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Sustaining Multi-Domain Battle

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This graphic represents the integration and convergence of the future multi-domain battlefield. Traditional battle zones have transformed to a layered schematic that calls for synchronization and integration across combatant commands. (Illustration by Stefanie Antosh)

"The reason sustainment will continue to be a challenge is that when we look at our concepts for MDB [Multi-Domain Battle], what we have are widely dispersed forces that may not be contiguous."

Gen. David G. Perkins, p.15

DEPARTMENTS

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By Order of the Secretary of the Army:

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Sustaining the Force in Multi-Domain Battle

In the Multi-Domain Battle environment, sustainers must develop their fundamental Soldier skills while also harnessing technology and innovation.

■ By Gen. Gustave "Gus" Perna

No one can predict with certainty where our next war will be. But we must be prepared for a near-peer adversary who will challenge our assertions and alter our response within a Multi-Domain Battle environment. Our traditional battle zones have transformed to a layered schematic that calls for us to project forces and equipment in a way that is synchronized and integrated across combatant commands—all while these battle zones are being contested by our enemy.

We can no longer assume continuous superiority across any domain; we must be prepared to react from a position of disadvantage. Before the first shot is fired, we must anticipate suffering a hit that could take out a brigade's equipment set, a major supply line, or a full ship.

The battlefield of the future is difficult to visualize. It challenges our current mindset of retreating to a forward operating base and relying on contractors for life support and equipment maintenance—notions that will likely be absent in the next war. The charge to logisticians is to draw the conceptual line from the new battlefield to the sustainment force and help others do the same.

While technology will offer many solutions, we must also rely on our fundamentals. By reviving Soldier tasks, skills, and responsibilities, we develop warriors who not only can maintain their equipment to a high standard but also can think their way through unforeseen obstacles. At the same time, we must cultivate innovation to increase efficiency, improvise solutions, and develop methods that identify and exploit our adversaries' vulnerabilities.

Sustaining the Multi-Domain Battle force is a tall order. We can answer the call if we clearly understand and define requirements, identify and assess risk, and focus efforts on outputs and end states. We now have more data and information available to us than ever before.

However, we cannot get consumed by logistics statuses, figures, and numbers to make decisions. We have to rely on our professional intuition and leaders and then use logistics data to have a greater understanding of our comprehensive capabilities.

For leaders and commanders, this means understanding the leading indicators across all echelons, anticipating requirements, and incorporating the most useful information. Leaders must understand how our available facts and figures inform decisions, and then they must follow through on execution.

As sustainers tackle their dual roles as stage setters and innovators, each organization's contribution is critical to our next fight. From transportation solutions, to life cycle management, and to research and development, all sustainment efforts are important to ensuring our force has what it needs today, is sustained in the highest working condition, and can anticipate needs for the future.

Multi-Domain Battle—across air, land, sea, space and cyberspace—brings both exceptional opportunity and vulnerability. As we prepare to sustain a mobile and expeditionary force, we must ensure effective training and the ability to respond to and exploit our adversaries. We must keep our skills sharp through repetition, challenge the status quo, and anticipate our logistics delivery posture in a degraded environment.

The Multi-Domain Battle environment will tax our logistics management and delivery systems and stretch our sustainment forces thin. With that understanding, each part of our vast materiel enterprise has an important role to play as we transform logistics operations to react to future wars.

Gen. Gustave "Gus" Perna is the commander of the Army Materiel Command at Redstone Arsenal, Alabama.

Multi-Domain Battle: Fundamentals in an Evolutionary Environment

Multi-Domain Battle will require sustainers who focus on the basics, understand how the Army runs, continue to grow professionally, and provide precise, timely, and accurate support.

■ By Lt. Gen. Aundre F. Piggee

In *This Kind of War*, T.R. Fehrenbach states, "You may fly over a nation forever, you may bomb it, atomize it, pulverize it and wipe it clean of life. But if you desire to defend it, if you desire to protect it, if you desire to keep it for civilization, you must do this on the ground the way the Roman legions did . . . in the mud."

Muddy boots are just as important in today's Multi-Domain Battle (MDB) environment as they were 55 years ago, when Fehrenbach penned this statement about the Korean War to explain the nature of ground combat. Chief of Staff of the Army Gen. Mark A. Milley introduced the MDB concept and described a future battlefield where our forces may no longer dominate across the land, air, maritime, space, and cyberspace domains.

Our adversaries already have, or will have, long-range precision fires, advanced weapons technologies, and drones. They may be able to hack into our systems and jam our networks, making battlefields, including urban areas, more chaotic and lethal than any we have yet to see.

You may be asking yourself, "What does this mean for logisticians?" In MDB, it will be even more critical to precisely meet the needs of the warfighter with accurate quantities of required materiel at the right locations and at the right time. We can no longer operate with "iron mountains."

Preparing for MDB

In the last year, the Army G-4 office has taken many developmental steps that lay the foundation for the Army to successfully fight in an MDB environment. We have grown Army pre-positioned stocks and assembled them in ready-to-fight configurations to quickly equip forward combat forces.

We have already divested or redistributed more than 825,000 pieces of excess equipment. Our goal is to divest another 1.7 million obsolete major end items over the next two years.

We have also completed the fielding of Global Combat Support System–Army, Increment 1, which is improving materiel management. We are capitalizing on the unprecedented data that the system is providing to improve readiness.

Many other Army logisticians are involved too. In this issue of *Army Sustainment*, you will read how we are already supporting the MDB fight in urban areas of Iraq under the leadership of Brig. Gen. Christopher Sharpsten.

Logistics Technologies for MDB

At Gen. Milley's direction, the Army also is aggressively exploring "leap ahead" technologies that will radically change methods to resupply the force. We are supporting the development of autonomous ground, aerial, and watercraft capabilities to move supplies to widely dispersed units.

If the commercial industry can deliver products to customer's doorsteps with driverless vehicles and drones, the Army should be able to conduct convoys along similar timelines with manned and unmanned teams when weather, terrain, and enemy threats

In MDB, it will be even more critical to precisely meet the needs of the warfighter with accurate quantities of required materiel at the right locations and at the right time.

HIP-POCKET GUIDE

TWO-LEVEL MAINTENANCE
(FIELD AND SUSTAINMENT ACTIONS)

A U.S. ARMY LOGISTICS, G-4 PRODUCT

FIELD MAINTENANCE ACTIONS (FSC, FMC, AND SMC)

1. ON OR NEAR SYSTEM
2. FEWER ACTIONS REQUIRING TOOLS
3. CONDUCTED ON COMPONENT ACCESSORY
4. ASSEMBLY, SUBASSEMBLY, PLUG-IN UNIT
5. SHOP REPLACEABLE UNIT, LINE REPLACEABLE
6. UNIT OR OTHER PORTION OF SYSTEM
7. REPAIR OF COMPONENTS AND END ITEMS
8. GIVEN PROPER TOOLS, REPAIR PARTS
9. REFERENCES AND TIME
10. INCLUDES:
    - A. ADJUSTMENT
    - B. ALIGNMENT
    - C. SERVICE
    - D. FAULT/FAILURE DIAGNOSES
    - E. FIELD LEVEL MWO APPLICATION
    - F. BATTLE DAMAGE AND ASSESSMENT REPAIR

SUSTAINMENT MAINTENANCE ACTIONS (DEPOT)

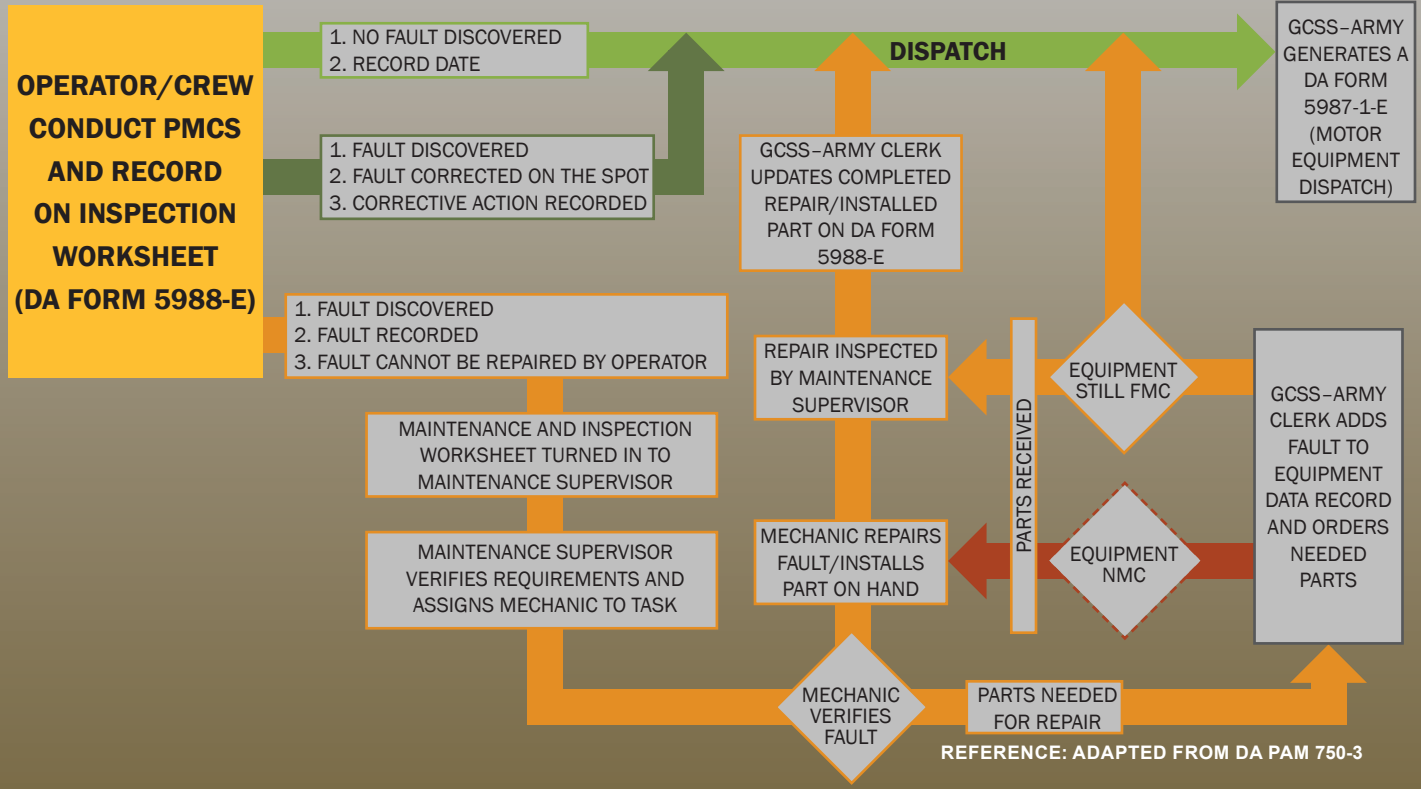
1. OFF-SYSTEM
2. DISASSEMBLE/ASSEMBLE
3. REPAIR TO NATIONAL STANDARDS
4. REQUIRES WIDE VARIETY OF TOOLS
5. COMMODITY ORIENTED PARTS

REFERENCE: ATP 4-33

HIP-POCKET GUIDE

FIELD MAINTENANCE WORK FLOW

A U.S. ARMY LOGISTICS, G-4 PRODUCT



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The high technology that the next war will bring may change war's character, but none of it matters if we cannot get our vehicles out of our motor pools or our helicopters off the airfields. (Illustration by Samuel Curtis)

pose too many risks.

Getting repair parts on a battlefield hours after they are needed is too late, so we are exploring additive manufacturing capabilities for repair parts and tools at forward positions at or near the point of need. This would reduce delivery time, distribution requirements, and storage.

In the future, Soldiers may have the capabilities to produce water themselves, use alternative fuels, and operate apart from existing power grids. We are looking to develop these types of innovations as well.

There are many obstacles to achieving what may sound like "mad science" to some. These challenges should not deter us.

Four Tips to Prepare for MDB

The Army must ensure it is prepared for the battlefield of the future, which may emerge faster than we expect. It is not too early for individual sustainers to be prepared as well. Here are four things that you can do.

1. Keep focused on the basics. All of the wizardry of high technology that the next war will bring may change war's character, but none of it matters if we cannot get our vehicles out of our motor pools or our helicopters off the airfields.

When the enemy damages or disrupts our power supplies or jams our networks, you may find that you have to do things the old-fashioned way: reading maps, using manual battle tracking, engaging in more direct communications, and using analog technologies.

We saw this recently in Puerto Rico with the Army's support of hurricane recovery efforts. One of the biggest challenge that Soldiers faced in Puerto Rico was operating without power or internet connectivity. Even as you focus on the basics, understand that the basics are evolving too. You will need some new skills, such as being adept at using technology.

2. Be precise, timely, and accurate. In the MDB environment, sustainers cannot be bureaucratic and slow. We have to act fast. We must modernize for greater lethality. We have to equip Soldiers to fight and win across all domains, and we must remain a learning and adaptive organization.

3. Understand how the Army runs. In this edition, you will see an article about two-level maintenance by Brig. Gen. David Wilson, the Army chief of ordnance. Two-level maintenance is important in the context of MDB because, as logisticians, we need to understand current policy and doctrine. We need to understand how it shapes and is shaped by force structure and how policy, doctrine, and force structure are all interrelated and support how we operate.

Knowing our craft is something that I emphasize every day because I have been in situations where I had munitions but not in the right location, where I had an abundance of fuel at the port but was challenged to get it to the foxhole, and where I had difficulties getting equipment to early-entry forces who needed to move quickly. Working together as a disciplined logistics team with a full understanding of the processes, doctrine, and operational environment, we can supply the fight and meet requirements.

4. Continue to grow professionally. The enemy's goal is to counter our comparative military advantages, what have long been our strengths: our ability to outmaneuver our adversaries, our development and use of innovative technologies, and our rapid adaptation of successful techniques, tactics, and procedures. We must retain advantages that can never be taken away. Our values of culture, leadership, trust, and integrity are currency that no one can steal. But, they require dedicated effort, hard work, and sacrifice to maintain.

General of the Army Omar Bradley once said, "The matter of learning is one of personal preference. But for Army officers the obligation to learn, to grow in their profession, is clearly a public duty."

Take that duty seriously. As the Army prepares for an unforgiving future war, instill in yourself the fundamental skills you will need.

Lt. Gen. Aundre F. Piggee is the Army deputy chief of staff, G-4. He oversees policies and procedures used by all Army logisticians throughout the world.

Sustainment Innovation for Multi-Domain Battle

■ By Maj. Gen. Paul C. Hurley Jr., Lt. Col. Tracie M. Henry-Neill, and Rebecca S. Brashears

After years of conducting counterinsurgency operations centered on forward operating bases (FOBs), the Army and Marine Corps have introduced a new operational concept to operate, fight, and campaign successfully in the 2025 to 2040 time frame. The concept, called "Multi-Domain Battle: Evolution of Combined Arms for the 21st Century," is generating discussion across the joint logistics enterprise. Its focus is how sustainers can best support U.S. forces in tomorrow's combat.

The future operational environment is expected to challenge forces with multifaceted dilemmas. These dilemmas include facing adversaries with similar or better capabilities and operating on a battlefield where freedom of action cannot be guaranteed.

In the complex Multi-Domain Battle (MDB) environment, near-peer competitors will challenge U.S. supremacy across all domains (land, air, maritime, space, and cyberspace). Sustainment formations will have to support large-scale combat operations characterized by distributed, semiautonomous brigade combat team (BCT) operations that are enabled by echelons-above-brigade formations in contested terrain and across all domains.

Army sustainers must consider how best to respond to the sustainment challenges of this new MDB fight. Most sustainment leaders and Soldiers have a wealth of counterinsurgency operations experience, and while those lessons are valuable, the future fight requires new ideas and solutions. Sustainers need to broaden their aperture and proactively respond to the future with an appetite for innovation in order to respond to the increasingly complex and challenging security environment.

The Combined Arms Support Command (CASCOM) is analyzing the sustainment implications of how the Army will fight in the future. The Army must develop leaders, design organizations, develop doctrine, and provide materiel solutions that will enable Soldiers to fight when they are out-manned, out-gunned, decentralized without connectivity, in an expeditionary environment, maneuvering against a peer competitor, and holding only temporary or periodic domain superiority.

CASCOM, as the Army's sustainment think tank, must drive innovation with new ideas, new devices, and new methods at every available opportunity in order to optimize the delivery of sustainment effects.

Semi-independent BCTs

A key element of the MDB concept is that of resilient formations featuring BCTs capable of operating semi-independently for up to a week without continuous resupply. Currently the brigade support battalion (BSB) holds 2 ½ days of supply.

In the new MDB environment, BCTs will be required to operate more independently and with fewer logistics constraints. In order to achieve the goal of seven days of supply, the Army must either triple the BSB's capacity or change the way sustainers provide support.

Dispersed Operations

The MDB concept describes adversary anti-access/area denial (A2/AD) capabilities that can contest U.S. forc-

The Combined Arms Support Command is figuring out how Army sustainers can best respond to the sustainment challenges of the new Multi-Domain Battle fight.

es across all domains, from predeployment to employment. The concept changes the age-old assumption that the U.S. military will have overmatch in any domain during battle.

This overmatch, which had allowed the Army to concentrate forces and establish large sustainment hubs, will easily be eliminated by peer competitors with aerial and surface long-range precision fires and other kinetic effects.

To mitigate MDB threats, the Army will require a combination of current and new ways of operating. In this MDB fight, U.S. forces must be able to combine traditional methods of camouflage and concealment with new techniques, such as "cyberflage." The Army must also consider a greater dispersion of forces and resources, which means logisticians must provide timely sustainment over greater distances.

In the future, BCTs will operate across larger areas using smaller, more decentralized units. Support areas across the battlefield will be vulnerable to enemy interdiction and must operate in a mobile, dispersed manner. The new expanded battlefield will require forces to reduce their electromagnetic spectrum signature using resilient mission command systems.

The force cannot assume unhindered access to space, cyberspace, and electromagnetic spectrum capabilities that are critical for current mission command systems to function effectively. Current systems that depend on assured communications and access to space capabilities must be adapted to conduct offline operations. Furthermore, operating dispersed over extended distances will increase vulnerability to cyberattack and disrupt the integrity of near-real-time data.

Finally, the joint force must develop greater countermeasures to protect against cyberspace threats, which if left uncontested will degrade reconnaissance, mission command systems, position, navigation, and timing.

Spider Web Sustainment

MDB requires an evolution in military logistics that applies global supply chain best practices in the context of the unique characteristics of the future fight. Simply stated, the battlefield is no longer linear; therefore, the supply chain can no longer be linear.

One concept to sustain MDB is spider web sustainment. Spider web sustainment is a complex web of logistics modes, nodes, routes, and suppliers that employ both old and new methods. It is also an acronym that stands for self-sufficient units, precision logistics, interoperability with partners, distribution, expeditionary sustainment, regional resources, widely dispersed, enabled mission command with enterprise resource planning, and brigade-focused.

This web creates multiple sustainment options, which provide more responsive and flexible sustainment solutions for the warfighter. Spider web sustainment evokes the independent, yet connected, and resilient strands of an actual spider web.

Current sustainment techniques, including Army pre-positioned stocks, operational contract support, and industrial partnerships, must continue to be integrated into the support plan. What must change are considerations for procuring and securing regional resources, developing alternate distribution methods, and executing precision logistics.

MDB requires a highly mobile and adaptive logistics infrastructure that is capable of responding to sustainment requirements. No longer can the Army establish static FOBs fed by a linear supply chain. Consideration must be given to the mission command necessary to execute spider web sustainment. Force structure modifications for sustainment commands are necessary in order to develop methods to enable fluid sustainment mission command across the battlefield.

RSOI in the Future

The future A2/AD threat requires forces to fight rapidly and transition quickly from strategic movement to tactical maneuver. Movement must mirror maneuver, and expeditionary forces must be able to respond in days, not months. These requirements will have a significant impact on reception, staging, onward movement, and integration (RSOI) operations. The continued investment and innovation in Army watercraft and joint strategic lift must allow for the impacts of moving combat configured forces.

In today's more permissive environments, typically all phases of RSOI occur within the theater of operations, from the port of debarkation to the tactical assembly area. In future nonpermissive environments, most phases of RSOI may have to occur within the strategic support area.

Until the A2/AD threat can be neutralized, the ability to conduct administrative strategic movement is compromised. Therefore, forces, equipment, and even munitions must be strategically moved or maneuvered together and prepared for rapid employment.

Demand Reduction

Operating semi-independently at the BCT level clearly presents challenges to sustainment; the level of demand will outweigh the Army's current ability to provide resources throughout the new battlefield. Demand reduction must be a guiding principle that is employed across the force. The military must look to (or lead) industry in developing new and innovative science and technology to reduce BCT consumption.

Consequently, CASCOM has prioritized its science and technology efforts. The development of technologies to produce supply at the point of need reduces distribution requirements, allows for more self-sufficient BCTs, and mitigates risk to sustainment forces over extended lines of communication.

CASCOM is currently pursuing science and technology advance-

A joint tactical autonomous air resupply system carries a small package during the Maneuver Fires Integrated Experiment at Fort Sill, Okla., on April 12, 2017. This technology offers sustainers the possibility of using unmanned aerial systems to deliver supplies on the battlefield. (Photo by Monica Wood)

ments such as additive manufacturing (3-D printing), alternative sources of water, and alternative sources of energy. As these innovative solutions are fielded, the requirements for materiel to be distributed will lessen, as will the BCT's dependence on echelons-above-brigade sustainment forces.

Expeditionary Sustainment

MDB will require a sustainment enterprise that can sustain forces over great distances in austere environments. The Army will no longer have the luxury of static FOBs and "iron mountains" of materiel for sustainment.

The spider web sustainment concept will provide the framework for future sustainment operations, but materiel development and investment will enable sustainers to operate in a mobile, redundant, and dispersed manner while retaining access to supplies and equipment.

Through greater investment in joint sustainment capabilities, such as strategic lift, pre-positioned stocks, and interoperability with sea basing, the Army can achieve greater expeditionary sustainment capability. Future sustainment nodes must be present within multiple domains, not simply on land.

Consequently, the Army must continue to improve its watercraft capabilities to deliver combat configured forces ready to fight. The Army is currently pursuing the maneuver support vessel (light) to provide this capability.

Atop the CASCOM science and technology priority list are autonomous distribution systems, both aerial and ground. Autonomy as an enabler is a necessary capability that provides the advantages of unit dispersion, distribution over extended distances, and prolonged endurance across all domains.

Autonomous and semiautonomous distribution capabilities will increase freedom of action for both the supported and supporting force. These technologies enable increased resupply throughput, reduce the number of required drivers, and increase force protection by reducing risk.

