wounded."[14] During his repulse of the First Step, Fifth Offensive Fleet authorized an astounding rate of fire for U.S. artillery. They fired 105 mm and 155 mm howitzers with 300 and 250 rounds respectively, successfully balancing the superior Chinese attacking force ratios.[15] When we compare these robust rates of fire with those during the first months of the Korean War we see the importance of readying large amounts of ammunition in order to halt a numerically superior force.

Perhaps no other vignette illustrates the power of the artillery's ability to forcibly assert the will of the American military than the massive barrage of 105 mm, 155 mm, and 8-inch projectiles used to secure Porkchop Hill. Fehrenbach said in relation to Porkchop Hill, "The United States Army had expended more than 130,000 rounds of artillery ammunition within 24 hours,"

10   Special Problems in the Korea Conflict, Eighth U.S. Army Korea, U.S. Army History Research Collection, Sept. 24, 1952, pg. 58.
11   This Kind of War: The Classic Military History of the Korean War, T. R. Fehrenbach, OpenRoad, March 1963, pg. 558.
12   Artillery in Korea: Massing Fires and Reinventing the Wheel, D. M. Giangreco, United States Army Command and General Staff College.
13   Korean War Logistics Eighth United States Army, Lt. Col. Leroy Zimmerman, FA, U.S. Army War College, May 9, 1986.
14   Steel for Bodies: Ammunition Readiness During the Korean War, Maj. Peter J. Lane, U.S. Army Command and General Staff College, 2003 pg. 31.
15   Ibid.

resulting in its denial to Chinese forces.[16] During the later phases of the war, the American supply system in close coordination with operational planners were able to stockpile vast amounts of ammunition making artillery barrages possible. Fleet exploited his artillery to the fullest extent by realizing the amount of artillery ammunition available to his battalions directly correlated with the success of operations.

Part II

In light of the three Korean War artillery challenges we've highlighted above, we'll now examine how the Fires community can rapidly evolve in order to prepare for the semi-independent operations we can expect in the event of conflict on the peninsula. We'll argue for the Army's integration of the Mandus/AM General Humvee-mounted 105 mm self-propelled howitzer (SPH). We'll touch on how the Picatinny Arms' M777 extended range (ER) barrel postures the 155 mm towed artillery piece to better shape the division deep fight between the coordinating fire line (CFL) and the fire support coordination line (FSCL). And finally, we'll conclude with recommending a change in force structure, consolidating all M777 howitzers with corps who will combine them with High Mobility Artillery Rocket System (HIMARS) battalions. This will create a more lethal general support M777/HIMARS composite battalion able to enact killing machine tactics under a division artillery headquarters supporting multiple maneuver brigade penetration operations of an in-depth North Korean defense.

The Hawkeye, a 105 mm Humvee mounted SPH, boasts several Korean conflict specific advantages over the Army's current M119A3 platform. Whereas other self-propelled howitzers such as the M109A6 rely on heavy armor to absorb large amounts of recoil, engineers at Mandus Group have leveraged soft-recoil technology, putting the guns on a much lighter Humvee chassis. The Hawkeye's M20 cannon is encased in a recoil/cradle sub-assembly enabling 70 percent reduction in recoil force allowing for its firing from a M1152A1 Humvee chassis.

This gun-prime mover combination has enormous potential for service in moun-

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16   Ibid.

U.S. Marines with C Battery, 1st Battalion, 10th Marine Regiment, 2nd Marine Division, fire a M777A2 155 mm howitzer during the 10th Marines Top Gun Competition for Rolling Thunder at Fort Bragg, N.C., March 15, 2018. The Marines were evaluated on their timely and accurate fire support capabilities and overall combat effectiveness. (Lance Cpl. Nghia Tran/U.S. Marine Corps)

tainous Korean terrain. For example, we can reasonably assume a brigade will perform large amounts of artillery air assaults to move guns over non-trafficable ridgelines, high peaks and dangerous valleys. In today's military, a battery commander can sling-load two full howitzer sections (one towed M119A3 and one prime mover per section) with four CH-47 Chinook helicopters. However, with the Hawkeye platform, a brigade can double its ability to project indirect Fires forward in support of a maneuver formation by sling-loading one Hawkeye SPH under each CH-47. For the first time in history the U.S. military will be able to airlift a self-propelled howitzer able to infill, fire and displace all under its own power.