One type of technology being pursued is cargo unmanned aerial systems, including the joint tactical autonomous air resupply system (JTAARS). The JTAARS is a joint initiative with the Marine Corps that provides scalable autonomous lift capabilities to dispersed forces. It is projected to be in use within the next 10 years. This method of distribution provides precise resupply at the point of need and enables semi-independent operations.

Precision Logistics

The dynamic nature of the MDB fight changes the variables of sustainment and drives the need for precision logistics. Precision logistics

is the accurate delivery of essential supplies and equipment to the right place at the right time and in the right quantity throughout the contested battlespace.

For precision logistics to succeed in the future, it requires innovation coupled with consideration of supply chain threats. The contested MDB supply chain will force sustainers to use new and innovative methods to operate with precision.

For example, it may involve predictive analytics that could redirect JTAARS to resupply widely dispersed, highly mobile forces. Sustainers may need to deliver goods using small drones that have the ability to reroute to a mobile customer.

Of course, the enemy creates additional variables that the Army must consider when distributing supplies to mobile customers. The complex environment will require maximized use of distribution platforms, especially over extended lines of communications.

Artificial Intelligence

A shared understanding is essential for mission command, which is paramount in the contested and degraded MDB operational environment. The Army is actively working to converge its networks in order to develop a comprehensive common operational picture (COP).

Converging the networks creates greater security and synchronization across the joint force. The sustainment aspect of the COP must incorporate the innovative application of artificial intelligence in order to improve the precision and velocity of sustainment.

CASCOM's leading artificial intelligence initiative is predictive analytics. Technology advancements will allow predictive analytics within platforms to automatically populate the sustainment COP in order to enable commanders to see real-time readiness indicators and predict future sustainment requirements. Sustainment systems improved with artificial intelligence tools will revolutionize forecasting and logistics decision support tools, making those tools integral to the COP.

An example of the powerful effects of convergent technology is a sustainment COP informed by condition-based maintenance plus technology that autonomously diagnoses system failures and places parts on order with minimal human intervention.

Future Sustainment Training

As innovation drives changes, sustainers must adjust the way they train. Training must drive thoughts and actions beyond past conflicts to prepare for future engagements. Training philosophy and methods must change to incorporate realistic challenges of operating with degraded capabilities in multiple domains. More importantly, future training must build sustainment planners, leaders, and Soldiers who can support the force in an ever-changing, degraded, and lethal environment.

Enhanced training requires an investment in training environments that will improve competency in expeditionary decentralized operations. CASCOM is working with the Army Reserve, the Army National Guard Bureau, the Forces Command, and First Army to improve the design and increase the rigor of sustainment training during warfighter exercises, command post exercises, combat training center rotations, and other collective training events.

Sustainment leaders and Soldiers must be prepared for enemy contact from fort to foxhole. Therefore, support units must become more lethal and develop capabilities to become generators of security, not merely consumers. Sustainment forces will need to develop new tactics, techniques, and procedures to execute sustainment for semi-independent BCTs.

Training to amass logistics effects where and when they are needed will be necessary to succeed in the future fight. These tactics, techniques, and procedures must be planned and rehearsed similarly to how maneuver forces execute passage of lines operations.

The sustainment challenges of the future will require changes in doctrine, organization, materiel, and training. CASCOM's goal is to bring new ideas and innovation to these areas.

CASCOM is leading the Army's effort to develop innovative sustainment capabilities, doctrinal changes, and training initiatives. The command's Sustainment Battle Lab is currently developing a white paper called "Sustaining Multi-Domain Battle" and welcomes the sustainment community to provide recommendations, additions, and contributions to sustainment innovation for the future.

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Lt. Col. Tracie M. Henry-Neill is a concept developer in the CASCOM Sustainment Battle Lab. She has a bachelor's degree in history from New Mexico State University and a master's degree in business for supply chain management from the University of Kansas. She is a graduate of the Ordnance Officer Basic Course, the Combined Logistics Captains Career Course, the Combined Arms and Services Staff School, resident Intermediate Level Education, and the Army Force Management Course. She is recognized by the International Society of Logistics as a Demonstrated Master Logistician.

Rebecca S. Brashears is a concept developer in the CASCOM Sustainment Battle Lab. She has a bachelor's degree in business administration management from Saint Leo University and is a graduate of the Army Force Management Course and the Logistics for the 21st Century program at the University of North Carolina.

The Naval Postgraduate School's Supply Chain Management Program

Logistics officers should consider completing the Naval Postgraduate School's supply chain management master's degree program as a career broadening opportunity.

■ By Capt. Michael McCrory

The Army must identify and reward its very best performers in order to retain top talent. Being among the very best performers requires an officer to be well-rounded and have a broad education. One way to accomplish this is by taking advantage of the Advanced Civil Schooling program.

Advanced Civil Schooling gives Army officers a chance to pursue advanced degrees in acquisition or business-related disciplines at civilian universities. One such degree is the master's degree in supply chain management (SCM) from the Naval Postgraduate School (NPS).

This course of study broadens a student's horizons in critical thinking and can enhance an officer's career. Anyone with a strong background in mathematics will find the 18-month SCM program enlightening and thought-provoking.

The majority of coursework required for the degree focuses on statistical simulation modeling. Students learn the basic equations behind the policies and procedures that drive the Department of Defense as well as the logistics operations of civilian corporations. These basic equations are then combined with different supply chain management theories, leading to further study of distribution and the costs associated with the risks of the outcomes.

If prospective students feel the SCM program might be too challenging mathematically, there are a few electives they can take to prepare. Students should not be discouraged because the business department strongly encourages students to take a few courses outside of the prearranged curriculum.

For instance, NPS offers a negotiation tactics course that examines real-world case studies that students role-play. Role-playing gives the students the opportunity to experience negotiation challenges firsthand.

The Defense Transportation System Course is also worthwhile. It reveals how little most students know about the U.S. transportation system and the resources that the government has at its disposal in times of crisis. The course is neither mathematically challenging nor does it require a great deal of reading. It is designed to be a thought-provoking, exploratory, self-learning study of transportation modes.

NPS focuses on the philosophical underpinnings of leadership and service. Its programs describe how to find and preserve equanimity in the midst of conflict.

The SCM program requires attendees to take one Joint Professional Military Education (JPME) class, which addresses problems that are of special interest to the government. During this class, some of the top experts in their fields assist students with their respective problems. In addition to taking one JPME class, most students (promotable captains and above) elect to take the remaining three courses to complete JPME I.

NPS is one of the top research schools for the Department of Defense. Unlike most business schools' MBA programs, NPS requires students to complete a thesis or project for publication. The students are required to develop a research topic that a professor or sponsor is interested in. The project can take anywhere from a few months to a year to complete.

There are a few downsides for the students who have families staying with them in Monterey, California, during their time at NPS. The cost of living in Monterey is high, and a cost-of-living allowance is not available for the area. Even when receiving an estimated $3,000 a month for housing, service members usually choose to live on post. The average rent for a four-bedroom house in a nice area of Monterey can run well over $4,000 a month.

The SCM program requires a considerable amount of studying and a focus on growing one's intellectual capacity to deal with new challenges in imaginative and thoughtful ways.

The NPS instructors ensure each attendee leaves the program well-equipped with the skills to solve the complex problems that face the Department of Defense. High-quality officers looking for a challenge will find themselves pushed to their intellectual limit, which is the mark of any program worthy of an officer's time.

Capt. Michael McCrory serves as an observer-coach trainer at the National Training Center at Fort Irwin, California. He holds a bachelor's degree in finance from Valdosta State University and a master's degree in SCM from NPS.

Second Lt. Sim Kyoohyun examines his group's map on Oct. 31, 2017, during the Quartermaster Basic Officer Leader Course at the Army Logistics University at Fort Lee, Va. (Photo by Julianne Cochran)

Decision Point Logistics in Multi-Domain Battle

■ By Capt. Alan M. Strange

Leaders throughout the Army depend on the military decisionmaking process and course of action (COA) development to determine the enemy's next move, properly arrange friendly forces for the next battle, and plan support for the force. Deciding which unit requires the next day of supply can be a significant event. This planning is achieved through requirements forecasting and is enabled through daily logistics status reports (LOGSTATs) provided by maneuver units.

However, receiving useful LOGSTATs is challenging. At the National Training Center, brigade combat teams average a LOGSTAT turn-in rate of 76 percent and their reports are often late and inaccurate.

Complicating logistics planning further is Multi-Domain Battle. In this environment, joint forces work together using cross-domain capabilities to deter aggression not only in the air and land domains but also at sea and in space and cyberspace. These operations require logisticians to support the battle across multiple domains.

Decision Point Logistics

A decision point used during the military decisionmaking process is usually associated with a specific target area and will give the commander sufficient lead time to engage the adversary in the target area of interest.

Decision point logistics is the ability to use the approved COA and branch plans at the lowest levels

to make a decision to best support the warfighter as far forward as possible as the battle develops.

Decision points are based on friendly forces' requirements and the enemy situation. For example, the concept of support plan or COA states that A Company requires support from the forward support company (FSC) first. Upon arrival at the logistics release point, the company first sergeants explain that the battle has changed and the logistician needs to make a decision that deviates from the original plan.

Sustainers best support the warfighter by establishing preplanned resupply decision points. As contingencies arise, the logistics plan must quickly adapt to meet new requirements.

The military decisionmaking process tends to focus strictly on developing a most likely enemy COA and a most dangerous enemy COA. This is too narrow a focus. Army Techniques Publication 2-01.3, Intelligence Preparation of the Battlefield, states, "In order to plan for all possible contingencies, the commander understands all COAs that a threat/adversary commander can use to accomplish his or her objectives. To aid in this understanding, the staff determines all valid threat/adversary COAs."

The Best Place for Decision Points

As the Army operates in a Multi-Domain Battle environment, supporting the warfighter at all tactical and operational echelons is critical. What echelon has the mission command to use decision point logistics? Is everyone from the FSC commander down to the distribution platoon leader empowered to use this process to make decisions?

The required decisions must be made as close to the forward line of troops as possible. The senior logistician closest to the fight needs to be empowered and able to leverage all methods of resupply from throughput to aerial delivery. Logistics planning starts in the brigade operations section with the logistics planner.

Capt. Alan Hastings, while serving as a National Training Center observer-coach trainer, separated tactical thinking into three levels. At the first level, tactical leaders think about a friendly COA versus an enemy COA. At the second level, they consider the COA versus the full range of enemy COAs. At the third level, they consider the range of the enemy's COAs and how they might fight the entire range of their own possible COAs.

When tactical leaders visualize multiple enemy COAs, they are less likely to encounter an unanticipated dilemma. Thinking about ranges protects the tactical leader against surprise. Logisticians must possess this mentality when supporting the ground maneuver commander.

Embedding the logistician at every phase of COA development in order to internalize the maneuver plan instills this essential thought process. This integration results in the establishment of pre-plotted decisions points that will help to keep the maneuver unit supported.

How It Works

Logisticians must understand the capabilities of the unit that they are supporting and develop a concept of support for how the unit will receive support.

The maneuver battalion S-4 creates a LOGSTAT to help project the unit requirements across time and space. The S-4 then develops the support plan during the orders process. The FSC commander is included in the plan's development to ensure the requirements do not exceed the FSC's capabilities. The FSC commander verifies the support plan in the operation order.

Applying decision points to the maneuver battalion's support plan extends operational reach and prolongs endurance. Logisticians on the battlefield can make decisions on the move as the battle changes and evolves across multiple domains. They do this by using logistics release points throughout the battlefield in their supply trains.

> The ability to adapt and integrate sustainment operations into the maneuver commander's plan is a combat multiplier.

These logistics release points act as decision points once the battlefield changes or the objective is achieved. Specifically, the decision-making logistician has to be a master of integration and improvisation, two of the most critical sustainment principles. The ability to adapt and integrate sustainment operations into the maneuver commander's plan is a combat multiplier.

Making It Happen

The Army Logistics University at Fort Lee, Virginia, has made great strides in developing junior leaders who have the tactical knowledge associated with COA development. That knowledge is the most important part of developing the concept of support and is critical for supporting the warfighter. These skills are developed during the Basic Officer Leader Course and the Logistics Captains Career Course.

At the Quartermaster Basic Officer Leader Course, lieutenants are put through an end-of-course cap-

Students in the Quartermaster Basic Officer Leader Course receive a quick after action review on Nov. 21, 2017, during the final field training exercise of the course at Fort Lee, Va. (Photo by Julianne Cochran)

stone exercise in which they move a company and act as distribution platoon leaders supporting maneuver battalions. During this exercise, the cadre test the student plan against enemy advancement and displacement and observe how the support for friendly forces changes.

Supporting the Multi-Domain Battle environment requires leader decisions on the go. Leaders cannot solely rely on computer-based systems that are vulnerable to hackers or that contain information that could be used against U.S. forces. The Army must develop leaders in institutional and operational domains to understand their decision-making roles.

Decision point logistics allows leaders to develop branch plans and apply them as the battlefield changes. Logisticians should have branch plans for their concepts of support. To ensure this happens, leaders must place the right people in key positions and empower them to support the customer based on their visualization of the battlefield.

If logisticians cannot secure or understand their places in the lines of the operation, they cannot get the right support to the force. Logisticians must fulfill their duties by maintaining combat power, enhancing readiness, and most importantly putting the customer first. Decision point logistics has the ability to prolong endurance for the maneuver element and enable them to exploit the objective.

Unless there are clear decision points, units often continue with the momentum of the current activity. In an uncertain environment such as Multi-Domain Battle, decision points may not appear until they are urgently needed.

Capt. Alan M. Strange is an instructor at the Army Logistics University. He holds a bachelor's degree from the University of Washington. He is a graduate of the Quartermaster Basic Course and the Logistics Captains Career Course.

Join the Conversation

ARMY SUSTAINMENT

Keith Archibald posted 2 days ago

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Onetexan_75 @Onetexan_75 · Nov 29
Improvise, respond...

> **Army Sustainment** @ArmySustainment
> Heavy equipment vehicles can't just go through the car wash before they are shipped home. That's when #USArmy firefighters step in to help get the mud off these massive tires. Get a quick glimpse below. #ArmySustainment #StrongEurope #KnightsPride

Philip Shouse The U.S.Army mess halls were great on Thanksg rockin' it I see . Army Strong !!
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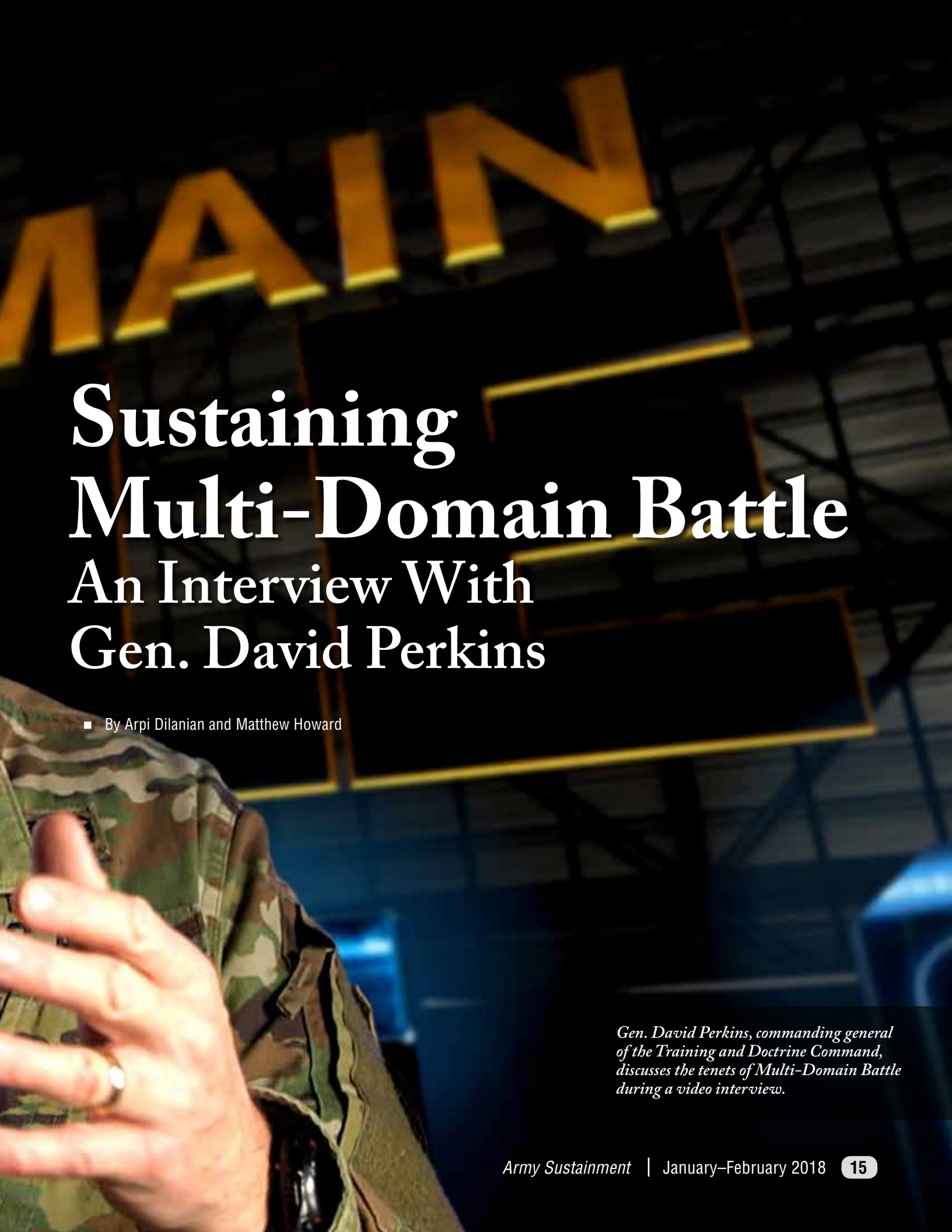
PERKINS

Sustaining Multi-Domain Battle

An Interview With Gen. David Perkins

■ By Arpi Dilanian and Matthew Howard



Gen. David Perkins, commanding general of the Training and Doctrine Command, discusses the tenets of Multi-Domain Battle during a video interview.

Gen. David Perkins, who is spearheading the Army's effort to develop the Multi-Domain Battle concept, describes how it will change sustainment.

As commander of the Training and Doctrine Command, Gen. David G. Perkins is spearheading the Army's efforts to develop the Multi-Domain Battle (MDB) concept, which describes how the Army will fight future wars. In his 37 years as a Soldier, Perkins has developed a reputation for breaking new ground.

In 2003, he commanded the 2nd Brigade, 3rd Infantry Division, the first brigade to cross the border during the invasion of Iraq, for which he earned the Silver Star. From 2011 to 2014, as commander of the Combined Arms Center, he led the synchronization of leader development across the Army. In this interview, Perkins offers his perspectives on sustainment for the MDB environment.

Why is it time for MDB?

Since [Operation] Desert Storm, and throughout the fights in Afghanistan and Iraq, most domains were uncontested. The Air Force had air supremacy everywhere, and the Navy had naval supremacy. We really had no enemy that could bring our cyber systems down. The only domain that was contested was the domain that we operate in, and that is land.

When we see what peer and near-peer competitors are doing, and we've seen their capabilities demonstrated around the world from Ukraine to Syria, we see them going after all of the domains. Therefore, we must assume that every domain will be contested in the next large fight that we get into—the air, the maritime, space, cyberspace, and obviously the land.

The Army can no longer constrain our attention to one domain. We've got to operate on land within the context of the other domains. We must contest all of them so that we can leverage that freedom of maneuver and not let the enemy box us out on land because of something they can do in cyberspace.

How do you anticipate force design evolving to support MDB?

We are already beginning to come up with new force design structures, and that is part of the concept that is becoming reality from an organizational point of view. Probably the first big change people are going to see is that we are standing up an MDB task force. It is meant to counter the anti-access/area denial environment that specifically aims to prevent the United States from getting into an area of operations through components of the land, air, and space domains. We are building this task force to have the ability to thwart that.

One of its unique aspects is that there will be a portion of it called the ICEW (intelligence, cyberwarfare, and electronic warfare) detachment. We have never had a unit that has a combination of those capabilities. But we are building a sub-unit within the larger task force because what we're finding is that we've got to converge the capabilities of multiple domains to stop what our enemies are trying to do, which is to take away freedom of maneuver.

Will battlefield sustainment change in an expeditionary environment with new domains?

When we take a look at actually operationalizing MDB, there are really two large challenges: how are we going to sustain our units, and how do we connect them via a network?

The reason sustainment will continue to be a challenge is that when we look at our concepts for MDB, what we have are widely dispersed forces that may not be contiguous. Therefore, we have large areas in between them that we do not necessarily control all the time.

When I was growing up in the Army under AirLand Battle, we would lay out our battlefield framework and have our operations overlay. Every piece of ground, somebody owned; we had one unit butted up

Gen. David Perkins, commanding general of the Training and Doctrine Command, discusses the Army Operating Concept with Soldiers and civilians during a leader professional development session at Fort Leonard Wood, Mo., on Feb. 3, 2015. (Photo by Michael Curtis)

against another. But it was assumed that the rear area was a secure area. A lot of our logistics activity would at least begin in the rear and move forward to the front, but it would be over lines of communication that really were secured all the time. In the future, we won't have that construct because there's really not a rear area that's not contested, and we probably won't have continual lines of communication that are secure all the time.

So now the challenge is how do I come up with a concept of sustainment that can operate in noncontiguous areas, cover vast areas, and provide flexibility as things develop very rapidly on the battlefield? I am seeing a couple of things that will help. One of those is in the realm of autonomous robotic systems. There are ways to move a lot of classes of supply autonomously with unmanned aerial and robotic systems and driverless vehicles.

Obviously that [unmanned delivery] really reduces the risk from a protection point of view. It allows us to operate on a 24/7 schedule because we're not having to manage the large number of people involved in a delivery and how it affects them personally. It could also allow us to deal with changing situations very quickly by programming sustainment systems to change as the battlefield changes. Say we're going to send ammunition here, but that changes at the last minute, and we send it somewhere else instead.

The other thing I think will leverage the network is telemedicine. Our ability to provide medical support to the Soldier on the battlefield is a sacred vow that we make to the Soldiers and the American people. We do that on the battlefield better than anybody in the world. We may not have the ability to immediately evacuate every wounded Soldier within the "golden hour," like we would prefer to now. We may have to bring medical attention to them via telemedicine. We may have robots doing medical procedures while being controlled by doctors located at a medical center somewhere far away.

Have you found anyone that is skeptical of the MDB concept, and if so, what do you say to them?

Sometimes people think this is old wine in a new bottle. They think this is just like AirLand Battle, that we have only changed the word from AirLand to Multi-Domain, and everything else is the same. I agree that many of the tenets are the same and that it is an evolution, not a revolutionary way of thinking. But there is one very big difference from AirLand Battle.

In AirLand Battle, we looked across a battlefield and by definition primarily focused on the two do-

mains of air and land. Then we said to the air guys, "You come up with some solutions," and to the land guys, "You come up with some solutions." And, oh by the way, within land I'm going to have warfighting functions, so there's a sustainment part, there's a maneuver part, there's an intelligence part, and there's a fires part. We would start solving these subordinate parts in their little stovepipes, but then to actually execute the mission, we have to bring it all back together.

We would bring all these systems together, and the intelligence system couldn't connect to the maneuver system, which didn't work with the sustainment system that didn't work with the fires system.

The Air Force had different ways of communicating and networking. What we ended up with were a series of federated solutions, which we then had to synchronize. We spent an inordinate amount of time synchronizing systems that were by definition not synchronized. The challenge with that is the rate of activity on today's battlefield and the rate of innovation change so quickly that if you're spending all day long synchronizing federated solutions, the enemy is adapting inside your decision cycle.

So the biggest difference is that we're saying from the very beginning that we must not come up with federated solutions that have to be synchronized, but rather, we must develop a uniquely converged solution that is already integrated.

When I look at a problem, I don't say that's a land problem, that's a fires problem, that's a sustainment problem. I say that's a problem. Inherent in that problem is a sustainment issue; there's a fires issue; there's a space issue; there's a cyberspace issue. We start solving those from the very beginning instead of breaking them out into 20 different working groups. That is going to be one of the biggest impacts—how we define problems and how we come up with converged solutions.

> "When I look at a problem, I don't say that's a land problem, that's a fires problem, that's a sustainment problem. I say that's a problem."
>
> —Gen. David Perkins

How are we balancing readiness today with modernization for the future?

Balancing readiness with modernization is a good way to describe it. The chief of staff of the Army's number one priority is readiness; it has been for two years, and I don't think that will change. Now, into the second half of his tenure, although he is not coming off readiness, he is applying more energy as we think about the future and modernization. I think we're seeing that in many ways and having discussions recently about establishing unity of command, unity of effort, how we acquire materiel, and how we modernize the Army.

It's very helpful to have a long-term vision of how we want to modernize so that when we make an immediate decision about readiness, there may be multiple options. I could take option A, which pushes me in this direction, or option B, which pushes me in that direction. If we know we want to go in one direction long-term, we might make a short-term decision on readiness that actually starts moving us in that direction. So I find it's not an all or none proposition.

Let me illustrate. We need to upgrade the current rifle that we have for our Soldiers. Well, there's been a couple of ways to look at it. We can take an incremental approach to what we have, or we can work with industry where there are some long-term possibilities out there. There are things we can do now that give us a near-term capability but also move us in that direction. The most important thing about having a long-term vision and concept for the future is that it enables us to make the right short-term readiness decisions.

Technology will play a bigger role on the complex, urban battlefields of the future. What innovations do you foresee changing the game for sustaining our units?

One of the biggest demands for our units, especially mechanized units where I've spent most of my life, is for energy. We spend a lot of time and resources, from a sustainment point of view, moving energy on the battlefield. A lot of it is fuel. We have large logistics convoys, and we have to secure them, and of course we have to have the roads and all that. So from a technology point of view, one of the things we're looking at is if there are other ways to move energy around the battlefield and to supply energy.

Right now most of the energy we move is fuel. It takes a lot of space, it's heavy, we have to have the means of conveyance, and it's got to be contained in a fuel truck or something like that. We're looking at electric-drive vehicles. We're looking at fuel cells and hybrids. Maybe if we could move fuel cells around the battlefield, we would have chunks of energy instead of tanks of energy, and it would be much easier to move. It would lend itself much more to autonomous operations.

If I could pre-position energy in places, drop off a chunk of fuel cells or a chunk of energy that somebody then moves to and uses, it's a very different way of running a sustainment operation than just miles and miles of fuel tankers going up and

down the roads.

The number one challenge we have is not energy on the battlefield, but moving it. Usually, we have a big pile of it somewhere; there's a big tank full of fuel maybe at the port. Fuel cells would put energy in a form that is much more easily moved around the battlefield.

Is there another example?

Repair parts and maintaining vehicles. If we can design our vehicles so they require much less routine maintenance and their reliability is much higher, we can really reduce demand on mechanics.

If we could 3-D print repair parts, we can just bring raw materials to the battlefield. We don't have to have every different kind of widget for every different kind of system out there. We just have some blank material and then we can 3-D print it to whatever part we need. That really cuts down on the size of the sustainment footprint.

What implications does the MDB concept have on the joint force?

MDB almost by design and definition is inherently a joint construct. We've known that from the beginning, so we've reached out to our partners in the Air Force, Navy, and Marine Corps as well as our coalition partners. A great example of that is our work with the Air Force as they look ahead to replace their JSTARS [Joint Surveillance Target Attack Radar System]. JSTARS is one of their airborne platforms that gives them what we call "moving target indicators," intelligence of things moving in our domain.

As we were talking to them [the Air Force], we said, "You have to take it to the next level. We don't only need intelligence for things that are moving on land, we really have to have multi-domain intelligence preparation of the battlefield. We have to know what's going on in cyberspace and space, and it's not about replacing a platform, it's about developing a capability."

What we find is there are a lot of things on the battlefield that can provide bits and pieces of this picture to create an understanding. So what we really need is a system of systems that we can knit together to provide this full picture, not just one airborne platform.

So we're sitting down with the Air Force and we're saying that part of this may be an unmanned aerial system that can go into very highly contested terrain and airspace that we may not want to send a manned vehicle into. That way, if we lose it, we're not losing a pilot.

There may be systems on the ground that we could plug into this. There's probably systems in space. There may be stand-off reconnaissance systems; they cannot go into contested airspace but they can stand off and look in and then cross-queue with something from space, collecting data from things that are on the ground. We can't have what I call "one-trick ponies." We want to present multiple dilemmas to the enemy. We don't want to have just one system, and if the enemy takes it down, they take our eyes away. We need multi-domain intelligence from all of the domains.

What advice would you give to Soldiers to adapt to the multi-domain environment?

The really good news is that the Soldiers we are bringing into the Army nowadays have grown up in a multi-domain, interconnected world, and they are used to having many options to deal with a problem. My advice to them is to think about how things occur in a non-military environment and really bring that thinking into the battlefield.

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? Do I send them a tweet? Do I text them? Do I go into Facebook? Do I go into LinkedIn? 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.

What we want folks to think about MDB is that we don't have just a land problem or just an air problem. We have challenges that probably have many different solutions. We want folks to be critical thinkers and think through this and say, "I could try this; if it's not working, I'm going to try my cell phone. Well, I'm not getting coverage there, but I'm right near the computer; I'll get on Facebook and do this."

They inherently do that anyway, and that's really the mindset we want them to bring into the Army. We want to give the commander many different options for delivering as many dilemmas to the enemy as possible, so don't ever limit yourself to just one way of going about the problem. And understand the problem is never defined by a domain; the domain is just something we use to help solve the problem.

As I grew up in the Army, people would say, "Well I own this domain, I own that domain, I own the land." We really have to get away from domain ownership and focus on domain usership. [We need to] think about how we can use a particular domain to our advantage. That would be the intellectual breakthrough Soldiers need to bring with them when they come into the Army.

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A Soldier wears an exosuit while on a three-mile outdoor course at an Army Research Laboratory facility at Aberdeen Proving Ground, Md. The suit, part of the Army's Warrior Web Program, has pulleys and gears designed to prevent musculoskeletal injuries caused by dynamic events that typically occur in the warfighter's environment. (Photo by Rob Carty)

Sustaining Multi-Domain Battle Through Science and Technology

■ By Maj. Gen. Cedric T. Wins

In the Army's modernization effort, the role of the Research, Development and Engineering Command (RDECOM) at Aberdeen Proving Ground, Maryland, is to develop the capabilities the force needs to rapidly transition to Multi-Domain Battle (MDB) while also discovering technologies the future force will need to maintain dominance as information, events, and weapons system advancements accelerate.

RDECOM has a global network of partners in academia, industry, and government agencies. This network positions the command to meet its goals by maintaining a balance between near-, mid-, and far-term development efforts and the organizational agility required to rapidly shift focus to meet new challenges. Institutional continuity is required in order to conduct the ongoing research and development that yields the technologies of tomorrow.

Improving Capabilities

RDECOM's internal efforts to meet the chief of staff of the Army's mandate to streamline and rationalize capability development have been focused into a campaign to improve the command's four main mission areas: integrated technology development and engineering services, human capital and infrastructure, business process and resource optimization, and strategic communications.

Delivering these capabilities quickly and effectively is key to empowering Soldiers in the MDB environment, and RDECOM is examining its posture to support that fundamental shift in how the Army fights.

In September 2017, the command participated in a MDB task force pilot program workshop at Schofield Barracks, Hawaii. During the workshop, participants from RDECOM's Communications-Electronics Research, Development and Engineering Center examined developmental technologies that could support task force exercises scheduled for the summer of 2018.

The center will work with U.S. Army Pacific partners to finalize the network architecture and validate configuration for future training engagements. This is a positive first step as the Army begins to embrace and engage the MDB concept of operations.

RDECOM scientists and engineers continue to execute long-term efforts that have the potential to affect the Army's top priorities. These efforts include advanced helicopters, long-range precision fires, air and missile defense, unmanned vehicles, virtual training, and Soldier lethality and survivability technology.

Future Vertical Lift

RDECOM is working on the Future Vertical Lift (FVL) program to produce the next generation of vertical take-off and landing aircraft. These helicopters will fly farther and faster, carry heavier payloads, and team up with unmanned systems. With the range of capabilities now being developed, Army aircraft will provide increased flexibility for Soldiers facing near-peer competitors, insurgent forces, or combinations of these threats across multiple domains.

The search for FVL technology is routed through the Joint Multi-Role Technology Demonstrator. Army researchers conduct demonstrations to vet new air vehicle systems such as engines, transmissions, airframe structures, and rotors. They also focus on air vehicle design, which includes avionics, structures, weapons, and sensors. For tactical operations, researchers are looking to integrate the new FVL fleet for use by both manned and unmanned teams.

Battlefield Technologies

RDECOM researchers are focused on providing Soldiers and small units with technologies that deliver decisive advantages on the battlefield. These technologies will help Soldiers shoot with more accuracy, move faster, and communicate more securely. Soldiers will also

Through collaboration with academia, industry, and government agencies, RDECOM drives research, development, and engineering efforts to prepare the Army for Multi-Domain Battle.

The Research, Development and Engineering Command explores the relationships between humans and machines, such as autonomous vehicles. (Illustration by David Vergun)

be better protected and more easily sustained.

RDECOM is researching ways to sustain Soldiers on the battlefield with safe airdrop and dismounted energy. To give Soldiers optimized and advanced lethality in urban, complex, and open terrain, Army scientists are studying Soldiers' cognitive and physical performance. The command evaluates Soldier performance by monitoring and integrating nutrition and hydration.

To give the force assured and secure communications, Army scientists are developing sensors that monitor Soldiers' performance and power management tools that observe their activity. They have also developed Nett Warrior, a system that provides dismounted leaders with situational awareness and mission command capabilities.

RDECOM scientists are developing body armor and integrated head protection to increase survivability. They are also working to protect Soldiers through signature management, concealment, and high-value asset decoys. Single- and multi-joint exoskeleton systems will give Soldiers enhanced mobility, endurance, and lethality.

Developments include an integrated warrior system that allows a Soldier to shoot, move, and communicate while wearing an enhanced mobility, load-sharing, life-protecting suite of technology. RDECOM is also delivering next-generation weapons with performance-enhanced optics.

Training Improvements

As an alternative to live training, the Army is using augmented reality to train Soldiers at all levels. For dismounted Soldiers, the augmented reality system is integrated into a kit worn during training.

Information such as navigation waypoints, potential enemy locations, and friendly unit locations are displayed through monocular head- or helmet-mounted displays that provide a clear view of the battlespace.

RDECOM is improving the synthetic training environment to prepare Soldiers for what they may encounter on the battlefield. This includes training a large number of Soldiers at the point of need through network- or cloud-based streaming.

Using various tools and algorithms that collect data for exploitation, terrain generation, storage, and distribution, RDECOM can create a virtual training environment that is almost identical to the environment Soldiers will enter when they deploy. In a few years, the Army will be able to train combined arms strategy and tasks through synthetic training in local training areas.

The NGCV

In the future, Army technology will deliver the next generation combat vehicle (NGCV) and other close combat capabilities in manned, unmanned, and optionally manned variants. Armed with the most modern firepower, protection, mobility, and power generation capabilities, the NGCV will ensure combat formations can fight and win against any foe.

In concert with industry, academia, and international partners, RDECOM scientists and engineers are designing a vehicle with next-generation capabilities. Smart, fast, lethal, precise, protected, and adaptable are the critical characteristics driving current NGCV concepts.

RDECOM's scientific underpinnings enhance the capabilities for future manned and unmanned platforms and provide the flexibility to adapt ground vehicles to ever-changing environments. The Tank Automotive Research, Development and Engineering Center plans to deliver two NGCV experimental prototypes by 2022.

The RDECOM workforce has the expertise and the network of partners to discover and develop these technologies. The command's campaign plan will create a more focused organization that can move at the speed required to support MDB.

Ready for Change

The need for speed imposes unique challenges on RDECOM in human capital and infrastructure, which are two areas of prime importance to its current organizational improvement campaign.

Sustaining a technological edge in the face of increasingly fast technological change means researchers must not only lead in the scientific disciplines that are currently important to the Army; they must also identify emerging disciplines as well as the threats and opportunities they present.

Changes in the communications used to occur over the course of a conflict as adversaries adapted from battle to battle. Now the Army faces the possibility of cyber challenges evolving within a single engagement. The accelerating pace of change in that domain may forecast how change will emerge in other domains.

This means the Army must be prepared to hire or partner with people who have knowledge and skills that may not yet exist to work in facilities the Army may not yet have. The faster these challenges and opportunities emerge, the faster RDECOM must react, so it must be organizationally and intellectually flexible. This calls for a skilled and agile workforce, an organization flexible enough to support it, and the ability to collaborate quickly and effectively to meet mission requirements.

RDECOM has long had relationships with organizations working on modernization. The command has provided scientific advice to the requirements community in the Training and Doctrine Command, and it has provided engineering services to program executive offices and life cycle management commands. It also has advisers supporting major Army and joint warfighting commands and liaison officers within many other commands.

These partnerships are key to RDECOM's charter mission of technology integration, which will only grow in importance. By its nature, the MDB against adversaries with a range of capabilities will force Soldiers and commanders to consider more factors than previous concepts of war entailed.

The Army cannot develop, field, and train for separate capability sets to use in different domain combinations against every potential adversary in every part of the world. It must integrate the necessary technologies into capabilities that Soldiers can use across the broadest possible spectrum of domains. This will impose new cognitive demands on Soldiers that must be recognized and mitigated if the Army is to remain the world's dominant land force.

The need to remain ready to achieve that goal drove the recent decision to form a task force led by the director of the Army's Business Office. The chief of staff of the Army and acting secretary of the Army will ultimately decide which task force recommendations they will implement to meet the goal of standing up a new command focused on Army modernization in 2018.

These decisions may make a considerable difference in how RDECOM scientists and engineers are tasked and how they report, but the underlying research, development, and engineering tasks are bound by physical laws as well as proven scientific and engineering methodologies.

Whatever changes MDB and future organizational alignments bring, the RDECOM team will continue to deliver technological capabilities that empower, unburden, and protect today's Soldiers while developing capabilities the future force will need to face the challenges it will encounter tomorrow.

Maj. Gen. Cedric T. Wins is the commanding general of the Research, Development and Engineering Command. He has a bachelor's degree from the Virginia Military Institute and master's degrees from the Florida Institute of Technology and the National War College. He is a graduate of the Field Artillery Officer Basic and Advanced Courses and the Command and General Staff College.

Maj. Gen. Randy S. Taylor, commander of the Communications-Electronics Command, discusses communications, computers, intelligence, surveillance, and reconnaissance sustainment challenges with Gen. Gustave Perna, commander of the Army Materiel Command, at Aberdeen Proving Ground, Md. The item in front of them is part of the transportable tactical command communications satellite terminal. (Photo by Sean Kief)

Sustaining Mission Command Capabilities for Multi-Domain Battle

■ By Maj. Gen. Randy S. Taylor


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Supporting Multi-Domain Battle means providing modern and reliable mission command capabilities that enable the shared understanding required to outmaneuver sophisticated adversaries.

Your greatest strength can become your greatest weakness if you fail to adapt to the changing conditions of your environment. The Army's lethality is underpinned by an unrivaled culture of decentralized execution and enabled by mission command capabilities that have been far more powerful and reliable than those of any opposing force to date.

Unlike recent operations, the Army's long-assumed strength of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) dominance is at risk of being a potential weakness in the emerging operational environment. In this environment, sensor-rich adversaries are committed to limiting U.S. access to space, cyberspace, and the electromagnetic spectrum.

To win now and in the future, especially when facing technologically advanced adversaries, leaders trust the Communications-Electronics Command (CECOM) to ensure that their C4ISR systems are sustained and ready as conditions change throughout a complex, highly lethal, multi-domain environment.

Today's Battlefield and Beyond

In Multi-Domain Battle, modernized and reliable mission command capabilities enable the shared understanding required to outmaneuver sophisticated adversaries. The Army's reliance on C4ISR systems will continue to grow with the unprecedented and increasing dispersion of small, yet more interconnected, units conducting decentralized operations.

Ahead of this challenge, CECOM is finding innovative ways to simplify sustaining the most advanced C4ISR systems ever used by U.S. Soldiers. CECOM's overarching mission is to sustain the readiness of C4ISR hardware and software in support of Army priorities and combatant commander requirements.

Sustaining C4ISR materiel readiness requires an aggressive and collaborative approach by CECOM, program executive offices (PEOs), and industry partners. CECOM, the PEOs, and more specifically program managers (PMs) must be integrated and synchronized from program acquisition inception through the transfer of C4ISR systems to the CECOM sustainment portfolio.

The decisions that PMs make early in the process significantly affect what happens in sustainment because 55 to 70 percent of a program's life cycle funds is spent on post-acquisition operations and sustainment. The other 30 to 45 percent is spent on research, development, testing, acquisition, and fielding. This ratio is understandable when you consider how long the Army typically sustains programs after initial fielding.

Life Cycle Sustainment Plan

The life cycle sustainment plan that the PM develops in coordination with CECOM must anticipate future requirements to modify the sustainment of C4ISR systems as technology, threats, and the operational environment change.

Going beyond the plan, the CECOM Research, Development and Engineering Center developed a uniform open system architecture to future-proof systems. The center created a method to upgrade software quickly by simply replacing a capability processing card.

This method not only will eliminate the number of boxes on platforms but will also reduce redundant parts, save time and money, and diminish the logistics burdens associated with retrofits off the battlefield.

Universal A-kit

Taking future-proofing a step further, the C4ISR Electronic Warfare Modular Open Suite of Standards lays out guidelines for a universal A-kit that eliminates the need for platform-specific integration. Ca-

pabilities can be fielded as circuit cards for common chassis and components that use existing cables.

The concept of a universal A-kit is a game-changing approach because it ensures commonality across multiple platforms while allowing for rapid insertion of the latest C4ISR systems. The universal A-kit better enables Soldiers for the next fight while simplifying training. It also provides significant cost savings during the sustainment phase of the life cycle.

The C4ISR Electronic Warfare Modular Open Suite of Standards will revolutionize sustainment. It will shorten logistics tails by having a greater number of common spares and reducing costs through competition and economies of scale. Sustainers will no longer need to purchase enough spares to last more than 30 years; they will be able to perform modernization through spares and upgrade to the latest hardware every five to 10 years.

Staying Updated

Keeping mission command capabilities ready requires that all C4ISR supply parts be available. This is an astounding challenge given the myriad systems and component parts required. There are many ways to attack this problem; among them are prompt and proactive divestiture of obsolete hardware and software.

The relationship between CECOM's Integrated Logistics Support Center and each unit commander is key to ensuring that the Army removes outdated legacy systems from its inventory. Divesting legacy systems and establishing pure-fleet solutions with backward compatibility will ultimately reduce the overall sustainment and supply footprint.

Software Sustainment

As technology advances and systems become more software-defined rather than hardware-defined, the most rapidly evolving facet of the multi-domain sustainment challenge is software. Every piece of modern hardware requires thousands, if not millions, of lines of software code to operate.

Unfortunately, software sustainment has often been the last consideration in acquisition planning. Historically, the Army has not placed a high priority on the long-term software sustainment challenge. As a result, a growing and underfunded requirement to renew hundreds of thousands of disparate, legacy software licenses is competing with the Army's ability to modernize and sustain better capabilities.

By addressing software sustainment early in the acquisition cycle and securing the appropriate intellectual property rights to the software code, the Army is significantly improving its future ability to address software modernization and sustainment.

A significant factor of the software sustainment challenge when facing a technologically savvy adversary is the constant need for protection against cyber vulnerabilities that an adversary could exploit.

Distributing information assurance vulnerability alert software patches to dispersed units around the world has been difficult because it involves physical delivery. We are changing that paradigm by employing over-the-network information assurance vulnerability alert patching.

A joint effort between CECOM's Software Engineering Center and CECOM's Tobyhanna Army Depot delivers protection against vulnerabilities securely and almost virtually—as quickly as those vulnerabilities are discovered. This ability to rapidly react to remain operable is exactly what Soldiers need for reliable, secure operations.

New Acquisition Construct

CECOM will be decisively engaged in the new acquisition construct of "adapt and buy." CECOM, along with the Army Materiel Command, will provide science and technology, contracting, and sustainment expertise to the cross-functional teams that are the cornerstone of the new acquisition construct. In the area of sustainment, the focus will be on reducing the demand on Soldiers and the Army's operational formations.

CECOM will reduce demands on Soldiers by collaborating early with PMs on strategies that will make sustainment intuitive. These sustainment strategies must focus on not burdening Soldiers while, at the same time, not sparking force structure growth.

This will require the milestone decision authority to make tough decisions early in a system's life cycle regarding intellectual property and technical data rights. These two components are critical to the Army's ability to sustain a system organically.

To meet the challenges described above, CECOM's amazingly capable individuals and teams and its industry partners will continue to meet the nation's needs through innovation, collaboration, and low-tech elbow grease—100 percent of the people doing 100 percent of the work.

CECOM is on the leading edge of the evolving relationship among Soldiers, machines, and software, and the risk of meeting technologically advanced adversaries is increasing. The stakes are high, and the time has never been more critical for CECOM to get C4ISR sustainment right.