In the event of resumed conflict on the peninsula we can undoubtedly expect our adversaries, in an effort to delay progress north towards Pyongang, to destroy key terrain such as load-bearing bridges able to transport our heavy armored formations. To this effect, in the recent Russian/ Ukrainian conflict we watched Russia expertly canalize Ukrainian armored formations resulting in the eventual annexation of Crimea.

As the Hawkeye retains the title of lightest 105 mm SPH, it can traverse secondary bridges deemed un-trafficable by retrograding North Korean forces. The Hawkeye's increased tactical maneuverability, when compared with other near-peer light SPH platforms, maximizes the potential routes available to it.

The gun-prime mover combination also lends itself to a smaller firing point "footprint" as each Hawkeye howitzer section consists of 33 percent less rolling stock (gun-prime mover and ammo truck as opposed to prime mover, gun and ammo truck).

In support of this point, the vice president of business development at Mandus Group, Rear Adm. (retired) Sam Kupresin, said there is a need for a very lightweight self-propelled howitzer to counter the improved counterfire threats from potential adversaries such as China and North Korea.[17] The Hawkeye, with its gun-prime mover combination, presents a smaller, more armored target for the formidable array of North Korean indirect Fires assets.

Yet another crucial advantage this new weapon system poses over its conventional 105 mm cousin is its ability to rapidly fire 360 degrees. Out-of-traverse missions can certainly be achieved with current M119A3 crews, but tend to cost a lot of time as Soldiers race to shift trails and find the correct gun target line. This creates large time differences between experienced and inexperienced crews.

In the Hawkeye weapon system, out-of-traverse fire missions are conducted in an automated fashion, severely decreasing time between the crew's receipt of fire mission and rounds fired. Due to the adversary's exploitation of infiltration and envelopment tactics, an efficient out-of-traverse shooter with increased tactical maneuverability becomes critical to our howitzers survivability during a conflict on the peninsula.

Therefore, we suggest the Hawkeye 105 mm howitzer finds its place amongst the U.S. military's direct support battalions in order to support the brigade knife-fight between the FLOT and the CFL. In an effort to portray how the artillery community can better posture for shaping operations between the CFL and FSCL on the peninsula, we'll describe how the Fires community can make the best use of Picatinny Arsenal's Extended Range Cannon Artillery (ERCA) program.

Since November 2016, the Picatinny Arsenal has teamed with the dual Army and Marine ERCA program to create an ER M777A2 (XM907 Cannon) able to fire on or about 70 kilometers.[18] When viewed through a Korean Peninsula lens, this increase in range will assist in countering the current standoff North Korea enjoys with systems such as the 240 Multiple Rocket Launchers (M1991/M1985), the 300 mm MRL (KN09), and the 170 mm SP Koksan Gun.

In a linear fight, the problems with the M777's mobility and survivability (in its current capacity) would be countered by its increased range. The ER M777A2 could emplace further behind the FLOT partially negating enemy infiltration techniques and counterfire in theory. The ER M777A2's decreased maneuverability, as evident in its inability to keep pace with Stryker brigades, is canceled out by its extended reach which doubles as its protection.

Of note, upon realizing the advantages of Mandus' Hawkeye SPH, the Fires community can expect the production of "The Brutus," a wheeled 155 mm SPH version mounted on a medium tactical vehicle (MTV) chassis, to counter the inherent mobility flaw in the M777A2. Transitioning back to Picatinny Arsenal, following the final demonstration exhibiting the merits of their ER M777A2 howitzer system we can project if and/or when the U.S. military will begin incorporating this new technology.

However, due to the impressive initial range extensions, the ER M777A2 as well as the entire ERCA project to include the XM1113 rocket-assisted projectile, the XM654 Supercharge, new autoloader, and new fire control system will change how division artillery shapes the division deep fight.

Keeping the Hawkeye and ERCA programs in mind, we'll now argue for numerous artillery alignment changes amongst the brigade, DIVARTY and corps levels. We imagine most maneuver commanders will have negative views at the thought of seeing their direct support M777A2 howitzers disappear.

However, M777A2s should be initially consolidated at the corps level, integrated into HIMARS battalions, and powered down to DIVARTY in a general support role to set conditions for cannon and rocket massing Fires in support of the division deep fight. The increased range found in the ER M777A2 will absolutely make them more relevant to the division deep fight as DIVARTY seeks to attain the correct force ratios in the division deep fight needed to move the CFL forward and transition battle space over to maneuver brigades.

The Fires community must bring all its long range assets under one headquarters to create the necessary conditions for the softening of a meticulously built North Korean in-depth defense.