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The Final Tactical Mile in Multi-Domain Battle: Seizing Mosul, Tal Afar, and Raqqa

By Brig. Gen. Christopher J. Sharpsten

An Iraqi Counter Terrorism Service convoy moves toward Mosul, Iraq, on Feb. 23, 2017. The breadth and diversity of partners supporting Combined Joint Task Force–Operation Inherent Resolve demonstrate the global and unified nature of the endeavor to defeat the Islamic State group in Iraq and Syria. (Photo by Staff Sgt. Alex Manne)

Today's sustainers live and operate in a multi-domain environment. Successful completion of the sustainment mission hinges on a holistic approach across the spectrum of land, air, maritime, cyberspace, and space domains.

The Army's Multi-Domain Battle concept, which is being developed under the leadership of the Army Capabilities Integration Center, focuses on the character of war in the 2040 to 2050 time frame. This will be a fight against a near-peer adversary, but the theoretical applications of Multi-Domain Battle doctrine are not just theoretical; they are in daily use today.

The battles to defeat the Islamic State group and liberate the cities of Mosul, Tal Afar, and Raqqa are all multi-domain fights. Our sustainers are actively integrated at multiple echelons supporting the fight through seamless integration across the land, air, maritime, and cyberspace domains to enable the fight. This is our story.

Operation Inherent Resolve

The Combined Joint Task Force–Operation Inherent Resolve (CJTF–OIR) mission is to defeat the Islamic State group in designated areas of Iraq and Syria and to set conditions for follow-on operations to increase regional stability. This is a multi-domain fight involving coalition forces, Iraqi Security Forces (ISF), and Syrian Democratic Forces (SDF).

The battles to seize and clear Mosul, Tal Afar, and Raqqa provide an excellent backdrop to describe our sustainment support in a multi-domain environment. The seizure of Mosul was a challenging nine-month urban operation for the ISF. Despite stubborn Islamic State group resistance and complex urban terrain, the ISF proved to be a resilient and professional force. Throughout the campaign, the ISF not only regenerated lost combat power but also continued to build new combat brigades for future fights.

Following a brief tactical pause of a few weeks to refit and reposition, the ISF postured for a multiprong assault using three Iraqi army divisions to seize and clear the city of Tal Afar and the surrounding area. Although this was expected to be another tough urban fight, the ISF masterfully maneuvered and drove the Islamic State group from their last stronghold in the north in an eight-day operation.

The SDF has used a similar method to grow its capability and strength. The SDF is a light infantry force, and it has expertly maintained the initiative over the Islamic State group through its ability to amass forces while simultaneously providing critical mission command.

The SDF's air assault seizure of key terrain near Tabqah Dam and the follow-on clearance of Raqqa is a perfect example of integrating multiple assets into a multi-domain battle. Through its ability to blend multidimensional warfighting, it created a window of opportunity that led to its ultimate success.

Through all of these fights, the CJTF–OIR coalition used a wide array of multi-domain enablers to facilitate the success of our partner forces, the ISF, and the SDF. These enablers encompass an array of tools across the warfighting functions to include sustainment.

The Traditional Domains

The traditional domains of land, air, and maritime have always been part of the Army's combat operations. While land combat is our core competency, we routinely use the air and maritime domains to create windows of opportunity for land forces. Within the CJTF–OIR area of operations, we rely heavily on ground and air lines of communication (LOCs). However, those LOCs are occasionally disrupted by weather, political sensitivities, and enemy activities. To overcome these frictions, our sustainers are seasoned to look for innovative ways to achieve logistics dominance by, with, and through our partner forces.

The air domain is a frequent solution for supporting the SDF in Syr-

Sustainers in Combined Joint Task Force–Operation Inherent Resolve are employing Multi-Domain Battle concepts to sustain their partners.

ia. In the past 12 months, the Army conducted over 100 airdrop missions that deployed more than 1,000 bundles of supplies to various geographically dispersed forces and isolated elements. By doing so, sustainers were able to provide a range of mission-essential supplies including meals, water, ammunition, and fuel. Airdrop, in addition to rotary-wing resupply operations, will continue to be a key sustainment enabler in the air domain.

While the maritime domain may seem absent from the CJTF–OIR's arid environment, it became a critical domain during the initial stages of the Raqqa campaign. The air assault across Lake Asad to seize Tabqah Dam was a classic example of creating a temporary window of superiority over Islamic State group forces.

However, Lake Asad presented a geographic obstacle for Army logisticians supporting an isolated force. With limited air assets and no ground routes available, they established a tactical sea LOC using Zodiac boats. The waterborne movements were critical to the fight by transporting personnel, equipment, and key resupply. We have since established a ground route to support forces on the other side of Lake Asad, but the sea domain technique remains a viable option in the future.

The Nontraditional Domains

During an Association of the United States Army hot topic session on June 30, 2017, Joshua Marcuse, the executive director of the Defense Innovation Board, challenged the audience "not to think about moving stuff, but to think about moving data."

Recent history and operations have highlighted the importance of mastering the cyberspace domain in order to achieve logistics success and sustain the fight. Furthermore, during discussions about future near-peer conflicts, Army leaders agree that concentrated logistics operations should be avoided to prevent targeting.

Although the threat of the Islamic State group targeting our logistics sites exists, the Army avoided concentrated logistics operations in Mosul, Tal Afar, and Raqqa for a completely different reason. The CJTF–OIR's operational environment has limited ground and air LOC capacity.

As a result, logistics mass is not feasible, and we have been forced to prioritize the exchange of information in order to provide a more responsive requirements process. This process hinges on cyber connectivity and integration before the physical distribution of materiel even begins.

Data exchanges between partner forces and supporting coalition forces enable the coalition to procure and distribute critical equipment and supplies as needed. In this environment, requirements visibility and efficient distribution replace logistics mass.

Internet portals, email, video teleconferences, and the iPhone Facetime application have all become routine cyber tools that are used to communicate with partner forces. We view these tools as a way to facilitate traditional methods of communication in an expedited manner.

As we move forward, we are looking for innovative ways to leverage commercial technologies in order to improve sustainment data feeds. The Iraqi telecommunications network has made great strides in the last decade. U.S. teams are looking for ways to harness the local network to provide a system for in-transit visi-

Sustainment units conduct aerial resupply to the Syrian Democratic Forces, who are partnering with the Army to fight the Islamic State group.

A tactical sea line of communication was established across Lake Asad using Zodiac boats. These boats transported personnel, equipment, and supplies to an isolated force when no ground routes were available.

bility (ITV). In the CJTF–OIR area of operations, we see a possibility for a capability similar to how Amazon links orders to the UPS system to provide ITV.

The existing radio-frequency ITV network is robust, particularly in the Kurdish regions of Iraq. If we can link the unclassified ITV database to the ITV network, we would be able to track requirements from initial request to final delivery. This would foster additional transparency, trust, and accountability among our partners.

Another cyber tool in our arsenal focuses on enhancing logistics security. The Army initiated the use of Secure Electronic Enrollment Kits (SEEK) on the Northern Distribution Network, a contractor-managed Kurdish regional route that provides a ground LOC from Erbil in Iraq to our major logistics node in northern Syria. The Northern Distribution Network had little military supervision, so the Army sought ways to oversee who was managing its cargo on the route.

SEEK biometrics improve contractor vetting efforts by screening drivers and passengers at pickup, border crossings, and delivery points. Since SEEK was implemented, we have been able to apprehend multiple Islamic State group sympathizers on the ground LOC, thereby safeguarding cargo.

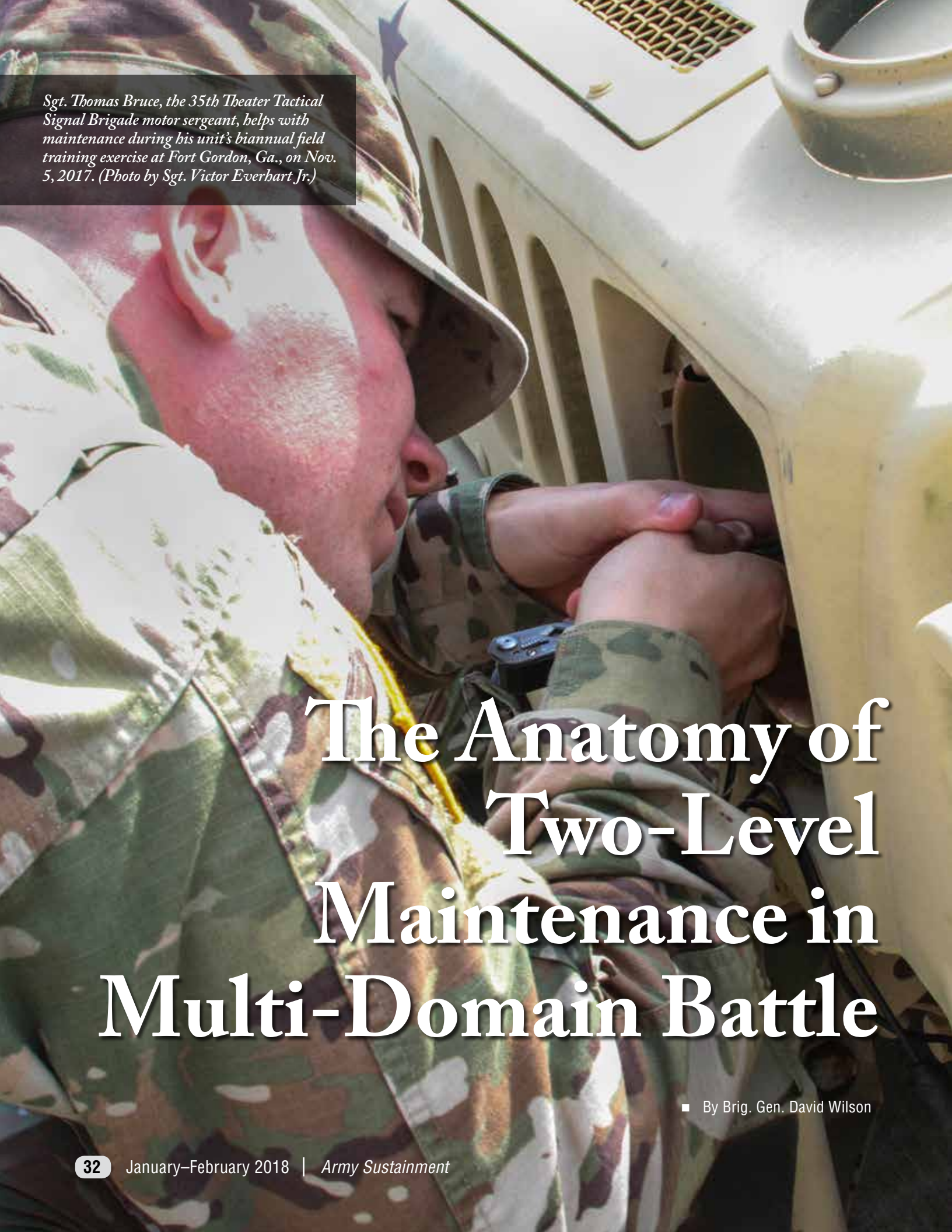
Lastly, there is the information domain. We view our efforts in this domain as passive, not active. The information domain is a dynamic landscape of tribal, cultural, religious, and political tensions. Sustainers and contracted vendors navigate this complex domain daily as they transit the region and acquire, store, distribute, and deliver needed cargo and services.

Daily engagements with the people of Kuwait, Iraq, and Syria put sustainers on the front line of CJTF–OIR messaging. This interaction helps us to remain ahead of enemy forces because our message—that we are here enabling our partner forces to defeat the Islamic State group—is heard first.

Gen. David G. Perkins, the commanding general of the Training and Doctrine Command, states in his July–August 2017 *Military Review* article, "The Multi-Domain Battle concept will continue to improve our capabilities across warfighting functions so we can arrive on the future battlefield as a converged and integrated joint force, one step further and one step faster than our enemy."

The Army is the world's preeminent land power that fights and wins wars as part of the joint force. Army forces are able to integrate, synchronize, and optimize the efforts of multiple partners. Our mission in Iraq and Syria is nested in those two topline messages. As we prepare for future fights in this complex world, we must be prepared to fight and sustain across multiple domains. Today's sustainers embrace multi-domain concepts in order to holistically support the force and maintain operational momentum over the enemy.

Brig. Gen. Christopher J. Sharpsten is the CJ-4, director of sustainment, for the CJTF–OIR. In previous assignments, he commanded the 3rd Expeditionary Sustainment Command at Fort Bragg, North Carolina, and served as the Department of the Army G-45/7 responsible for Army logistics force structure, doctrine, and strategy development.



Sgt. Thomas Bruce, the 35th Theater Tactical Signal Brigade motor sergeant, helps with maintenance during his unit's biannual field training exercise at Fort Gordon, Ga., on Nov. 5, 2017. (Photo by Sgt. Victor Everhart Jr.)

The Anatomy of Two-Level Maintenance in Multi-Domain Battle

■ By Brig. Gen. David Wilson

In Multi-Domain Battle (MDB), maintenance will remain the cornerstone of readiness and logistics will remain the muscle that enables the fist to strike. MDB will require the logistics professionals responsible for maintaining the force to master two-level maintenance (TLM) processes. These processes will enable them to maintain forces at the tip of the spear using capabilities that allow them to fix far forward.

To do this, maintainers and logisticians will be required to execute an enterprise maintenance process across five domains (air, land, maritime, space, and cyberspace) that will allow the Army to meet expeditionary, operational, and home-station requirements simultaneously. This process will ensure that maintainers in all components are ready to operate anywhere, anytime, and in any environment.

This will require rigorous training and discipline in maintenance management operations. In order to master TLM, Army organizations and personnel must understand its anatomy.

The Anatomy of TLM

It has now been more than a decade since Army maintenance officially morphed from four levels to two. So what is TLM? Why did we change the maintenance process? What is the standard? Are we spending too much time on maintenance? Are we over-maintaining our equipment?

The TLM system is how the Army delegates the responsibility of specific tasks to ensure weapons and equipment are maintained effectively and efficiently. The system separates Army maintenance into two categories: field-level maintenance and sustainment-level maintenance. Field-level maintenance is an on-system or near-system repair process that returns equipment to the user. Sustainment-level maintenance is an off-system repair process that returns equipment to the supply system.

Implementing TLM reduced the Army's logistics footprint and allowed for a swift maintenance response in any environment. TLM repairs equipment at the point of need. It uses fewer maintenance echelons, which eliminates duplication of work and procedural steps. The result is increased productivity and combat power. The commander's ability to build and preserve combat power in MDB will be enhanced by maintainers' mastery of TLM.

Commanders at all levels are mandated by Army Regulation (AR) 750-1, Army Materiel Maintenance Policy, to maintain equipment to the maintenance standards specified in paragraph 3-2. The Army maintenance standard has not changed from when it was first implemented in 1979. It is defined by the equipment's technical manual (TM) 10 series or TM 20 series or technical data plan. What has changed is the echelon at which the standard is achieved.

Field-level Maintenance

Field-level maintenance is performed by individual units, or their supporting units, on their own equipment. Systems are repaired in maintenance facilities, motor pools, mobile shops, or the tactical environment.

Duties for this level of maintenance include approved field-level modification work orders, fault and failure diagnoses, battle damage assessment and repair, recovery, calibration, and replacement of damaged or unserviceable parts and components. Other duties include the manufacturing of critical unavailable parts and inspecting, servicing, lubricating, adjusting, and replacing parts, minor assemblies, and subassemblies.

Two groups perform maintenance actions at the field level: crews/operators and maintainers. Each maintainer is responsible for specific functions at a certain level of maintenance according to a maintenance allocation chart found in the TM for each piece of equipment. All TM

Operators and maintainers must be well-versed in two-level maintenance processes in order to keep pace with the demands of Multi-Domain Battle.

Two-Level Maintenance *(Effective 2005)*	Four-Level Maintenance *(Before 2005)*	Maintenance Level	Types of Organization *(Not all inclusive)*
Field (Includes operator and maintainer levels.)	Operator/Crew	10	**All**
	Organizational	20	Forward Support Company Field Maintenance Company Support Maintenance Company Logistics Readiness Center
	Direct Support	30	
Sustainment (Includes below depot and depot levels.)	Direct Support	30	Logistics Readiness Center with approval
	General Support	40	
	Depot	50	**Army Depots** Anniston, Alabama Corpus Christi, Texas Red River, Texas Letterkenny, Pennsylvania Tobyhanna, Pennsylvania

Figure 1. Two-level maintenance realigned maintenance tasks into field-level and sustainment-level maintenance.

10 series and TM 20 series tasks and 70 percent of TM 30 series tasks are aligned under field-level maintenance. (See figure 1.)

For example, a brigade combat team, the Army's primary combat formation, has the full complement of maintenance capabilities within its organic units. If a brigade weapon system is damaged and is reparable using field maintenance, there is no need to evacuate that system to another unit or echelon. The forward support companies and field maintenance company within the brigade support battalion have the ability to do all field-level repairs.

Another example is the combat sustainment support battalion's support maintenance company. Army Techniques Publication 4-93, Sustainment Brigade, says that the support maintenance company provides field maintenance and technical assistance support to echelons-above-brigade units on an area basis.

The support maintenance company's capabilities include communications, electronics, small-arms, radar, and missile repair, welding, fabrication, and recovery assistance to units within its area. When attached to the combat sustainment support battalion, this unit does not provide sustainment maintenance.

Sustainment-level Maintenance

Some maintenance tasks that had been performed at the unit level were moved to the sustainment level. In fact, 30 percent of TM 30 series and all TM 40 series and TM 50 series tasks are performed at this level.

Sustainment-level maintenance is performed at specific facilities that specialize in national-level maintenance. These facilities include the depots, Army field support brigades, Army field support battalions, and logistics readiness centers when granted authorization from the Army Materiel Command. The sustainment maintenance function can be employed at any point in the integrated logistics chain.

It is important to remember that when equipment is evacuated or sent to a depot facility, a supply transaction takes place. Once the equipment is received, repair or replace tasks are performed by personnel who have higher technical skills using specialized tools and equipment that are not available at the field level. Those tasks include inspection, test, repair, modification, alteration, modernization, conversion, overhaul, reclamation, and reconstruction of parts, assemblies, subassemblies, components, equipment end items, and weapon systems.

Readiness

Maintenance is the cornerstone of readiness. As long as you are good at maintaining the eight conditions of the maintenance standard described in AR 750-1, you are good at TLM.

Time. Are we spending too much time on maintenance? You be the judge. Before you decide, you have to understand the difference between the TM 10 series and TM 20 series standards.

PMCS. Readiness starts with preventive maintenance checks and services (PMCS). In order to achieve the Army's maintenance standard, every piece of equipment goes through the PMCS process. PMCS starts with the operator, the equipment, and the associated TM. It gives the operator or crew member a checklist that delineates an order of checks and services. Each step is clearly defined and tells the

user what to check, when to check it, and exactly how to check it.

According to TM 10 series manuals, PMCS is conducted before, during, and after any type of movement or use. On the other hand, TM 20 series manuals have the maintainer performing routine quarterly, semiannual, annual, and biennial services.

Both standards require the unit to conduct scheduled services, lubricate equipment, record and report deficiencies and shortcomings, and order replacement parts.

Through the PMCS process, all faults should be identified. Are Soldiers conducting their required inspections before, during, and after use?

Faults. Faults are listed in the equipment's TM, which tells the operator or maintainer if a fault makes the equipment not mission capable (NMC). According to AR 750-1, a fault indicates "that a piece of equipment has a deficiency or shortcoming." A deficiency is "a fault or problem that causes equipment to malfunction. Faults that make the equipment NMC are deficiencies." A shortcoming is "a fault that requires maintenance or supply action on a piece of equipment but does not render equipment NMC." So, deficiencies deadline equipment; shortcomings do not.

Reporting. The key to maintaining readiness is reporting—not just reporting, but reporting accurately and on time. Inaccurate or late reporting leads to limited resources and a false sense of readiness. Poor maintenance supervision contributes to a user's failure to check the condition of equipment and report faults accurately.

Leadership. Where are leaders throughout all of these processes? On the line! The commander's maintenance program is most successful when leaders at all levels are fully engaged. Their involvement in maintenance meetings underscores the principle that maintenance is the cornerstone of readiness and readiness is a priority.

Complacency is the enemy of leaders, maintainers, and operators alike during routine actions in a non-combat environment. Therefore, a leader's presence on the line is critical to enforce standards of discipline, impart pride in ownership, and keep Soldiers engaged. Soldiers care when they see their leaders care. Is maintenance your priority? If so, it will be theirs.

Over-maintaining equipment. Are we over-maintaining our equipment? No. You can never over-maintain. Perhaps you can over-service. Scheduled and unscheduled maintenance are equally important. The more we touch our equipment, the more likely it is to be ready at a moment's notice.

The hard questions. I encourage you to ask the hard questions. Is my unit really ready? Can I do more? Your involvement is critical to building and preserving readiness.

TLM in MDB

TLM will be required to keep pace with the demands of MDB. When operational readiness rates are consistently above the Army standard, a commander has the flexibility and confidence to act immediately to create and exploit temporary windows of advantage, restore capability balance, build flexible and resilient formations, and alter force posture to enhance deterrence.

It is critical that operators and maintainers be well-versed in TLM processes as the Army begins to incorporate new technology in the maintenance arena. This will enable maintenance formations to preserve weapons and platform security, use condition-based maintenance (CBM) and CBM+, and employ additive and subtractive manufacturing. These promising capabilities will enhance maintainers' ability to support the demands of the warfighter on the multi-domain battlefield.

Emerging weapon systems and platforms demand a systematic approach to ensure security and protection against cyberthreats capable of limiting, disabling, or destroying weapon systems and platforms.

CBM and CBM+ support predictive maintenance capabilities. According to the CBM+ guidebook, it uses a "systems engineering approach to collect data, enable analysis, and support the decision-making processes for system acquisition, sustainment, and operations."

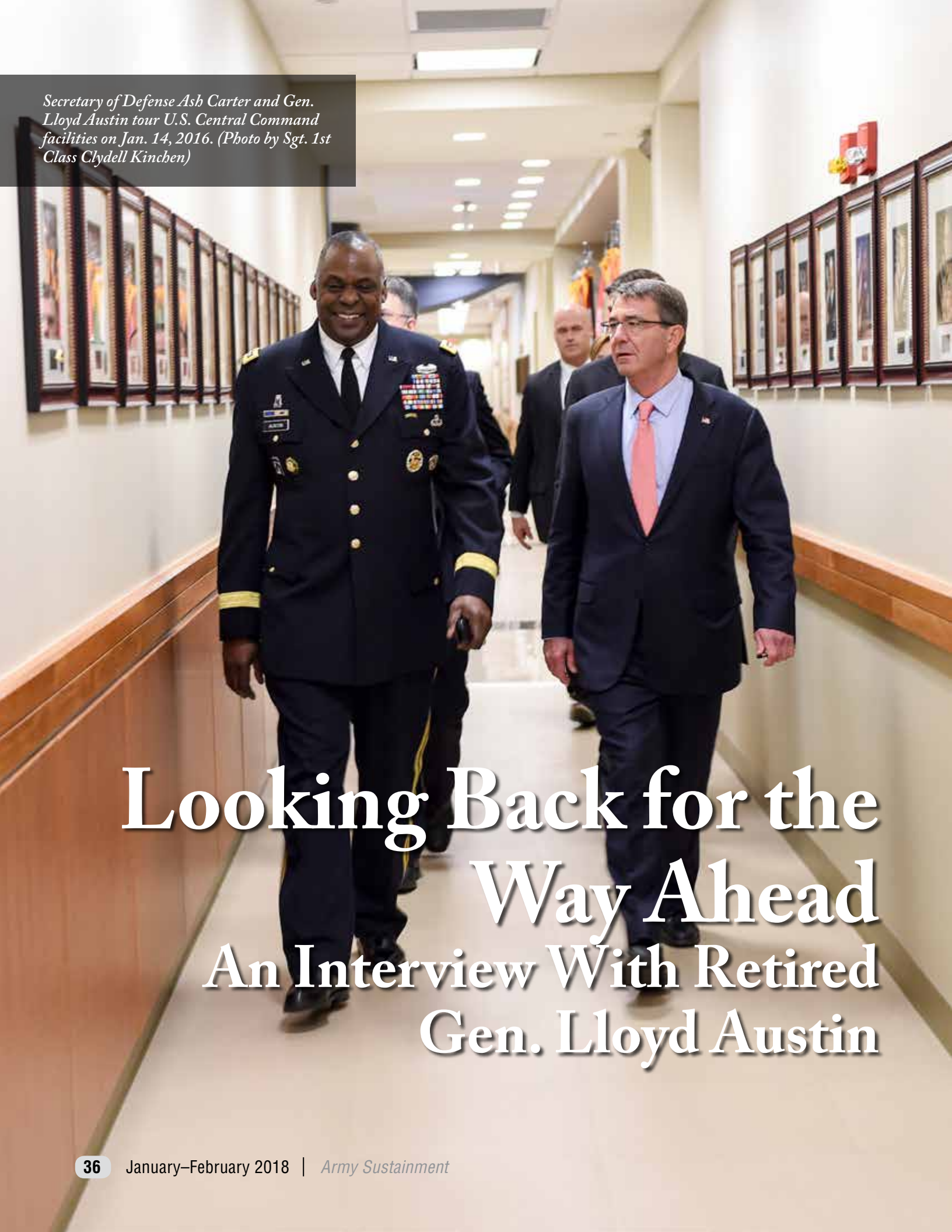
Additive and subtractive manufacturing, such as 3-D printing and computer numerical control machining, provide unique or low-density parts at the point of need, reduce the demand on the supply chain, address parts obsolescence, and enhance on-system and off-system repairs forward.

Reliable access across space and cyberspace will be increasingly important to support emerging technologies that increase the Army's ability to sustain an expeditionary force across a distributed battlefield.

What risks are inherent with increased use of technology in the maintenance arena? How do we maintain readiness during periods of disconnected operations? Can we diagnose faults, manufacture parts at the point of need, or employ predictive analytics when satellites are down? These questions demand our consideration.

As we leverage technology to expand our maintenance capabilities, we are aware of the inherent risks. For this reason, we must never forget that our most critical, trusted assets are our maintenance professionals and the leaders who demand a disciplined approach to TLM. Through a disciplined approach to TLM, we will be able to fix far forward and provide service to the line, on the line, on time. Go Ordnance!

Brig. Gen. David Wilson is the 40th chief of Ordnance and the commandant of the Ordnance School at Fort Lee, Virginia. He is a graduate of The Citadel, The Military College of South Carolina, and the Industrial College of the Armed Forces.



Secretary of Defense Ash Carter and Gen. Lloyd Austin tour U.S. Central Command facilities on Jan. 14, 2016. (Photo by Sgt. 1st Class Clydell Kinchen)

Looking Back for the Way Ahead

An Interview With Retired Gen. Lloyd Austin

During his 41-year career, retired Gen. Lloyd J. Austin III led many troops into combat. He served as the 3rd Infantry Division's assistant division commander for maneuver during the invasion of Iraq, the vice chief of staff of the Army, the commander of the Combined Joint Task Force–Afghanistan, and the commander of the U.S. Central Command before retiring in 2016. In this interview, he reflects on what history teaches us about transforming to a Multi-Domain Battle (MDB) force.

Throughout your career, you saw the Army undergo several major transformations. What were some of the most challenging, and how did you adapt?

In over 41 years of service, I had the honor to see and experience a lot of change. The Dupuy Reforms in the mid-to-late 1970s, the rise of TRADOC [the Training and Doctrine Command], the development of the "big five" weapon systems, and the AirLand Battle doctrine have all been truly transformational. The end of the Cold War, the nuclear weapons drawdown, and the subsequent proliferation of conventional arms have shaped how we view the operational environment.

I was one of the first cohorts of officers to benefit from the move to the all-volunteer force. Operationally and logistically, I saw and experienced the move from the linear battlefield to the nonlinear battlespace and now to MDB. Dramatic changes in the operational environment today reinforce the need for a focus on the Third Offset Strategy and MDB.

The Gulf War was truly the watershed event in how we understood the post-Cold War operational environment. The events of 9/11 brought an end to the notion of a water's edge dividing matters of the foreign and the domestic and how we defined military operations other than war in its newest form of "gray zone" warfare.

Shifts in operational art, force development, and employment designs and methods drove our concept of a heavy force versus a light force; [we were] constantly in search of an effective middleweight force and operational method. We developed over-the-horizon strategic employment techniques using the counter-Islamic State group campaign as a recent test case. This has re-emphasized the importance of the indirect, by-with-through approach, which uses a mix of precision fires, special operations forces enablers, and intelligence, surveillance, and reconnaissance (ISR) in support of a reliable, indigenous ground force partner.

The one constant that I have observed throughout all of these transformations, the one essential element of continuity that we could always rely on, was the American Soldier. The Soldier is, and has always been, the central key to successful adaptation.

AirLand Battle doctrine took shape in the early '80s and guided the Army's readiness and development through the end of the Cold War and Operations Desert Storm, Iraqi Freedom, and Enduring Freedom. Do you foresee that MDB will be similarly significant?

As I learn more about the concepts, force designs, and innovations coming about under MDB, I'm reminded that history is a willing teacher, when and if we choose to listen to its lessons. History teaches us that the character of our fights have changed and will continue to change. Today, I see us facing compound threats. These threats don't just add up to a bigger sum of a problem facing our forces, but rather are multiplied problem sets that we will have to face and overmatch.

I believe that these new compound threats feed new compound wars. To achieve synergistic wins in a compound war, we are going to need at least matching compound capabilities. A good example of this is the compound war that we now face in Syria and Iraq.

To be a successful and usable doctrine, MDB will have to be built with this new environmental compound

A retired general who served as vice chief of Staff of the Army and led troops in Iraq and Afghanistan lends his 41 years of Army experience to explain how recent history can prepare the Army for Multi-Domain Battle.

security reality in mind. It must be designed and manned with new force tools, updated employment and sustainment techniques, new formations, and most importantly with new talent. The competent and confident Soldier, operating with agility in this environment, is most critical.

In 2010, as the commander of U.S. Forces–Iraq, you oversaw the Army's largest logistics operation in six decades to remove millions of pieces of equipment. Can you elaborate on the impact of sustainers on this effort?

The impact of our great sustainers was nothing less than the decisive effort and action of this final phase of our campaign. It's not often that you hear sustainment operations described in this way, as the decisive action.

We have to change our traditional ways of seeing and approaching tooth-to-tail operations. In both war and peacetime operations, the truly decisive action is always in the finishing; that's not something that's limited to only tooth operations, especially in the contemporary operational environments. As the Army moves toward MDB, we absolutely must change how we think about this.

You were the architect of the counter–Islamic State group campaign in Iraq and Syria that we are using today. What lessons learned can you share about the way the Army should operate as we move toward the MDB concept?

I think we got the counter-Islamic State group campaign plan more right than wrong in our strategy, operational approach, and force redesigns. We identified early on what Abu Bakr al-Baghdadi's main strategic error was—erasing the Iraqi-Syrian international border when he did. This enabled the United States and our coalition partners to deliver fires into Syrian sanctuaries. We had the vision early on to exploit this to our advantage.

That experience emphasizes the importance of gaining and maintaining an accurate appreciation of the ever-changing operational environment. The necessity of coalitions, comprising willing and able partners, built and maintained through security force assistance activities is an essential enabling capability.

The kinds of compound wars we face today, and what our counter-Islamic State group campaign faced, demand extreme strategic patience. Vital to this is having a clear strategy to give us a sense of perspective. Our ability to keep in perspective the many tactical setbacks, stalls, and stalemates we experienced throughout the campaign, along with those we had projected we'd likely experience, is essential.

Another lesson gathered is that of fast power. This entails placing the enemy on the horns of multiple dilemmas near simultaneously and being able to sustain this multiprong pressure over time and expansive distances. Momentum was key and will be essential in MDB.

Lastly, a revolution in technological affairs does not equal a revolution in military affairs. At times, we've placed too much hope and credit on the winning ingredient being technological solutions. Technology is a necessary ingredient to any and all winning combinations of strategy and force, but it is insufficient alone. The key is human talent. It's the pure and noble courage of the American Soldier that counts the most.

As you know, the chief of staff of the Army's number one priority is readiness. How do logisticians need to change to maximize readiness as the Army shifts to a more expeditionary environment?

Supply versus demand has always been a false choice. Effective operational doctrines find ways of achieving and sustaining both in cost-effective ways. We must reconsider and think bigger about what we define as readiness. We need to think and act in terms of comprehensive joint readiness. New thinking and new ways of research and development, procurement, and maintenance of pre-positioned stocks to enable forward presence are key. I believe there are ways to enable coproduction through revised foreign military sales (FMS) or direct commercial sales and pooled, partnered investments in pre-positioned stocks.

Building partner capacity with full-suite, full life cycle, head-to-tail, train, advise, and assist support is an amazing enabler. Our partners' tails will be the lifelines of our tooth operations; their tail is, in essence, our tail. Thus, we need to resource and advise, assist, and accompany accordingly.

From a training perspective, we need to have longer duration assignments of our talent base with foreign partners. This will grow our operators and logisticians abroad as well as at home. We need to be more multilingual in our operations and logistics and have as much expertise in our partners' defense and security enterprises as we do in our own.

We need to relearn and remember the paradoxical lessons of small footprints and retrograde operations. Having fewer of our own boots on the ground incurs having more mission command, fires, medevac, and ISR assets in the MDB fight.

In future wars, we will likely not have the major forward operating bases and contractor support we've had throughout the past 16 years. What benefits and challenges will this smaller footprint have for battlefield sustainment?

While I see the rising anti-access/area denial threat, I don't see it as having completely arrived upon us yet. On the contrary, the United States at this very moment still enjoys a robust, worldwide forward presence supporting over 180,000 Soldiers in forward operating bases ranging from austere to mature. In fact, in the Middle East, greater Levant, and Central Asian States, the United States enjoys a very mature forward presence and transregional security architecture.

It was because of over 40 years of

continuous investments in building partner capacity and foreign assistance programs that we were able to adjust and respond so rapidly and effectively to the threats of the Islamic State group in 2014. This is just one example.

I believe we should be doing all we can to preserve our current forward presence to the greatest extent possible rather than cede ground and regional partnerships. We should extend and expand on our lessons learned, showing the benefits of long-term investments in theaterwide infrastructure and the capabilities of joint and combined pre-positioning of common enablers such as ballistic missile defense, cyber, C4ISR [command, control, communications, computers, and ISR], and transregional strategic mobility assets.

We should also look to leverage creative solutions via conditional foreign military financing and FMS. Achieving 100 percent readiness of the force at home will come at the cost of not having a sufficient, ready force for our fights abroad at the times and places of our choosing. If we do move to smaller footprints overseas, we'll need to support smaller formations with more, not less. This means more ISR and mission command headquarters as well as robust force-projection platforms. Presence buys you influence, which is built on trust; you can't surge trust.

Robotics, autonomous systems, and artificial intelligence are transforming the private sector. How do you see advancements in technology impacting the Army's future sustainment operations?

Each service has been working to bring new and innovative solutions to support the Department of Defense's Third Offset Strategy. The idea in this strategy is that advances in autonomous systems will lead to a new era of human-machine collaboration and combat teaming.

I see this happening across all battle operating systems and certainly across our sustainment functions. As I understand it, the Army Capabilities Integration Center is working on plans to help reduce logistics footprints through commercial and military technologies such as additive manufacturing, alternative fuels, advanced power generation, autonomy, artificial intelligence, and laser weapons.

Looking at long-term demand reduction returns, our efforts to provide capabilities to use alternate sources of energy, such as hydrogen vehicles or hybrid-electric technology, could further reduce demand on the supply chain and prevent a pause like the one that occurred on the road to Baghdad in 2003.

Additionally, autonomous aerial distribution is a desired capability. Unmanned aerial systems could deliver supplies 150 kilometers away with a payload of up to 2,000 pounds. Lighter versions that fly closer to the surface of the earth might carry 500 pounds and supply an infantry squad every three or four days with fuel, ammunition, and water.

How will the Army's shift to MDB doctrine affect our allies' and coalition partners' fights?

My crystal ball is not any better than anyone else's in predicting this future effect. However, I will predict that if combined operations are not at the heart and bones of MDB, it will be a failure. We can't allow that to happen.

The services should avoid three traditional pitfalls revealed during times of geostrategic ambiguity and change, defense budget stringency, and force reductions. First, avoid becoming infatuated with, and overcommitted to, the latest trends at the expense of hedging against the recurring challenges that have manifested throughout strategic history. Second, avoid being tempted to rename or oversell the creation of new war concepts, especially in support of single-service interests that distract from the timeless and enduring nature of conflict. And third, avoid being guilty of overplaying the "hollow force" card.

Readiness needs to be seen, understood, appreciated, and approached in nothing less than terms of comprehensive joint and combined readiness. In today's world of compound security threats and gray zone conflicts, alliances and coalitions are the new centers of gravity. They are the sources of power and legitimacy supporting the order of the system as well as the reputational and instrumental power of the United States as the leader. As such, alliances, coalitions, and regional partnerships must be invested in accordingly.

History doesn't repeat itself, but we do. And we tend to do so in the worst ways and at the worst times when we fail to know our own history or decide to ignore it outright. History can and should be illustrative for us as we consider the potential advantages and challenges of MDB.

In the 1980s, it was the Desert One mission [rescue operation] that made our lack of jointness obvious, undeniable, and most tragic until our Army and sister services began to fully embrace this concept. Even then, it took Congress to mandate it for us to begin to finally inculcate jointness.

In the wake of the 9/11 attacks, our own leaders' assessments summed up our lack of jointness as a collective failure of imagination. Our failures to embrace the imperatives of integrated intergovernmental and interagency operations led to gaps in our understanding of the operational environment.

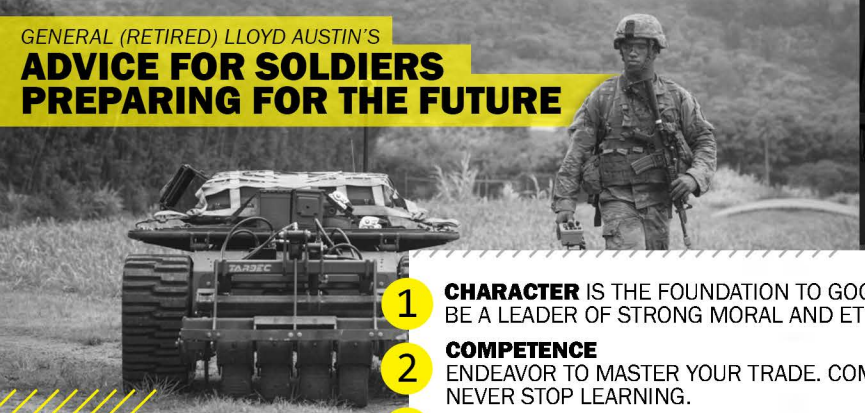
The environments of both today and tomorrow demand nothing less than joint, intergovernmental, interagency, and multinational approaches. MDB cannot afford to leap ahead of our alliances and coalition partner capabilities.

Trust is the essential ingredient to forming, norming, and holding together coalitions. Coalition management has to be at the core of future MDBs.

This interview was conducted by the Office of the Army Deputy Chief of Staff, G-4, Logistics Initiative Group.

GENERAL (RETIRED) LLOYD AUSTIN'S

ADVICE FOR SOLDIERS PREPARING FOR THE FUTURE



1. **CHARACTER** IS THE FOUNDATION TO GOOD LEADERSHIP. BE A LEADER OF STRONG MORAL AND ETHICAL VALUES IN EVERYTHING YOU DO.
2. **COMPETENCE** ENDEAVOR TO MASTER YOUR TRADE. COMMIT TO BEING A LIFE-LONG LEARNER. NEVER STOP LEARNING.
3. **LEAD BY EXAMPLE**
4. **HUMILITY** ENABLES YOU TO RECOGNIZE YOUR STRENGTHS AS WELL AS YOUR WEAKNESSES.
5. **CREATE & MAINTAIN INCLUSIVE ENVIRONMENTS AND UNDERWRITE PRUDENT RISKS**
6. **FOSTER ENVIRONMENTS CONDUCIVE TO VALUE-BASED OPPOSITION,** OR WHAT IN THE ARMY WE REFER TO AS CANDOR. BE WILLING AND CAPABLE OF SPEAKING TRUTH WITH CANDOR TO POWER, BUT DON'T MISTAKE THIS BY BEING A REBEL WITHOUT DUE CAUSE.

Logistics Support to Semi-independent Operations

Sustainment units must be prepared to support future brigade combat teams that will be required to operate semi-independently for up to seven days.

■ By Dominick L. Edwards

Training and Doctrine Command Pamphlet 525-3-7, The U.S. Army Functional Concept for Movement and Maneuver (AFC-MM), outlines the way the Army must operate to win against future threats. This guidance has implications for all warfighting functions. The most significant impact to the sustainment community is the requirement for future brigade combat teams (BCTs) to be able to operate semi-independently for up to seven days without relying on ground lines of communication.

The future battlefield will be more active and lethal, and every domain—land, air, cyberspace, space, and maritime—will be contested. According to the AFC-MM, this will drive the Army to "operate dispersed to avoid enemy strengths and evade enemy attacks, while retaining the freedom of movement to concentrate combat power rapidly across domains to fight, survive, and win."

To address this requirement, the AFC-MM prescribes a break from the tightly controlled and rigidly synchronized battles that systematically clear enemy forces from terrain. The concept further states that BCTs must be able to conduct semi-independent operations by possessing "sufficient mobility, firepower, protection, intelligence, mission command, and sustainment capabilities to conduct cross-domain maneuver at extended supporting range and distance for up to seven days while achieving operational objectives."

In turn, BCTs may be relieved of the requirement to secure traditional lines of communication. This will provide the BCTs time to amass combat power, move freely to create dilemmas for the enemy, rapidly concentrate combat power, and attack the enemy at its weakest point. These operations introduce challenges for logisticians. Meeting the BCTs' new requirements will require the Army to change how it operates and sustains its forces.

The BCT must be able to move quickly to capitalize on opportunities without being tied to a cumbersome tail. To fulfill this requirement, the Army must change both ends of the supply chain. First, BCTs and their support structure must reduce demand. Simultaneously, logistics elements must improve their ability to support BCTs and to survive on the modern battlefield.

Reducing Demand

The AFC-MM states that semi-independent operations "require a fundamental reduction in demand" in order for a BCT to operate for up to seven days. Water, fuel, and ammunition constitute the BCT's greatest sustainment footprint, so reducing those demands will provide the largest gain. The solution is to employ both disciplined consumption of commodities and acquisition of more efficient platforms and systems.

BCTs are organized to store and transport three days of supply. This "tail" requires combat power to keep it secure against peer threats and reduces the BCT's maneuver options. Consider an armored BCT conducting offensive operations; the BCT's requirements and capabilities generate a 16 kilometer-long logistics column with more than 98 truck and trailer systems to transport classes I (subsistence), III (petroleum, oils, and lubricants), V (ammunition), and IX (repair parts).

When a BCT operates semi-independently for up to seven days, the BCT's logistics tail grows significantly. This increases endurance but sacrifices agility and the BCT's ability to rapidly respond to opportunities. To help demonstrate the difference in current and future requirements, figure 1 shows how this change affects several key supply items.

The challenge for logisticians is to increase the BCT's endurance while maintaining or improving agility and flexibility. Part of the solution is to reduce logistics demand.

Water and fuel. Most of the BCT's sustainment assets are tied to storing and transporting liquids. Soldiers are unlikely to reduce their water requirements; however, the Army should invest in innovative water generation and purification capabilities to use water available in the air and on or below the surface. However, these solutions must be fuel efficient to avoid simply exchanging one liquid for another in the supply chain.

Reducing fuel demand is an obvious solution that will require significant investment. First, the Army must procure vehicles with more fuel-efficient engines. These vehicles must be able to use various types of fuel to allow for the use of locally procured fuel to reduce transport requirements.

While few hybrid electric engines produce the torque necessary to move

heavy combat vehicles, building lighter, more fuel efficient combat vehicles with improved armor and active protective systems will help close this gap. Lighter mobile bridges, transporters, and recovery assets could be developed to support the reduced size and weight requirements, generating second-order fuel conservation.

The Army must also study all power generation requirements in the BCTs and their supporting elements to find opportunities for fuel savings. Inefficient systems in command posts increase a generator's fuel consumption. Some goals of command post convergence should be to streamline mission command systems' power requirements and to procure fuel-efficient power generation equipment. The Army should look at innovative power solutions to further reduce demand.

Ammunition. The BCT's ammunition requirements are significant and very dense, often leading to wasted space as transport vehicles "weigh out before they cube out." Handling heavy ammunition requires materials handling equipment, which generates its own sustainment and fuel requirements.

The Army should invest in lightweight capabilities that provide increased lethality and are easier to transport. Caseless ammunition is one potential solution that can reduce ammunition weight. Another solution is to develop directed energy weapons with lightweight, reliable, and fuel-efficient power requirements.

Repair parts. Class IX constitutes the next largest class of supply for the BCT to store and transport. Reducing demand will require a twofold approach to reduce both stocks and maintenance.