By consolidating long-range shooters under one DIVARTY, the division actually gains needed Fires-centric control during operations such as wet gap crossings, brigade air assaults and brigade breaches. As brigades lose their 155 mm formations from the composite M119A3 and M777 battalions, an opening is left for the integration of one Hawkeye battery per battalion.

Ultimately, corps has the responsibility to set the FSCL appropriately in order to give the division adequate time to shape beyond the division CFL.

This alignment allows a DIVARTY to leverage the increased ranges found in composite ER M777A2 and HIMARS battalions (respectively 70K and 45K M26A2)

17   *Humvee-Mounted Howitzer Dazzles at Modern Day Marine, Defensetech, Matthew Cox, www.defensetech.org/2017/09/19/humvee/mounted/howitzer/dazzles/ at/modern/day/marine, accessed on Nov. 18, 2017.*
18   *Picatinny Arsenal advances M777 extended range howitzer, Daniel Wasserbly, Washington, DC - IHS Jane's Defense Weekly, March 1, 2017.*

to adequately team with its combat aviation brigade (CAB) in order to enact the killing machine as described in the Center for Army Lessons Learned February 2017 article titled "An Integrated Division Deep Fight, Deep Battle 2.0."

Critical to a division's ability to shape the deep fight is the inaction of the killing machine, specifically the utilization of manned-unmanned-teaming, often in the form of multiple lines of Grey Eagle systems, to identify enemy air defense artillery and fire support (FS) assets between the CFL and FSCL.

For maximum efficiency, the Grey Eagle feed must be located inside the DIVARTY tactical operations center (TOC) immediately next to the fire control element in order to immediately process targets as acquired.

The DIVARTY will then exploit the extended ranges found in its ER M777A2 and HIMARS systems to destroy ADA and FS targets, allowing freedom of maneuver for the CAB to find and destroy enemy armored maneuver formations.

In conclusion, the DIVARTY headquarters must take the lead in always advocating for increased range and fire power to ease its fellow maneuver brigades forward. By studying our experiences during the Korean War, the Fires force can project what we may face in the event of resumed conflict on the Korean Peninsula. By remaining open to current technological advances we can gradually phase out old systems in favor of new platforms granting greater responsiveness to an increasingly sophisticated threat.

And finally, by looking inward we can set the necessary conditions to provide both timely responsive Fires for our maneuver brethren while simultaneously providing our DIVARTY TOCs with the tools needed to create a catastrophic problem for any adversary: that of overwhelmingly accurate and destructive Fires ruthlessly massed upon any and all weapon platforms meant to delay our inevitable advance forward.

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Capt. Adam Wilson is the 3rd Battalion, 7th Field Artillery Regiment fire support officer. Wilson attended the Field Artillery Basic Officer Leaders Course at Fort Sill, Okla. Prior to serving in the 82nd Airborne Division, Wilson was the A Battery, 2nd Battalion, 319th Airborne Field Artillery Regiment fire direction officer, platoon leader and executive officer. He also served previously as the Headquarters, Headquarters Battery, 2nd Battalion, 319th Airborne Field Artillery Regiment battalion fire direction officer. Wilson attended the Captains Career Course at Fort Sill and is now stationed at Schofield Barracks, Hawaii.

U.S. Army Paratroopers assigned to C Battery, 4th Battalion, 319th Airborne Field Artillery Regiment, 173rd Airborne Brigade, fire the M777A2 Medium Towed Howitzer during exercise Eagle Strike on Oct. 26, 2017. The 173rd Airborne Brigade is the U.S. Army's Contingency Response Force in Europe, providing rapidly deploying forces to the U.S. Army Europe, Africa and Central Command Areas of Responsibility within 18 hours. (Staff Sgt. Alexander Henninger/U.S. Army)

Emerging air defense challenges
Unmanned aerial systems

By 1st Lt. Nicholas Culbert

The battlefield of the 21st Century is becoming ever more complex. Long gone are the days where combined arms maneuvers and operations consisted of simply infantry, artillery, armor and fixed- and rotary-wing manned aviation. New combat domains are being exploited by our military and those of our enemies. From cyberwarfare, to space operations, to new developments in unmanned aerial systems (UAS), countering a growing number of threats has spread resources thin in the effort to protect this nation and its critical assets.