The Army should look for opportunities to use common engines, drivetrains, and suspension components across vehicles to reduce the number of lines in the authorized stockage list. Secondly, the Army should design more reliable and maintainable vehicles and systems that require fewer repair parts and less maintenance.

Batteries. The Army should develop lighter batteries that provide improved performance. While lighter batteries will affect all BCTs, this will mainly increase how long infantry BCTs and reconnaissance formations can operate semi-independently.

Footprint. The Army must seek ways to reduce the logistics footprint and consumption for BCT sustainment organizations' demands during semi-independent operations. This will require the sustainment community to operationalize innovative resupply methods that get the Army beyond its current distribution-centric model.

Improving BCT Support

The AFC-MM outlines how the sustainment community can support semi-independent operations. BCTs must have "100 percent mobile sustainment assets and capabilities" that meet demand at the point of need. Sustainment elements must be able to deliver support by "using multiple routes, modes, nodes, and suppliers, to provide freedom of action to the supported commander." And, most importantly, the BCT must improve medical life support and develop a sustainment common operational picture (COP).

Medical life support. The AFC-MM specifies that "semi-independent and dispersed BCT operations generate the requirement for an enhanced organic medical suite of enablers for prolonged care forward." Units cannot assume air evacuation will be feasible and must assume that ground evacuation may not be possible.

The BCT is currently limited to 72 hours of medical supplies. It is not Role 3-capable and lacks mortuary affairs capability. Most significantly, the BCT cannot hold patients for extended periods during offensive operations.

Designing the BCT's medical organizations to support semi-independent operations will require several lines of effort. First, the Army must resource a capability such as an advanced trauma management module to prepare forward medics for additional lifesaving responsibilities.

Second, the Army must train medics to sustain a large patient load for up to seven days at Role 1 and Role 2 medical facilities. Finally, the Army must study and determine the required medical equipment sets and class VIII (medical materiel) stockage levels to support a BCT for seven days. One goal of this study must be to define the BCT's medical storage and transportation requirements.

The COP. The AFC-MM states that freedom of action "requires disciplined resource consumption and materiel management." Therefore, the Army must develop and field a sustainment COP that enables accurate reporting and allows sustainers at all levels to forecast BCT requirements.

Today, tactical units carry unnecessary supplies when they lack confidence in sustainment systems. There is blame for such systemic breakdowns at all lev-

Supply Items	3 Days of Supply		7 Days of Supply	
	Amount	Transport Requirement	Amount	Transport Requirement
Meals ready-to-eat	132 pallets	17 flat racks	308 pallets	39 flat racks
Bulk water	60,000 gallons	30 hippos	140,000 gallons	70 hippos
Bulk fuel	313,000 gallons	63 5,000-gallon tankers	730,000 gallons	146 5,000-gallon tankers
Ammunition	117 pallets	15 flat racks	273 pallets	35 flat racks
Repair parts	60 pallets	8 flat racks	140 pallets	18 flat racks

Figure 1. This table outlines the logistics requirements to sustain armored brigade combat team operations for three and seven days.

els, from the maneuver platoon to the expeditionary sustainment command, and the Army must address this additional unnecessary burden because it reduces the BCT's agility and mobility.

BCTs must carry only what they need during semi-independent operations instead of dedicating space and weight for nice-to-have or redundant items. BCTs should review their load plans and eliminate all unnecessary items so that they can use all available space to store essential supplies. For example, tank crews could leave tarps behind to create space in the bustle rack for class I items. However, practices like this will generate only some of the required reduction of supplies.

BCTs must also have a COP to ensure accurate reporting and timely visibility of the BCT's logistics status so sustainers can forecast requirements and plan resupply operations. This COP should enable sustainers to provide the required supplies at the right time to create the trust that will make maneuver units more confident "operating on amber."

Additionally, the COP must be capable of transmitting large amounts of data very quickly during limited windows of connectivity when the Army network is degraded. It must also be protected from cyberspace attacks, electronic warfare attacks, and the threat's artificial intelligence and machine learning tools.

Innovative support. Sustainment elements must find innovative ways to improve support to the BCT. One idea being developed is a capability that provides responsive aerial resupply without rotary-wing assets.

Another opportunity is to develop systems and procedures for conventional units that mirror those used by special operations sustainment units. Finally, the Army should explore how BCTs can use operational contract support when the operational environment allows.

Improving Survivability

Future threats pose significant risks to sustainers; they must change how they think, function, and operate. Sustainers supporting BCTs must move quickly and operate deep in enemy territory on an increasingly lethal future battlefield. Traveling on supply routes always involves risk; however, this risk increases during semi-independent operations against an armored threat, especially if BCTs are bypassing combat forces along the way.

The AFC-MM acknowledges and addresses this challenge with two recommendations. First, sustainment forces must increase their internal protection and offensive capabilities in order to travel on long, contested supply lines. Sustainment platforms must incorporate armor and protection without sacrificing payload, mobility, and fuel economy. Sustainment forces must be able to disable or destroy unmanned aerial systems that provide targeting data to artillery systems and must possess the weapons and training needed to defeat large threats.

Second, sustainment organizations must be able to seamlessly communicate and coordinate with all units that operate in the support area. Reducing the size and increasing the mobility of the brigade support area (BSA) and other logistics nodes will contribute to rapid maneuver and will increase survivability because enemies easily locate and target large, static assets. Decreasing demand and using alternative distribution methods will contribute to this effort.

However, the BSA will remain a lucrative target, so sustainers must become masters of camouflage to reduce their odds of detection. All logisticians must know how to use terrain to hide assets, and they must always employ proper camouflage.

All sustainment nodes must become as invisible as possible across the full electromagnetic spectrum. This will require learning and enforcing proper communications discipline, but the Army is also seeking technical solutions that will mask, obscure, and reduce the BSA's signatures.

To ensure survivability and best enable semi-independent BCT operations, sustainers must be equipped and trained to "own the night." Operating at night reduces the risk to sustainers as they travel on contested supply lines and reduces the risk to maneuver units.

The Army must examine existing tables of organization and equipment for logistics organizations to ensure the BCT's sustainment Soldiers are equipped with enough modern night-vision devices and weapon sights to conduct resupply quickly and safely at night. Finally, sustainers must train during periods of limited visibility to ensure they can support semi-independent operations under all conditions.

The AFC-MM describes how the Army must fight to win against future threats. It specifies that the Army must operate with increased dispersion and mobility by conducting semi-independent operations for up to seven days to achieve operational objectives.

The AFC-MM acknowledges the associated sustainment challenges and asserts that sustainment forces must "support semi-independent and dispersed BCT operations with reduced demand, improved shared understanding, and enhanced distribution." In addition, the concept adds that logistics elements must increase their organic survivability to support semi-independent operations.

The Army must examine how to reduce demand in the BCTs, increase sustainment capability to support semi-independent operations, and improve the survivability of logistics forces to enable future maneuver as described in the AFC-MM. This will take a deliberate effort by many stakeholders, and the force must begin working today to dominate in the future.

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Vehicles from the 224th Sustainment Brigade stand ready at Military Ocean Terminal Concord, Calif., on Jan. 18, 2017. (Photo by Capt. Dalia Sanchez)

Modern Sustainment Warfare: Operation Patriot Bandoleer

■ By Col. Julian H. Bond

The California Army National Guard has collaborated with the Army Materiel Command, the Army Sustainment Command, the Military Surface Deployment and Distribution Command, and the National Guard Bureau to create an opportunity for National Guard units to participate in sustainment missions involving the transport of munitions throughout the continental United States.

This opportunity is Operation Patriot Bandoleer (OPB), an ongoing training mission that facilitates multicomponent integration in an austere environment. The collaborative effort reinforces the Forces Command (FORSCOM) Total Force Partnership Program, which was developed in 2012 by the secretary of the Army.

The Purpose of OPB

OPB meets the Total Force Partnership Program's objective to unite the active and reserve components in training exercises focused on enhancing the readiness of Army forces. The success of OPB demonstrates the Army's ability to operate in a total force partnership.

OPB has become one of the largest multicomponent logistics events supporting the Army pre-positioned stocks program. It involves the movement of thousands of tons of munitions and war reserve materiel. The event addresses the importance of linking reserve component Soldiers to Army pre-positioned stocks redistribution as a means to support total force development and prepare for future humanitarian and contingency operations.

Planning and Execution

The January 2017 OPB rotation employed units based on the FORSCOM regional partnership task organization. Specifically, it aligned units from the 4th Sustainment Brigade (active component), the 304th Sustainment Brigade

Soldiers from the 1113th Transportation Company check their vehicle's snow chains during an inclement weather convoy operation on Jan. 19, 2017. (Photo by Capt. Howard Knapp)

(Army Reserve), the 17th Sustainment Brigade (Nevada Army National Guard), and the 224th Sustainment Brigade (California National Guard).

The 224th Sustainment Brigade headquarters, known as Task Force 224, assumed mission command of OPB in June 2016 and began planning. In August 2016, five participating states volunteered to support the task force, and the mission commenced on Jan. 17, 2017.

OPB participants successfully delivered a total of 375 class V (ammunition) 20-foot equivalent unit containers from Military Ocean Terminal Concord, California, to McAlester Army Ammunition Plant in McAlester, Oklahoma, and Hawthorne Army Depot in Hawthorne, Nevada. The task force logged more than 645,000 miles and delivered 5,879 tons of class V with the help of more than 700 Soldiers and 160 vehicle systems.

The total force partnership offered a range of nonscripted and real-life dynamic training opportunities in an austere environment. The participants collaborated with new partners to develop lines of communication and practice exchanging information in an unfamiliar environment.

During OPB, Soldiers encountered an array of challenges, including conducting line-haul operations in intense weather conditions, such as black ice, snowstorms, and heavy rain. Since collective training for routine line-haul trucking is conducted in warm and arid climates, approximately 68 percent of the Soldiers across all formations had never before operated tactical vehicles in the snow or used snow chains.

Cold weather conditions can greatly affect line-haul operations, as reflected in an ammunition truck accident in Europe in January 2017. During a line-haul movement in Poland, a truck carrying tank ammunition and Soldiers skidded off a slippery road because the driver was going too fast for the road conditions. The cause of the accident was a lack of realistic training opportunities, and a remedy is dynamic, real, and aggressive but safe training.

Expeditionary Mindset

In today's operational environment, it is imperative that logistics leaders be able to perform expeditionary logistics. Task Force 224 reinforced the Army's expeditionary mindset by establishing and operating its command post from a Standardized Integrated Command Post System tent.

A portion of OPB participants used assigned weapons, followed difficult routes (such as roads with closures and civilian traffic), and overcame difficult weather condi-

tions. Soldiers logged long hours and distances on their equipment, and they also drove through densely populated areas and encountered heavy traffic and narrow roads, which added elements of risk.

Mission Command

OPB provided leaders at the brigade, battalion, company, and platoon levels with an opportunity to reinforce the importance of mission command in real-world scenarios. Leaders had multiple opportunities to lead by example in a constantly changing and unscripted operational environment.

Commanders at all echelons had to make quick decisions to accommodate convoy support centers, force protection, route changes, local law enforcement requirements (such as road closures and snow chain requirements), stevedore adjustments, and safety modifications (such as adjusted rest plans, recovery operations, and fuel stops).

Inhibiting leaders' ability to execute rapid decision-making hinders their ability to be adaptive and resilient. The seven company commanders who participated in OPB reported that the experience forced them to think critically, improvise, and innovate in a realistic learning environment.

Communication

Task Force 224 used SHOUT nano satellite communication devices to augment their primary tactical communication assets. Training was provided across formations and to Soldiers at the lowest levels. The SHOUT nano proved to be an invaluable tool that provided streamlined communication and tracking capabilities across the total force regardless of the status of the units' primary communications equipment.

The task force also used Joint Capabilities Release Logistics (JCR–Log) for redundant tracking and communication with convoys. With its logistics enhancements, JCR–Log enables logisticians to support unified land operations safely and on time.

The SHOUT nano map and JCR–Log map were projected in the tactical operations center at all times throughout the mission. Very small aperture terminals also facilitated communication lines at Military Ocean Terminal Concord and Hawthorne Army Depot.

The task force had a Command Post Node team from the 240th Signal Company that provided Nonsecure Internet Protocol Router Network access, voice over internet protocol, laptop workstations, and an information technology help desk in the tactical operations center.

Recovery Operations

Moving convoys effectively and efficiently along designated supply routes is essential to the successful transport of commodities. Recovery and wrecker operations are critical to that process. The rapid but safe recovery of equipment is similarly critical and even more so in inclement weather conditions, such as black ice and snowstorms.

The Task Force 224 convoys were integrated with several wrecker recovery assets, including an expanded-mobility tactical truck wrecker and several M1088 tractor trucks, to facilitate recovery operations. Battle drills were rehearsed prior to the convoy. The task force conducted more than 45 recovery missions in inclement weather and followed real-world mission timelines.

Maintenance

During OPB, maintenance played a vital role in ensuring equipment readiness and expedient recovery. Although maintenance teams had to conduct operations in heavy rain and cold weather, the task force maintained a 96 percent operational readiness rate and successfully tracked more than 450 pieces of equipment, completed 246 work orders (two-thirds of which were for not mission capable faults), and conducted 34 quality control pre-convoy maintenance checks.

Unit maintenance support teams also had the opportunity to practice military occupational specialty tasks on the move when faced with equipment failure. The mission afforded Soldiers a comprehensive experience.

The goal of FORSCOM's Total Force Partnership Program is to integrate the Army's active and reserve components for training exercises and planning and to improve interoperability. OPB is an ideal collective training opportunity to achieve those goals.

OPB should be used as a capstone training event for units in program year 4 (ready) of the Sustainable Readiness Model. Planners should consider including a third week, similar to combat training center rotations, in order to integrate Objective T (such as live-fire events).

The primary training events for brigade combat team sustainment-enabling units are rotations to combat training centers. However, significant training opportunities are lacking for non-brigade combat team sustainment units, primarily line-haul truck companies and combat sustainment support battalions.

OPB is a collective training event that can mitigate the lack of program year 4 training opportunities. It incorporates the total force of active, Army Reserve, and National Guard service members in a multiechelon, multicomponent, efficient, dynamic, and decisive training program.

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Spc. Luis Palacios, an automated logistics specialist with A Company, 64th Brigade Support Battalion, 3rd Armored Brigade Combat Team, 4th Infantry Division, pulls a pallet jack with vehicle repair parts while deployed to Skwierzyna, Poland, in support of Operation Atlantic Resolve on Feb. 24, 2017. (Photo by 2nd Lt. Edward A. Garibay)

Deploying an SSA to an Immature Operational Area

■ By Capt. Michael E. Whitted Jr., 2nd Lt. Edward A. Garibay, and Chief Warrant Officer 2 Kyona Hendricks

According to Army Materiel Command officials, it had not been done in over a decade. The supply support activity (SSA) of the 3rd Armored Brigade Combat Team (ABCT), 4th Infantry Division, packed up their entire warehouse of more than 3,000 lines of stock, from nuts and bolts to tank tracks and engines, and deployed it to a completely new operational area. Although a whole SSA had been moved before, it had not been done like this.

When the Soldiers of the 64th Brigade Support Battalion (BSB), 3rd ABCT, arrived in Poland in support of Operation Atlantic Resolve, they found no unit to replace, no preestablished supply structures to fall in on, and certainly no one to show them the ropes. Everything had to be built from the ground up.

As the troops and tanks came rolling in, the SSA's job was to build combat power for an ABCT spread out along eight countries in Eastern Europe. While not everything went right, lessons were learned every step of the way and the mission always

was accomplished. These lessons learned are applicable to any SSA, BSB, or professional logistician.

Be Mobile, Even in the Rear

Even though Army doctrine tells SSAs to stay mobile, it is too easy for them to spread out and get comfortable. When an SSA goes to the National Training Center at Fort Irwin, California, it does not need to bring its entire stock. There are parts and supplies on site ready to issue as soon as they arrive.

When units arrive in Iraq or Afghanistan, nine times out of 10, they fall in on a preexisting SSA. So unless they receive a warning of a need to be mobile, there is no urgency to turn an SSA into a mobile warehouse capable of rapidly deploying and maneuvering around the battlefield.

Most of the issues faced by the 3rd ABCT's SSA were caused by rapidly transforming from a garrison-style warehouse into a highly mobile SSA capable of supporting a brigade support area in a deployed environment. So, a key takeaway is to go mobile even if the Army is not ordering it directly.

By the time an SSA receives notification of a pending deployment, it is almost too late. Training exercises are placed on the calendar, and ranges, gunneries, and taskings begin to take priority over a conversion to a mobile SSA.

To make matters worse, when the brigade receives funding, supplies flood the warehouse. The SSA's workload goes from 15 pallets of work per day to 50 pallets per day. If personnel and processes are managed properly, all the pallets can get processed on the same day, but this leaves very little time to become mobile and expeditionary.

Even if SSA personnel wait until the predeployment cycle to improve mobility, they should not wait until the end. They should start as soon as possible. It may seem like the only time to accomplish the task is after the chaos stops, but it will create a significant backlog that will still be there when the unit arrives at its destination.

If an SSA were to shut down 60 days early to prepare stock, deploy forces, and stand back up, it could face a situation much like the 3rd ABCT's SSA faced. When the SSA hit the ground on the other side, it had 20 containers or more of backlog.

Also, when an SSA deploys to an unestablished area, the support structures to catch back up are not available like they are in garrison. Having a backlog in the rear and a reasonable plan to overcome it is far better than having a backlog while deployed with limited resources to fix the problem.

Some of the things the 3rd ABCT's SSA did to increase its mobility index, which measures a warehouse's ability to deploy at a moment's notice, was to move stock into field pack-up mobile warehouse containers, position bulk items (such as engines and tank tracks) in 20-foot containers, and rework some internal processes.

Even if an SSA is not slated to deploy, it should move toward a more mobile storage system and build and train on rapid deployment standard operating procedures. It should identify how many containers are needed to comfortably fit bulk stock and SSA equipment and create a plan for loading and inventorying.

If an SSA is scheduled to deploy, it should coordinate early with the supporting sustainment brigade to start supplying the rear detachment as soon as practical. This will give the SSA additional time to prepare and prevent a backlog.

Perform Reconnaissance

Reconnaissance and coordination are part of any military operation, but deploying to an area where there is no unit to replace involves some extra considerations. First, the accountable officer or noncommissioned officer-in-charge need to be present early. With no one on the other side to give guidance and recommendations, it is up to the SSA subject matter experts to identify issues, make plans to overcome them, and advise the command team.

The biggest oversights will be the things normally taken for granted. Something as simple as missing electrical outlets could result in weeks of downtime.

Identifying problems early makes it possible to coordinate in advance to minimize the impact on the mission. For instance, the 3rd ABCT's SSA knew that computer connectivity would not be available on arrival, so the team arranged to have their satellite and computers arrive by airplane at the same time.

Unfortunately, the flight was delayed and the equipment did not arrive for weeks. So, the team coordinated with U.S. Army Europe to resource equipment from the nearest unit in Germany to establish operations long before their supplies reached them. This strategy was a success. All units should coordinate for backup equipment support prior to a deployment.

The lesson is that even though there may be no local support structure, there should still be regional support. Long before an SSA arrives in a new area, leaders should identify what supporting assets are nearby. By communicating with these assets early on and finding out what they can provide and their limitations, an SSA can plan for at least some support in an area that seems to have none.

Make Inventories a Priority

Do not compromise on performing inventories. During the first five days after hitting the ground, an SSA should conduct a 100 percent inventory of its entire stock to make sure everything is in order.

It may be difficult to express to those outside the warehouse the importance of this process. It just does not brief well that units cannot get vehicle repair parts for nearly a week because Soldiers have to count wash-

ers and widgets. But an inventory is so much more than that. It corrects issues that may have occurred in transit; those issues could slow down the operation later. Performing an inventory also familiarizes troops with the stock, thereby speeding up efficiency.

If an SSA gives into pressure and puts off inventories for the sake of the backlog, then a clog in the system is almost guaranteed, but this time it will be even harder to explain. The ball will already be in motion, operating tempo will be at its fastest, and the SSA will always be playing catch-up because there simply is no time to shut down operations and perform a full inventory.

Leaders at all levels need to set the expectation that the SSA will not boot up all sections at once (stock control, storage, receiving, issue, and turn-in). Even a computer boots up one system at a time before going full force.

For an SSA, the stock control and storage sections should do a full inventory first. Reasonably, a light detail should be dedicated to processing parts and preparing them for shipment during this time, but this should not be the primary focus. Only high-priority repair parts should be processed and shipped out during this time to allow the other pieces of the logistics chain to effectively accomplish their missions.

Once the inventory is complete, a strong element should be dedicated to working through any backlog accumulated in transit. Then as the demand increases, the turn-in section should be opened. Once through the backlog, the SSA will be prepared to get back into a normal battle rhythm.

Although this sequence may not align perfectly with each situation, leaders need to make a plan for how to bring the SSA up to full strength once at the destination. The key component will always be effective cross-training and exercising procedures prior to deployment.

If troops have to be trained while deployed, the entire process will slow down and the SSA will not produce the desired results. So, do not let Soldiers become worker drones that can only operate in one section of the warehouse. Train early, train often, and train as you will fight so that anyone can inventory, anyone can process, and anyone can turn in.

Use an Objective Rally Point

In basic tactics, a unit stops short of an objective to make final preparations before jumping into action. It allows troops to prepare their equipment, review the battle plan, and conduct last-minute reconnaissance to get an update on their objective.

The same concept should be applied when deploying an SSA to an area without any support. Deploy first to an established area that can provide a full spectrum of support, get organized, and then jump forward into action. This was one strategy the 3rd ABCT's SSA was not able to implement, but it would have enhanced the team's mobility, reconnaissance, coordination, and inventories.

When the 3rd ABCT's SSA arrived in Poland, it faced all of these challenges and found ways to overcome them, but if the SSA had to do it all over again, it would have done things a little differently. The SSA would have arrived in Germany at least 30 days before the maneuver units and used the resources of the military bases there to expedite inventories and process backlogs.

This would have allowed the SSA to use pre-established equipment and communication systems to sustain it until its delivery arrived. Then, when things were all set, the SSA would have been able to jump right into Poland and provide seamless support.

The success of the 3rd ABCT's SSA mission was based largely on getting back to the fundamentals of an expeditionary SSA. Many capabilities that are normally taken for granted were not available. To succeed in such an environment, leaders must diligently go down the checklist and get back to the basics of a mobile SSA focused on the brigade support area.

Leaders need to inform their higher commands about the needs of the SSA and the challenges to success. They should coordinate with their nearest support elements and understand what they can use to help them accomplish the mission. But most of all, they need to start early and practice, even before it becomes a requirement.

For the 3rd ABCT's SSA, this was the first time in 10 years that an entire SSA deployed to an unestablished area. Without a doubt, it will not be another 10 years before the next SSA follows in its footsteps. Start preparing now, and the only result will be excellence.

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Brigade Logistics Support Team 101

The answers to six questions can provide the basics needed to understand a new assignment as a brigade logistics support team chief.

■ By Maj. Michael Spears

When I became the brigade logistics support team (BLST) chief for the 1st Armored Brigade Combat Team (ABCT), 1st Cavalry Division, at Fort Hood, Texas, in June 2016, I had very little knowledge of what a BLST chief was. In my previous assignments, I was a logistics plans officer on the III Corps G-4 staff and a brigade S-4 in the 3rd ABCT.

I took it upon myself to research the duties and responsibilities of a BLST chief. Department of the Army Pamphlet 600-3, Commissioned Officer Professional Development and Career Management, and Department of the Army Pamphlet 750-1, Commanders' Maintenance Handbook, provided limited information. So, I checked Army Regulation 700-4, Logistics Assistance; Army Materiel Command (AMC) Regulation 700-19, Mobility Program for Logistics Assistance Program (LAP) Civilian Personnel; and the AMC BLST Handbook. I developed the following six questions that I wanted answered about being a BLST chief:

- ☐ Who does the BLST chief turn to in a time of need?
- ☐ What is the task organization of a BLST?
- ☐ When does the BLST chief start building support relationships within his unit?
- ☐ Where can the BLST chief go to find the resources he needs to best support his unit?
- ☐ Why is a BLST so important to its supported unit?
- ☐ How can the BLST chief ensure his supported unit is successful at combat training centers (CTCs) and while deployed?

The BLST Chief

A BLST chief is usually a major or chief warrant officer 4 or 5 who acts as AMC's advisor to the brigade combat team (BCT) or combat aviation brigade (CAB) commander. The BLST chief is responsible for coordinating all AMC alternative support with the BCT or CAB commander and staff. He coordinates day-to-day activities through the BCT's brigade support battalion (BSB) support operations (SPO) section, S-3, S-4, and S-6.

The LMS

A logistics management specialist (LMS) is responsible for monitoring unit equipment readiness. The LMS provides assistance in analyzing, reporting, effecting improvements, and coordinating support for LAP-related trends and issues.

The LMS directly advises the Army field support battalion (AFSBn) commander on equipment readiness issues and trends that may affect national-level provider resources. The LMS performs the duties of the BLST chief in his absence and has operational control of logistics assistance representatives (LARs).

LARs

LARs provide weapon systems-oriented supply, maintenance, and technical assistance to supported units. LARs have substantial technical experience on the equipment they support and answer questions about maintenance, training, supply parts, and operational readiness.

LARs share information from the field with their respective life cycle management commands (LCMCs) and the Army Sustainment Command to efficiently and effectively support equipment and systems throughout the Army.

Support Relationships

The BLST chief must build several support relationships in order to be successful. The BLST chief's most important support relationship is with the BCT commander. Building rapport with the BCT commander and establishing strong lines of communication will enable the BLST to effectively support the BCT.

Another important support relationship is between the BLST chief and the BSB commander and SPO officer. These relationships will help keep the BLST chief up to date on any class IX (repair parts) requisitions that take over 30 days to arrive to the unit's supply support activity (SSA).

BLST Task Organization

A BLST is organized to meet the needs of its supported unit. (See figure 1 on page 50.)

An ABCT BLST is authorized 10 LARs. However, it usually has four LARs from the TACOM LCMC, one LAR from the Aviation and Missile Command (AMCOM) LCMC, and three LARs from the Communications-

ABCT		IBCT		SBCT		CAB	
BLST CHIEF		BLST CHIEF		BLST CHIEF		BLST CHIEF	
LMS		LMS		LMS		LMS	
TACOM		**TACOM**		**TACOM**		**TACOM**	
LAR	Combat	LAR	Armament	LAR	Armament	LAR	Armament
LAR	Armament	LAR	Tactical	LAR	Tactical		
LAR	Tactical	LAR	Tactical	LAR	Tactical		
LAR	Tactical			LAR	Tactical		
CECOM		**CECOM**		**CECOM**		**CECOM**	
LAR	IT-Radio	LAR	IT-Radio	LAR	IT-Radio	LAR	Avionics
LAR	IT-Switch	LAR	IT-Switch	LAR	IT-Switch		
LAR	Sensor	LAR	Sensor	LAR	Sensor		
		LAR	P&E	LAR	Sensor		
AMCOM		**AMCOM**		**AMCOM**		**AMCOM**	
LAR	Missile			LAR	Ammunition	SSTR	Advisor
				LAR	Missile	LAR	Electronics
				LAR	Supply	LAR	Electronics
				LAR	Supply	LAR	Electronics
						LAR	Electronics
						LAR	Electronics
						LAR	Electronics

Legend:
ABCT = Armored brigade combat team
AMCOM = Aviation and Missile Command
BLST = Brigade logistics support team
CAB = Combat aviation brigade
CECOM = Communications-Electronics Command
IBCT = Infantry brigade combat team
IT = Information technology
LAR = Logistics assistance representative
LMS = Logistics management specialist
P&E = Power generation and environmental control equipment
SBCT = Stryker brigade combat team
SSTR = Senior system technical representative

Figure 1. This table outlines the task organization of the different types of brigade logistics support teams. The organizational structure is based on the needs of the supported unit.

Electronics Command (CECOM) LCMC.

An infantry brigade combat team (IBCT) BLST is authorized seven LARs. Typically an IBCT BLST has three TACOM LARs and four CECOM LARs, including one power generation and environmental control equipment LAR. The IBCT BLST does not have an AMCOM LAR assigned because of its low density of ground missile systems.

A Stryker brigade combat team (SBCT) BLST is authorized 15 LARs but normally is assigned 12. The 12 LARs provide a variety of technical skills including ammunition, supply, communications, electronics, missile, armament, and automotive support. The increase in LARs for the SBCT BLST is based on the fact that it serves a greater number of maneuver battalions.

A CAB BLST is authorized nine LARs. The CAB BLST usually has one TACOM LAR, one CECOM LAR, and six to eight AMCOM LARs based on the total number and type of aviation battalions that are organic to the CAB it supports.

There is usually one AMCOM LAR for each of the five battalions, two LARs for each Apache battalion, and one senior system technical representative who acts as the CAB's senior technical advisor and mentors all AMCOM LARs within the CAB.

The 026 Report

The 026 report is the Army maintenance report that provides information about deadlined equipment. It is the document most used by the BLST chief and is updated daily by the SPO staff.

The BLST chief must be able to accurately read the BCT's 026 report and to correctly identify not-mission-capable system trends that affect the supported unit's readiness rate.

During the BCT's weekly maintenance meeting, the BLST chief and LMS use the 026 report to track critical parts for combat systems and to determine long estimated ship dates for repair parts that are hard to get. The BLST chief and LMS will identify long lead time parts (LLTPs) for systems and expedite LLTPs through lateral support from units within the brigade, throughout the installation, and throughout Army.

The COP

The common operational picture (COP) is a snapshot of the supported BCT's total combat power. It includes information on combat, combat support, and sustainment readiness percentages, the total number of LLTPs that affect the BCT's systems, fleet readiness issues, and readiness drivers. It also outlines the amount of equipment on hand for critical systems, the authorized to forecast status of the SSA warehouse, LCMC concerns, support activities, and support priorities.

The COP also includes a snapshot of the BCT's annual training calendar with key training events that allow the BLST chief to predict possible LLTPs that will be needed no less than 365 days ahead of time. The COP allows senior leaders across the Army to access equipment readiness data and answer readiness questions effectively.

Training and Deployment

The BLST chief is fully engaged and embedded with his supported unit during all phases of CTC operations. During CTC training, the BLST chief and his team plan, coordinate, and synchronize AMC and LCMC capabilities to effectively and safely sustain and support the unit through all phases of operations.

The BLST chief and the LMS deploy with the unit to the theater of operations. The BLST chief should coordinate with the supported unit at least three months before deployment to determine the best time to arrive in theater. The incoming BLST chief should determine the exact arrival date and coordinate with the outgoing BLST chief and LMS. This process begins with obtaining deployment orders from the local AFSBn S-1.

So who does the BLST chief turn to in time of need? The BLST chief turns to his LMS and LARs for subject matter expertise on critical parts. What is the task organization of a BLST? The task organization of the BLST depends on the type of unit it supports.

When does the BLST chief start building support relationships within his unit? Immediately! The BLST chief needs to build a support relationship with key personnel throughout the brigade and battalion in order to ensure that the importance of expediting critical parts for combat systems is echoed at all levels.

Where can the BLST chief go to find the resources he needs to best support his unit? The BLST chief's primary documents for unit support are the 026 report, the COP, the situation report, and the not mission capable over 60 days report.

Why is a BLST so important to its supported unit? The BLST is the single face to the field for technical, logistics, and acquisition support from the AMC enterprise.

How can the BLST chief ensure his supported unit is successful at CTCs and while deployed? The BLST chief must be able to develop solutions to overcome LLTPs, ensure that critical parts for combat systems are quickly identified and ordered immediately, and work with his LMS and item managers to expedite or redirect critical parts to the supported unit.

Knowing the answers to these questions sets the BLST chief and, in turn, the supported unit up for success.

When does the BLST chief start building support relationships within his unit? Immediately! The BLST chief needs to build a support relationship with key personnel throughout the brigade and battalion in order to ensure that the importance of expediting critical parts for combat systems is echoed at all levels.

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Developing a Common Operational Picture for Sustainment

■ By Maj. Aaron M. Cornett and Maj. Justin M. Redfern

The Mission Command Training Program based at Fort Leavenworth, Kansas, is the Army's only worldwide deployable combat training center. Its Operations Group Sierra provides observer-coach trainers to instruct expeditionary sustainment commands (ESCs) and sustainment brigades during warfighter exercises.

During a warfighter exercise, the decisive action training environment replicates phase III of joint operations against a near-peer competitor. The sustainment community's challenge is to sustain the other warfighting functions throughout the operation by increasing operational reach, providing freedom of action, and prolonging endurance.

A sustainment common operational picture (COP) provides a clear picture of the sustainment situation at any given time and is critical to increasing operational reach, freedom of action, and prolonged endurance. Over the course of several warfighter exercises, Operations Group Sierra identified that developing a sustainment COP is a common challenge.

What Is a Sustainment COP?

The sustainment COP is how sustainment forces visualize and assess the effects of sustainment on the battlefield. The sustainment COP also provides context that commanders can use to describe and direct future operations.

The sustainment COP synchronizes requirements with capabilities over time and provides a single framework that represents the current situation. It is used to identify future gaps, shortfalls, or excess capacity within the sustainment network.

How Does Time Affect the COP?

To be effective, a sustainment COP must focus on efforts and commodities over time. A unit commander requires time to make decisions and deliver support or commodities to the end user. For an ESC, lead times typically range from 96 to 120 hours, while sustainment brigades require 48 to 96 hours to get supplies to customers.

A way to decipher the time factor on a COP is to map the time it takes for a commodity or service to travel from start to finish. This time starts prior to the commodity entering the theater of operations, continues as it transits the supply chain, and concludes with its delivery to the end user.

Essentially, a commander and staff must understand how long it will take to influence operations. Is the ESC or sustainment brigade able to deliver a commodity or service in time to maintain momentum or extend operational reach? Is the lead time associated with a particular commodity or service going to slow the pace of operations? If the sustainment commander and staff understand that time factor, they can more easily plan and manage expectations.

Identify Sustainment Elements

The first criterion for a relevant COP is a terrain-oriented visual depiction of sustainment entities in the area of operations (AO). Important red (enemy) and blue (friendly) activities also should be depicted. For an ESC, the sustainment COP should include regional hubs and distribution nodes such as logistics support areas, central receiving and shipping point yards, and aerial ports and seaports of debarkation across the AO, with special focus on the joint support area.

For a sustainment brigade, the depiction should be more focused and pay special attention to the sustainment forces within the division AO, including nondivisional units in the division support area.

Once sustainment elements are identified, operation orders should provide criteria such as stockage objectives or daily requirements in order to assess the capabilities and critical commodities employed or distributed through the AO. This assessment can be color-coded. If colors are used, it is important to provide a clear definition of what each color represents.

A staff's understanding of how the commander visualizes information can go a long way in making the sustainment COP effective. If there is not enough information to make inclusive and relevant assessments, the sustainment community in theater should establish internal measurements. These measurements should be communicated and nested in operation orders to help inform the commander and enable timely decisions. This visual representation should be the baseline from which the rest of the COP is built and can be based on the output from the intelligence functional cell during mission analysis.

The second criterion for developing a sustainment COP is depicting operations in the AO that affect sustainment operations. Sustainment units cannot just focus on sustainment without regard for maneuver force or enemy force activities.

Activities that influence sustainment and sustainment staffs must be depicted on the sustainment COP to show the commander how both friendly and enemy activities affect or could possibly affect sustainment. It

is also important for the sustainment COP to clearly show lines of communication, such as main and alternate supply routes, as well as supported unit boundaries.

The third criterion revolves around the sustainment headquarters support operations section's commodities. The data provided by each commodity section informs decision-making and problem-solving.

Most of this data will be kept internal to each section. It is impossible for a single sustainment COP to show every piece of information from every commodity. Therefore, it is imperative that the sections responsible for each commodity develop their own COPs or running estimates to complement the overall sustainment COP.

Detailed commodity-specific COPs provide the background information to round out the much broader and less detailed sustainment COP. When the commander has a question about specifics not displayed on the sustainment COP, his or her staff should reference the commodity COPs in order to find a detailed answer.

Five Sustainment COP Essentials

Operations Group Sierra has identified five areas that should be represented in every sustainment COP:

- ☐ Key and essential movements in the first 24, 48, 72, and 96 hours.
- ☐ Bulk fuel nodes and distribution plans.
- ☐ Critical munitions status and distribution plans.
- ☐ Internal and external combat power (the combat slant).
- ☐ Medical nodes, locations, capacity, and bed status.

While Operations Group Sierra considers these five areas the most critical to a sustainment COP, the team acknowledges that each organization must decide what information is most important and what information the commander needs to make effective decisions.

Additionally, the S-4s and G-4 should provide a combat slant that explains what the sustainment brigade's functional companies can accomplish with the combat power they have. This additional information helps to paint

PLANS Long-range Planning	FUTURE OPERATIONS Mid-range Planning	CURRENT OPERATIONS Short-range Planning and Execution
Plan movement and maneuver.	**Lead support operations distribution, plans, and integration.**	**Lead movement and maneuver.**
Includes representatives from all warfighting function cells and special staff as mission dictates. ☐ Develops initial operation plans (OPLANs) and operation orders (OPORDs). ☐ Plans for follow-on sequels. ☐ Assesses long-range progress of operations.	Includes representatives from all warfighting function cells and special staff as mission dictates. ☐ Refines and modifies OPLANs and OPORDs, and issues fragmentary orders (FRAGORDs). ☐ Develops branch plans. ☐ Assesses mid-range progress of operations.	Includes representatives from all warfighting function cells and special staff as mission dictates. ☐ Monitors, evaluates, directs, and controls execution of orders. ☐ Provides operations update and assessment brief.
Examples: Intermediate staging base operations, deployment, and new site	Examples: Convoy planning, central receiving and shipping point operations, and task organization modifications	Examples: Monitor convoys and battlespace management
"What next?"	**"What if?"**	**"What is."**

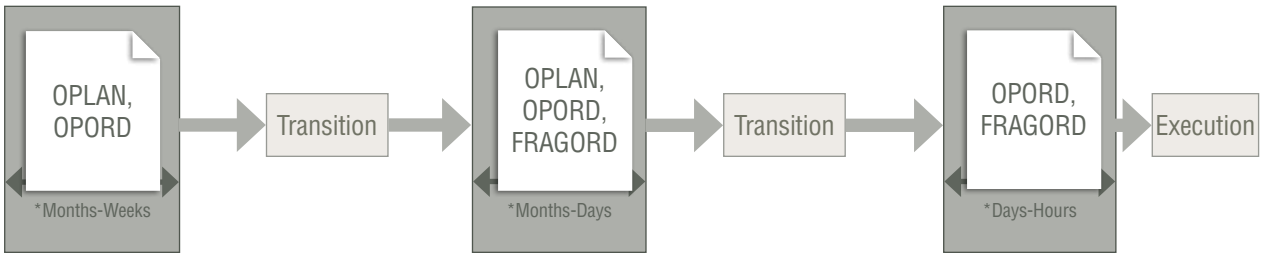

Figure 1. This flowchart demonstrates how time horizons for the operations process vary depending on the level of command and mission variables.

a clear picture for the commander.

Other information that may prove critical in certain circumstances includes class I (subsistence) nodes and distribution plans, mortuary affairs and replacement movements, and information relating to the fielding and distribution of critical class VII (major end items).

Future activities, such as the transition of unit boundaries or the establishment of logistics support areas, require additional planning and should have space allocated on the sustainment COP. It is important for the commander to see what is on the horizon in order to understand how current operations will affect future plans. A small block that shows a sliding scale of current planning efforts and their level of completion can help to create much needed dialogue between the commander and staff.

An Analog Sustainment COP

The 21st century Army greatly benefits from technology and digital advances. The ability to produce and share information electronically has significantly improved shared understanding during operations. Of course, too much reliance on technology can be a downfall when a system fails or power is lost.

Using analog products to back-up digital products is absolutely critical to the continued success of a sustainment organization in the event a system goes down. When it comes to the sustainment COP, sustainment organizations should develop an analog product that mirrors the digital product.

A large scale map with acetate works incredibly well and allows graphics and other information to be updated regularly. If the analog product is updated regularly and mirrors the digital product, then the commander will not struggle to see the environment or make decisions in the event of a system failure.

The sustainment COP provides sustainment commanders with a clear picture of the sustainment situation at any given time. It also enhances the ability of sustainment organizations to increase operational reach, provide freedom of action, and prolong the endurance of maneuver forces.

Sgt. 1st Class Joseph Samuel Massey points to a map during Saber Guardian 17 at Novo Selo Training Area, Bulgaria. (Photo by Spc. Rafael Garibay)

High functioning staffs create a sustainment COP by including similar internal and external sight pictures, a snapshot of critical commodities nested with current and future operations, and transitions. By integrating all warfighting functions, the staff also includes the priorities of support and the decision support matrix.

A standard operating procedure that sets the conditions for these mission command tools sets a staff on the right path to meeting intent at the speed of trust.

Great units are able to use all of the information in the COP to anticipate requirements, remain responsive, and provide uninterrupted sustainment. In essence, the sustainment COP is the best way for sustainment organizations to develop shared understanding, solve problems, and synchronize sustainment operations.

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Lt. Col. Erik Hilberg and Stanford Locher contributed to this article.

Sustaining the Brigade Engineer Battalion for Decisive Action

Forward support companies can support maneuver units by echeloning trains, but a modified field trains concept would better support brigade engineer battalions.

■ By Capt. Gregory A. Long

Brigade engineer battalion (BEB) forward support company (FSC) leaders are charged with ensuring that the BEB is fueled, fed, and fixed as far forward on the battlefield as possible. Doing so allows the BEB to operate uninterrupted with maximum operational reach, freedom of maneuver, and prolonged endurance.

The BEB FSC relies on current doctrine, a synchronized concept of sustainment across the brigade, and the maneuver commander's intent to guide its operations and the physical location of its equipment and personnel on the battlefield. However, current sustainment doctrine does not necessarily apply to BEB logistics operations.

BEBs typically have low consumption rates and time-distance factors. Sustaining the BEB requires a unique and dynamic application of current doctrine that is synchronized with the brigade concept of sustainment.

FSC Doctrine

Sustainers use doctrine to shape their operations. According to Army Techniques Publication (ATP) 4-90, Brigade Support Battalion, "The BSB [brigade support battalion] enables operational reach by task organizing FSCs with required capabilities to prolong the endurance of brigade operations while maintaining sufficient support to ensure freedom of action."

However, ATP 4-90, which states that echeloning trains is the backbone of sustainment operations, is purposely vague about the manner in which FSCs enable operational reach.

Echeloning Trains

In their September–October 2016 *Army Sustainment* article, "The Optimal Employment of the Forward Support Company in Decisive Action," Lt. Col. Brent Coryell and Capt. Christopher Devenport state that FSCs are the link between the brigade support area (BSA) and the supported units near the forward line of troops (FLOT).

FSCs accomplish support by employing assets at both the field trains command post (FTCP) and the combat trains command post (CTCP). Coryell and Devenport write, "Both the FTCP and the CTCP are mobile mission command posts for logistics that execute supply break points to build combat-configured support packages for forward units."

Executing sustainment operations through the BSA, FTCP, CTCP, and company trains is known as echeloning trains. Traditionally, the FTCP is either co-located with the BSA or 1 to 2 kilometers from it. The FTCP serves as a sustainment coordination center where the brigade support operations officer (SPO) synchronizes push/pull logistics and convoys to each battalion's CTCP.

The CTCP is typically the closest sustainment node owned by the supported maneuver battalion. The FSC commander and most of the distribution and field feeding assets often reside at the CTCP in order to execute convoys to the company trains areas to resupply company elements maneuvering near the FLOT.

Estimates Affect Emplacement

Logistics running estimates from the battalion staff determine sustainment node emplacement for the FSC. These estimates, which include planning variables such as consumption rates and time-distance factors, will guide the SPO's concept of sustainment. The concept of sustainment then synchronizes sustainment nodes across the battlefield based on the location of the maneuver elements, the BSA, and where each battalion's FSC places the FTCP and CTCP.

While echeloning trains is doctrinally sound and critical to the success of most FSCs, the model is not well-suited for an FSC that supports a BEB. Logistics estimates from brigade engineers routinely show low consumption rates, and with the exception of two line companies, the supported units within the BEB do not travel anywhere near the FLOT because of the battalion's mission set.

Logistics running estimates alone must shape sustainment node emplacement for the BEB's FSC. The brigade concept of sustainment must then incorporate said nodes in the overarching brigade sustainment plan.

Optimal Emplacement of Assets

How can an FSC best posture itself to support the BEB and its unique mission set? During Army Warfighter Assessment 17.1 at Fort Bliss, Texas, Echo FSC was attached

Sgt. 1st Class Adam Asher, Echo Forward Support Company, 40th Brigade Engineer Battalion, supervises troubleshooting procedures of an assault breaching vehicle engine at the maintenance collection point during Army Warfighter Assessment 17.1 at Fort Bliss, Texas.

to the 40th BEB, 2nd Brigade Combat Team, 1st Armored Division, and provided logistics support without running a true FTCP and CTCP.