According to a Torchbearer National Security Report published in July 2010, the U.S. Army deployed only "three UAS with 13 aircraft" in support of Operation Iraqi Freedom.[1] Today, the U.S. Department of Defense operates over 11,000 UAS in support of a multitude of operations worldwide.[2]

While the intentions of our military and the Army are noble, the same cannot be said of America's enemies. The growing intricacy of warfare and the increasing number of mission sets has left us, in some cases, vulnerable with little or no counter to emerging threats. As air defenders, it is our responsibility to address, adapt and counter these threats.

Lessons from the 2014 Russian annexation of the Crimean Peninsula and the resulting military conflict between Ukrainian

1   Association of the United States Army | Voice for the Army – Support for the Soldier. Accessed Dec. 18, 2017. https://www.ausa.org/sites/default/files/TBNSR-2010-US-Army-Unmanned-Aircraft-Systems-Changing-Modern-Warfare.pdf.
2   Department of Defense. "Unmanned Aircraft Systems." DoD. Accessed Dec. 18, 2017. https://www.defense.gov/UAS/.

Soldiers of 2nd Battalion, 263rd Air Defense Artillery, 678th Air Defense Artillery Brigade, South Carolina Army National Guard, conduct validation training at Fort Bliss, Texas. The validation training culminated with a live-fire event where Soldiers engaged drones with the Avenger weapon system and shoulder-mounted Stinger missiles during both day and night fire operations. (Sgt. David Erskine/U.S. Army)

and Russian-backed forces have shown how effective and unpredictable UAS operations can be in a modern conventional war. As identified by the U.S. Army's Counter UAS (C-UAS) Strategy, both sides in this conflict have used UAS, large and small, for intelligence, surveillance and reconnaissance (ISR) purposes. However, Russian-backed forces have demonstrated "one UAS capability in particular… [emerging] as a substantial enabler: target acquisition for artillery."[3] This new tactic has far-reaching implications for a multitude of actors and poses a larger indirect fire threat to U.S. ground forces. The C-UAS Strategy goes even further, presenting claims that UAS conducting ISR in support of Fires resulted in nearly double accuracy during combat operations.[4]

Countering this new tactic and others like the weaponization of small UAS (sUAS) is perhaps, alongside ballistic missile proliferation, the largest air defense challenge in the history of the branch. With air defense batteries deployed worldwide, often in fixed locations, and each with their own unique mission sets, integrated air and missile defense capabilities against sUAS and large UAS are needed more than ever.

The current arsenal of air defense weaponry is unfortunately, ill-suited to meet this task. With the mass proliferation of UAS and their commercialization, the cost to effectively employ these systems on the battlefield is miniscule in comparison to a multi-million dollar Patriot interceptor. New air defense systems are desperately needed to effectively and efficiently eliminate threats to key defended assets worldwide so as to preserve the mission set of already deployed air defense units. New funding and technology, while critical in countering this new and emerging threat, are not the answer alone. Cross-domain warfare with fields such as electronic warfare and cyberspace operations will, and is, helping to redefine combined arms efforts to defeat America's enemies. Ultimately, the air defense strategy against emerging UAS threats will require a holistic approach, involving a joint effort with allies and partners, the development of new technologies, and the redefinition of combined arms and cross domain warfare.

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3   United States Army Fires Center of Excellence (FCoE). "Counter - Unmanned Aircraft System (C-UAS) Strategy Extract." Home - Army Capabilities Integration Center. Accessed Dec. 18, 2017. http://www.arcic.army.mil/app_documents/army-cuas-strategy.pdf.
4   Ibid.

In the next issue of Fires

July-August 2018, Red + Blue Fight Club. Fires Supporting Maneuver

The deadline for submissions is June 1, 2018. This issue will take a look at the current successes and shortfalls in how Fires supports maneuver. It will also discuss Maneuver-Short Range Air Defense, interoperability with joint partners and more. For more information call (580)442-5121 or send submissions to usarmy.sill.fcoe.mbx.fires-bulletin-mailbox@mail.mil.

Soldiers from 3rd Battalion, 157th Field Artillery Regiment, 169th Fires Brigade, Colorado Army National Guard, fire an M142 High Mobility Artillery Rocket System through the sky in a demonstration at Adazi Military Base, Latvia. The demonstration is part of a mass offensive attack featuring the capabilities of U.S. Air Force, U.S. Army, and U.S. Marine assets, as well as Polish tanks and Italian Mechanized Infantry. The exercise falls under Saber Strike, a U.S. Army Europe-led multinational combined forces training exercise in the Baltic region. The exercise tests the capability of multiple nations to act against a threat. (Sgt. Shiloh Capers/U.S. Army)