Battalion staff logistics estimates showed low consumption rates, and minimal time-distance factors were associated with the rear-area and wide-area security missions for the BEB. This ultimately drove the FSC's asset emplacement strategy.

The distribution platoon and maintenance platoon were co-located with the BEB tactical assembly area (TAA), which was separate from but co-located with the brigade TOC approximately 5 to 7 kilometers from the BSA, which the FSC was also tasked to support. The distribution platoon used the BEB TAA as its main distribution hub to push bulk petroleum, ammunition, and repair parts.

Fuel asset placement. The FSC had four M978 fuel tanker trucks for bulk fuel distribution. The most economical method to distribute fuel at the BEB TAA and brigade TOC was to station one tanker at each location because of their low rates of fuel consumption. Only one vehicle was needed to refuel of all power generation equipment and vehicles for each area.

The M978s did not need to pull additional fuel from the BSA or to receive refills very frequently. On average, each truck was refilled every three days. The FSC's other two M978s and crews supplied fuel to the two engineer companies that executed Sapper, route reconnaissance, mobility, and countermobility missions much closer to the FLOT.

Maintenance asset placement. Maintenance operations were conducted at a maintenance control point (MCP) co-located with the BEB TAA. Not only did this prevent the MCP from having to provide its own security, but it also allowed for responsive repairs. Co-locating the MCP with the BEB TAA allowed maintenance leaders to manage and delegate workloads while mechanics quickly diagnosed and repaired equipment from all of the BEB's units.

Forward maintenance teams were

located in the company trains area to provide engineer companies with dedicated maintenance assets to support forward operations. Engineer platforms that could not be fixed in the company trains area were evacuated back to the BEB TAA where the mechanics repaired platforms and returned them to the company trains.

Planning section placement. The FSC executive officer (XO) and the BEB S-4 were co-located in the BSA for sustainment planning, integration, and coordination. The two officers coordinated directly with the brigade SPO, analyzed battalion mission sets and consumption rates, planned convoy operations, and ensured configured loads were built on time for convoy execution. This resulted in seamless sustainment synchronization and coordination, which resulted in planned sustainment operations instead of "emergency" resupply operations.

An automated logistical specialist was stationed with the FSC XO in order to send repair parts forward to the BEB TAA for eventual distribution. A food operations sergeant and an ammunition handler were also stationed with the FSC XO to manage class I (subsistence) and ammunition and ensure the commodities were properly prepared for convoy operations.

Minimal FSC representation in the FTCP and BSA was optimal because it allowed assets to be stationed forward in the BEB TAA to conduct logistics release point operations with the BSB's distribution company and in company trains with engineer companies that were operating near the FLOT.

Field feeding asset placement. Because the BSA was located in proximity to the food rations break point, Echo FSC experimented with placing its field feeding section in the BSA for easy resupply. Unfortunately, this resulted in the FSC's headquarters platoon having to convoy to the BSA to receive food from the field feeding section for forward distribution. This was not efficient and took manpower from the company command post.

The optimal placement for the BEB FSC field feeding section is co-location with either the BEB TAA or the brigade tactical operations center (TOC). The FSC should choose the location with the greatest personnel head count.

Logistics running estimates from the battalion staff determine sustainment node emplacement for the FSC. These estimates, which include planning variables such as consumption rates and time-distance factors, will guide the SPO's concept of sustainment.

Another BEB FSC's Experience

Scrapping strict adherence to echeloning trains also worked well for an FSC that was attached to the BEB for 3rd Brigade Combat Team, 1st Armored Division, during its decisive action rotation to the National Training Center in 2016. The FSC commander placed the FSC XO at the BSA in order to coordinate and plan with the brigade SPO.

The commander also had commodity managers in the BSA to process parts and help build supply packages. Most of the distribution platoon was co-located with the BEB TAA, which allowed for responsive delivery of supplies to both the brigade TOC and the BEB's two engineer companies as they maneuvered near the FLOT.

The maintenance platoon was co-located with the BEB TAA, which allowed for swift repairs and responsive recovery missions. A field maintenance team was attached to each engineer company to provide forward maintenance in their company trains.

The dining facility section was co-located with the BEB TAA. This was economical because most of the BEB's Soldiers were in the TAA. It also allowed for easy supply point distribution. The FSC's first sergeant delivered chow to fellow BEB first sergeants at the brigade TOC and other logistics release points as required.

The FSC is an agile organization created with modularity in mind. Each FSC must task organize across the battlefield in a manner commensurate with the battalion S-4's logistics running estimates that consider fuel consumption rates, time-distance factors, time-idling factors, battle damage losses, and the maneuver battalion's overall mission set.

By incorporating the running estimates from each battalion into the concept of sustainment, the brigade SPO can effectively synchronize key sustainment nodes across the battlefield with a logistics common operational picture in mind. This leads to streamlined sustainment as the BSB pushes supplies to the FSC to support the maneuver unit.

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Brig. Gen. Kenneth L. Kamper, 4th Infantry Division deputy commanding general, discusses different rail loading strategies with leaders assigned to the 3rd Armored Brigade Combat Team, 4th Infantry Division, during a predeployment site survey at Camp Karliki in Zagan, Poland, on Nov. 3, 2016. (Photo by Sgt. William A. Tanner)

Tools and Models for Sustainment Preparation of the Operational Environment

■ By Lt. Col. Thomas E. Goyette and William L. Knight Jr.

Military history is riddled with accounts of operations that failed, faltered, or assumed additional risk because of ineffective or poor logistics intelligence. Operation Urgent Fury, the invasion of Grenada in 1983, is one example of the U.S. military being hindered by not only an unexpectedly strong Cuban and Grenadian resistance but also difficulties in planning, intelligence, and logistics.

Planners made unexamined assumptions about logistics and medical support and failed to integrate sustainment into planning efforts. This failure was directly affected by a compartmentalized planning process and operational security restrictions that limited logistics planner involvement.

Prior to the operation, the critical intelligence needed about roads, potable water sources, local sources of supplies and services, medical facilities, and airfields was incomplete or unavailable. Maps were generally inaccurate and not available in sufficient quantities. The Marines supporting the operation had only six crude maps for an entire battalion landing team.

Additionally, since standard military maps were not available, nonstandard maps and tourist maps were used with an improvised military grid overlay.

The Analysis

Army Doctrine Publication 4-0, Sustainment, states that sustainment preparation of the operational environment (SPoOE) is "the analysis to determine infrastructure, environmental factors, and resources in the operational environment that will optimize or adversely impact friendly forces' means for supporting and sustaining the commander's operations plan."

SPoOE tasks executed by sustainment planners and staffs provide a basis from which sound sustainable plans can be built. This analysis allows the commander to better visualize the operational environment (OE) and see how conducive the OE is to sustaining military operations. The challenge for a sustainment planner, as was learned in Operation Urgent Fury, is how to obtain the data early on to support this analysis.

Field Manual (FM) 100-16, Army Operational Support, referred to this analysis as logistics preparation of the theater, which is now called SPoOE. Although it is now obsolete, the manual provided useful information that was not captured in other doctrinal publications. This useful information included directions to potential sources of logistics intelligence and information.

Per FM 100-16, potential sources of intelligence or information include U.S. bilateral relations fact sheets from the Department of State, CultureGrams, assessments from Army civil affairs units, country studies, and weather or terrain data gathered from intelligence preparation of the battlefield (IPB). Having this logistics intelligence better enables operational-level commands to assess the logistics suitability of countries within their areas of responsibility.

At the time that FM 100-16 was printed, much of the intelligence gathered about a country was obtained from tangible printed documents. The same was true during Operation Urgent Fury. Today, based on advancements in technology and automation, sustainment planners have access to these same products digitally. Digital innovations have enabled planners to attain greater detail for their SPoOE assessments.

The Tools

Army Doctrine Reference Publication 4-0, Sustainment, provides six factors for examining the SPoOE: geography, supply and services, facilities, transportation, maintenance, and general skills. Assessing these factors is best done in country through a predeployment site survey or by an in-country assessment team.

However, an in-country assessment is not always possible based on the tactical or political situation within the country or region. In these instances, sustainment planners can execute a virtual SPoOE assessment by leveraging digital research.

Planners can access these tools and the valuable unclassified data the tools provide using open and common access card-enabled web sources. Some of the sources may also require approval of a system access request. These are some of the more beneficial digital research tools to access for SPoOE assessments:

- ☐ Air Mobility Command maps.
- ☐ Army Geospatial Center products.
- ☐ Civil affairs operations running estimates on MilSuite.
- ☐ Country handbooks from the Marine Corps Intelligence Activity.
- ☐ Country information resources from the Combined Arms Research Library.
- ☐ CultureGrams from ProQuest.
- ☐ Integrated Service Distribution Data Cleansing Tool maps from the Electronic Transportation Acquisition.
- ☐ Intellipedia-U from Intelligence Community Enterprise Services.
- ☐ NASA's Earth Observing System Data and Information System.
- ☐ National Geospatial-Intelligence Agency maps.
- ☐ The Central Intelligence Agency's World Factbook.
- ☐ SkyVector aeronautical charts.
- ☐ The Transportation Infrastructure Archive from the Transportation Engineering Agency.
- ☐ The U.S. Transportation Command's Single Mobility System.
- ☐ The World Port Source website.
- ☐ U.S. Bilateral Relations Fact Sheets from the Department of State.

These tools provide valuable sources of data and information; however, a framework is needed to provide context and translate the data into sustainment knowledge of the OE.

The Models

A number of effective models are available to translate data. Four of the most common models include the blended framing construct model, the joint doctrine model, the IPB model, and the SPoOE planning process, which is taught at the Command and General Staff College (CGSC).

The blended framing construct model. The blended framing construct model uses elements and variables from Army doctrine to frame the information as it relates to the sustainment suitability of a selected country or region.

It is not possible to visualize the sustainment suitability of an OE using a single framing construct; however, visualization is improved considerably by using and combining multiple framing constructs. This tailorable approach to SPoOE allows the sustainment planner to assemble parts and elements of the constructs that are key to theater sustainment planning in order to form a single planning model.

The joint doctrine model. A second approach to analyzing the sustainment suitability of an OE is using the joint doctrine model. Joint doctrine, the Universal Joint Task List, and the logistics staff estimate provide a common framework for con-

Soldiers during Operation Urgent Fury use maps to locate key areas in Grenada. (Photo courtesy of the Department of Defense)

ducting theater logistics analysis (the joint version of SPoOE) to achieve a common understanding of the environmental factors potentially affecting sustainment support.

Joint publications are useful for conducting this analysis because many of the logistics-related publications include appendices with checklists for analyzing airfields, seaports, roads, joint logistics over-the-shore operations, bulk petroleum, health service support, and labor, to name a few. These checklists provide a common frame of reference for examining the OE's sustainment suitability as it relates to joint force requirements.

The IPB model. The IPB model provides a third approach to analyzing an OE's sustainment suitability. One of the greatest lessons learned from Operation Urgent Fury was that integrating logistics and sustainment into operational-level planning is not only preferred but essential to an operation's success.

This model includes integrating sustainment intelligence and information requirements into IPB while analyzing the OE and determining its effects on the operation. Planners are aided in this task using the Generic Intelligence Requirements Handbook. The handbook, produced by the Marine Corps Intelligence Activity, provides frequently used intelligence requirements. These intelligence requirements are well-suited for assessing the SPoOE for a given country or region.

The SPoOE planning process model. In 1995, the Command and General Staff School included the SPoOE planning process model as an appendix in its Student Text 4-1, Theater Sustainment Battlebook. Since that time, the model has been taught within the Command and General Staff Officer Course curriculum.

CGSC's Department of Logistics and Resource Operations expanded the previously mentioned six factors (geography, supply and services, facilities, transportation, maintenance, and general skills) into fifteen topics for operational-level sustainment planners. These fifteen topics were further developed into the Logistics Preparation of the Theater Mission Analysis Process.

Based on changes in doctrine, the process was updated and further refined into today's SPoOE planning process. This CGSC model is arguably the best of the models for sustainment planners as it was designed specifically with them in mind.

These models and tools enable sustainment planners to collect, categorize, organize, and interpret sustainment data. Once the operational-level sustainment planner identifies the "so what" of this data, he or she can better understand what resources are available in the host nation or region, what capability gaps exist, and how best to develop a support concept or plan before executing an operation.

With today's technology, digital planning tools, and models that provide an expanded and more thorough process to identify, collect, and analyze logistics intelligence information, future operational-level sustainment planners will be better educated and equipped to plan for missions much more complex than Operation Urgent Fury.

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William L. Knight Jr. is an assistant professor in CGSC's Department of Logistics and Resource Operations. In 1983, he was the maintenance officer for B Company, 82nd Aviation Battalion, 82nd Airborne Division, and deployed with this unit to Grenada to support Operation Urgent Fury.

The authors thank Bob Bayless for his contributions to the article.

The Army constructed port facilities along the southeastern coast of France near the existing ports of Bassens and Bordeaux. This port became known as American Bassens. Once operational, it became one of two principal ports for the American Expeditionary Forces. (Photo courtesy of the Army Quartermaster Museum)

World War I as a Transition Point for Army Sustainment

The Army's logistics transformation during World War I helped the United States emerge as a world power.

■ By Leo P. Hirrel

In April 2017, the Army observed the 100th anniversary of the U.S. military's entry into World War I. It is important to recognize how this conflict helped the United States become a world power. The Army entered the war only partially comprehending the requirements for organizing and maneuvering a multimillion-Soldier force in an overseas theater. By the close of that war, the Army was a truly modern force.

The transformation in sustainment constituted a critical part of the emergence of the Army as a world-class power. When the United States entered the war, Army sustainment rested on an archaic bureaucratic system that was best-suited for supporting a relatively small peacetime Army.

An embarrassingly poor performance against Spain in 1898 led to some reforms in the support structure. One change was creating the Quartermaster Corps in order to combine the Subsistence, Pay, and Quartermaster Departments and to militarize logistics supply and ser-

Quartermaster Soldiers from the 77th Division complete paperwork in a tent on Sept. 9, 1918. (Photo courtesy of the Army Quartermaster Museum)

vices. Overall the Army was woefully unprepared for the logistics and personnel issues associated with a modern war, especially a war fought overseas. By the close of the war, the Army had a credible sustainment system.

To place the magnitude of the achievement in perspective, in 1898 the Army experienced incredible difficulties in moving a single corps from Tampa, Florida, to Cuba, and then it delivered insufficient supplies once in Cuba. In contrast, by the close of World War I, more than two million Soldiers were moved to and sustained in France. This was by far the largest overseas deployment anywhere in the world up to that time; it was about four times the size of the British deployment during the Boer War.

Learning to Harness Industry

Problems with industrial mobilization developed very quickly during World War I because of the lack of preparation. Without a site selection plan, construction of the necessary training camps took longer than expected. The Army missed an opportunity to purchase wool while it was available, and shortages of blankets and warm clothing were compounded by the exceptionally cold winter of 1917 and 1918.

U.S. factories lacked the dies, jigs, and precision tools for the mass production of munitions, including rifles, artillery, tanks, aircraft, and ships, forcing U.S. allies to make up the shortfalls until the end of the war. Wartime railroad congestion was so bad that it paralyzed the East Coast in December 1917.

Bureaucratic dysfunction made the difficult task of arming the nation even worse. Up to this time, supply systems were stovepiped to the extreme. Not only were the Army and Navy competing against each other for commodities, but bureaus within the War Department were competing against each other for scarce supplies. Contracting prior to the war employed a highly inflexible bidding system at fixed prices. This system worked in peacetime but not in the uncertainties of war.

At the outset, President Woodrow Wilson was reluctant to use his powers. He even initiated a program to build wooden ships to avoid having to use his authority to commandeer steel for shipbuilding.

Gradually the nation learned how to correct these deficiencies. Reorganizations within the War Department and within the larger government bureaucracy provided for more efficient operations. By 1918, President Wilson gave his War Industries Board sufficient backing to cajole industry into cooperation. Giving the war effort a higher prior-

ity for raw materials, production, and transportation introduced order into the chaos.

By the summer of 1918, the United States was reaching its potential for war production. In October, the wartime Emergency Fleet Corporation produced 33 percent more ships in one month than the nation produced during the entire year of 1916. If the war had lasted into 1919 as expected, the surge in productivity would have had noticeable results. In the interim, the United States depended on its allies for industrial support.

Overseas

At the time of the U.S. entry into the war, the Army lacked the operational experience and doctrine needed to conduct a major war. It had some limited operational experience in Mexico, the Philippines, and other areas, but nothing comparable to the challenge it would soon face.

Field service regulations (doctrinal publications of that time) offered only vague guidance about how a support structure should work in a major war. In fact, the publications contained only nine pages describing the entire line of communications.

Not surprisingly, the efforts of the American Expeditionary Forces (AEF) to create a workable sustainment system involved initial confusion, often causing the troops to suffer from the poor support. In time, the AEF addressed issues of organization, but it frequently reorganized throughout the war. Performance steadily improved, and by October 1918, the U.S.-operated ports accepted more than 900,000 tons of supplies in a single month.

The AEF entered the war expecting to rely on the French to operate ports and railroads. Upon arrival in France, however, the AEF realized that the French transportation system was too stressed by the war to provide this support.

Consequently, the AEF assumed increasing responsibility for operating French ports and railroads and improving existing facilities. Without previous experience in these operations, the Army relied on civilians to manage these projects.

Closer to the front, the AEF faced logistics challenges that Soldiers would not have contemplated during the frontier days. The introduction of motor vehicles helped with transportation problems, but their use introduced the problems of petroleum resupply, maintenance, and repair parts.

Because vehicles lacked standardization, repair parts became a nightmare. So, the Ordnance Department experimented with a mobile ordnance repair shop, thus introducing the concept of field maintenance. Graves registration and field laundry became military functions for the first time. Army cooks employed the new mobile kitchen trailers to prepare hot meals near Soldiers.

Throughout the war the Army continued to improvise with new types of organizations to meet unexpected demands, such as forestry units to provide the necessary lumber for construction.

Because of difficulties in transporting supplies across the Atlantic, the AEF relied on the French to an unprecedented degree, similar to the host-nation support used in today's operations. Upon Gen. John J. Pershing's insistence, the AEF developed a method of centralized management for overseas purchases to prevent the different bureaus from driving up prices by competing against each other.

The AEF also found ways to purchase supplies from neutral nations. French laborers, especially women, did invaluable service by operating warehouses, repairing textiles, producing macaroni, turning sheet metal into cooking utensils, and a variety of other tasks. All of this effort reduced the shipping requirements for the AEF.

Undoubtedly, the wide variety of support tasks came as a surprise to Soldiers accustomed to thinking of warfare in terms of enemy engagement. To their credit, members of the AEF sustainment community quickly recognized the importance of their work and adjusted to provide the necessary support to the fighting forces.

Human Resources Support

Functions that today might be termed human resources support matured significantly under the direction of the Adjutant General's Department. During World War I, the Army needed to find ways to match Soldiers to the multitude of skills required beyond the combat functions, so they employed IQ and occupational skills testing.

The Army also needed a system to send replacements to the divisions during the fight. With some difficulty, the Army developed a system that began with replacement training centers in the United States and ran through to replacement depots in Europe. Unfortunately, the system did not mature until after the war, but the model served well for the remainder of the century.

Other personnel innovations included a central records office in theater, the use of serial numbers, and the Army's assumption of postal duties. Functions that today might be called morale, welfare, and recreation were handed to the women and men from volunteer organizations, but the lessons were remembered when the Adjutant General's Department created the Special Services Division for the purpose of troop morale.

Significance

By the end of the war, the AEF had developed into a credible fighting force capable of successfully engaging the Germans in some of the most difficult terrain in France. The transformation of the Army's sustainment structure was a major part of the development of the United States into a world power.

Certainly the organization had shortcomings, but American Soldiers had the means to do their jobs. It is difficult to imagine how the AEF could have fought in the final bat-

Workers at the Nevers Depot move subsistence in April 1918. Feeding an Army that eventually reached two million Soldiers required extensive manual labor. (Photo courtesy of the National Archives)

tles of 1918 if the various supporting branches had not rapidly adapted to modern warfare.

Effective sustainment operations in World War I had further implications. At the time of the U.S. entry into the war, French and British allies proposed blending U.S. Soldiers into their own formations because they were unsure of their new ally's ability to manage large operations. The Army's immature sustainment capabilities in 1917 were an important consideration. By developing the capacity to support the AEF, rear-area Soldiers enabled the fielding of an independent Army that would ensure that the United States had a voice in the post-war peace conference.

The Post-War Period

In the years after World War I, the Army temporarily returned to its previous status as a small force, and investments in sustainment diminished accordingly. However, the war left an intellectual legacy for future senior leaders on the intricacies of supporting a huge Army.

With the establishment of the Army Industrial College in 1924, officers had the chance to consider the problems of homefront mobilization and wholesale logistics. The painful lessons in moving supplies led to the creation of the Transportation Corps in 1942 as a permanent branch of the Army.

Lessons from World War I helped President Franklin D. Roosevelt and his advisers understand the need for a pre-war mobilization program in the period before the U.S. entry into World War II. Leaders also applied tested organizational and doctrinal solutions to the new war. Military logistics and personnel operations are never perfect, but in the 1940s, the Army was far better prepared for the next global conflict.

Members of the sustainment community of World War I made two tremendously important contributions to the U.S. emergence as a world power: they provided the means for the AEF to function as a separate army, and they left an intellectual sustainment legacy that enabled the Army to enter World War II as a premier fighting force.

Dr. Leo P. Hirrel was the Quartermaster School historian from 2011 to 2017. He is the author of the recently published "Supporting the Doughboys: U.S. Army Logistics and Personnel During World War I," which is available for free at http://www.armyupress.army.mil/Portals/7/combat-studies-institute/csi-books/Supporting-the-Doughboys-(Web).pdf.

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Lt. Gen. Edward Daly, Army Materiel Command deputy commanding general, addresses attendees at the Logistics Support Activity Logistics Training Forum at Redstone Arsenal, Ala., on Aug. 23, 2017. The forum facilitated the exchange of information and allowed the discussion of current topics affecting Army logisticians. (Photo by Sgt. 1st Class Teddy Wade)

The Army Materiel Command's Logistics Support Activity (LOGSA) will host the Logistics Training Forum (LLTF) March 26-30, 2018, at Redstone Arsenal, Alabama. The LLTF showcases the most current logistics tools and programs available to assist in sustaining and generating readiness for today's warfighter. The annual event provides a forum for Army logisticians—officers, warrant officers, noncommissioned officers, Department of the Army civilians, and contractors—to share both logistics challenges and successes. Visit the LOGSA website for the latest information and updates at https://www.logsa.army.mil. For additional questions or information not found on the site, email the LLTF team at usarmy.redstone.logsa.mbx.service-desk@mail.mil.