Unified Land Operations in the 2040 Timeframe – Autonomy-Enabled Platoon-Level Missions

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This article provides ideas about the future force by describing how currently maturing autonomy-enabling solutions might be employed for the Army in 2040 timeframe. We want to provoke constructive dialogue that studies our accepted understanding of what may seem possible in the coming decades.

This is vital because the U.S. Army's ability to achieve significant leaps in warfighting efficiency and effectiveness demands a healthy understanding of the interaction of technology-enabled capability with doctrine and tactics, techniques and procedures – and the resultant impacts across doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF). Significant advances in our ability to realize efficient, expeditionary ground warfare is dependent on our collective ability to appropriately embrace the benefits of emerging operational capability and to mitigate the operational risks of the new capability while understanding the necessary doctrine and tactics that fully exploit its operational potential.

Many historical examples are available to reinforce this premise. Consider the advent of tanks on the World War I battlefield, the evolution of tank warfare during the interwar years and the significant impact on warfare during World War II. Armies around the world who chose to dismiss the potential of that new capability found themselves quickly overmatched by those who embraced it, studied it and optimized their doctrine around the newfound velocity. Today we must follow the later example and not fall prey to an institution's natural resistance to change.

This article does not propose drastic or radical changes in how we conduct warfare. The fundamental principles of war remain the same: warfare has been and remains a uniquely human endeavor. Autonomy-enabled systems (AS) are tools to enhance the human potential of our force across the spectrum of operations. These systems augment the operational dimensions of time and space. In a kinetic operation they will find, fix, delay, divert or stress and help defeat an opponent, disrupting his actions, without committing Soldiers. Incorporating AS this way allows our Soldiers to gain a time and space advantage. In non-kinetic operations, Soldiers are required to engage with local populations and build trust. In these stability operations, AS will enable efficiencies across intelligence, sustainment and mission-command functions that support the main effort.

U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) believes the U.S. Army must focus its science and technology efforts on concept-based requirements while fostering innovation that empowers, unburdens and protects Soldiers. TARDEC is developing autonomy-enabling concepts to help shape and support the integration of these emerging capabilities into our formations.

2040 environment

First let's review our understanding of the environment in the 2040 timeframe.

Operating environment. The operating environment will be characterized by:

- Uncertainty;
- Complex and urban terrain;
- Extended distances for both employment and deployment;
- Decentralized operations;
- Anti-access and area denial (A2AD);
- Hybrid threats;
- Host-nation and allied forces;
- Non-governmental organizations; and
- Media interaction with civilians.

Autonomous systems will enable formations and the Soldiers they operate with throughout these environments and in various regions of the world.

Regional environments. AS must be capable of operating in virtually all environments and conditions. They provide us the ability to enhance our operations in areas such as in the high terrain of Afghanistan or the deserts of North Africa, where they may not be impacted by the lack of oxygen in a thin atmosphere or the temperature swings of a desert landscape. Operations in some regions may be more or less conducive to AS. Combat operations in an urban environment may be easily exploited by AS, which can operate in subterranean environments without light or oxygen. Conversely, conducting humanitarian-assistance or peace-support operations in the same locale may not be amenable to AS due to the high degree of human interaction with local non-hostile populations.

Threat. Aerial ports of debarkation (APODs)/surface ports of debarkation will be at risk from capabilities and hybrid threats; state actors with little money and hybrid capabilities; vast deployment distances (as we will be a continental United States (CONUS)-based force); non-state actors with regional influence and access to niche technologies; terrorist groups; transnational drug-trafficking operations; and weapons of mass destruction. Equipment will be more sophisticated relative to both current capabilities and our projected capabilities (we can no longer expect a significant overmatch in terms of technology for most systems), and they will logically improve with technologies such as night vision, signals intelligence or directed-energy weapons. Threats will be comfortable with and operate routinely within civilian populations.

Expeditionary capability. Given the fiscal reality of a CONUS-based Army, we must seek to enhance our expeditionary capability through the use of AS. AS may be used to help set the conditions for successful A2AD operations by early insertion into areas to degrade or eliminate enemy A2AD capabilities, allowing us greater options in forced-entry or early-entry operations. Also, at the tactical edge, if we are able to remove Soldiers from combat platforms, we are able to deploy smaller/lighter unmanned combat systems with initial forced-entry forces, enhancing the force's ability to more quickly gain and maintain momentum and accomplish their mission.

The operational spectrum and range of military operations remains the same.

Warfare fundamentals same

The principles of war remain unchanged; however, autonomous systems may allow their application in new and different ways. The warfighting functions remain unchanged; however, AS can help enable them and support decisive action.

We must avoid the temptation to believe that autonomous systems somehow change the underlying principles under which the Army operates (reference "Principles of War in the Information Age" and the "Revolution in Military Affairs" mindset of the 1990s). They can contribute to varying degrees when integrated into our formations and enable them.

Impetus for autonomy

The inability of solely manned formations to physically occupy and operate with the battlespace required at a formation level drives the need for autonomous systems.

As seen through history, we expect increasingly lower and lower echelons of units to occupy greater and greater areas of terrain (World War I rifle company to Operation Iraqi Freedom (OIF) company). As we have moved from "shoulder to shoulder" operational constructs to such things as wide-area security (WAS), we have increased the risk of knowing less and less about ever-larger areas of our operational areas. Use of AS will allow unit leaders and Soldiers to regain a more detailed understanding of terrain they are operating in and through, perhaps providing that tactical edge that is the key to success on the battlefield.

The requirement for continuous (24/7) operations remains; AS provide the ability to maintain operational security in continuous operations. AS may in fact permit the Army to fully operate throughout the day-and-night cycle by overcoming the circadian rhythm that makes Soldiers less awake in the very early hours of morning, or by providing the ability to conduct continuous and sustained resupply through automated convoys – or even individual vehicles.

Operations in and among the population place increasing demands on formations to maintain much higher levels of situational awareness and situational understanding of their environment (in other words, no "free fire zones"). As we operate within populations, we must increasingly be able to discriminate between friendly, neutral, non-

hostile and hostile personnel, which mean we must gain more detailed information about the peoples with whom we are interacting.

Unified land operations

The unified-land-operations concept frames how the Army will operate and remains valid regardless of the manner in which the Army is manned, equipped or organized.

We need to view autonomous systems as another tool within the inventory that enhances the Army's ability to generate and apply combat power. We must always look at autonomous systems through the generation/application of combat-power lens; if AS do not generate/apply combat power, they are not value-added.

Tactical examples

Following is a series of tactical vignettes intended to generate thought and discussion on how autonomous systems might be useful to the Army, including the general/broad considerations that such application/employment might engender across the DOTMLPF framework. These are not meant to be comprehensive but to help Soldiers and leaders visualize the utility of AS in relevant operational contexts.

Vignette 1: guard mission

Task/purpose: *Guard* is a security task to protect the main body by fighting to gain time while also observing and reporting information, as well as prevent enemy ground observation of and direct fire against the main body. Units conducting a guard mission cannot operate independently because they rely on the main body's fires and functional/multifunctional support assets. A guard is typically a mission assigned to a combined-arms unit possessing the organic capability to provide early warning and maneuver space to a larger main body element.

Doctrinally, the force performing the guard mission must be able to engage and defeat enemy reconnaissance forces; force the enemy unit to deploy into either an attack or defensive posture; and deceive the enemy as to the true location of the friendly main body. Since the elimination of the G-series Cavalry platoon, generally a company-team has been the lowest-level tactical unit assigned this mission. However, autonomy-enabled Cavalry platoons can once again provide this capability at the lowest tactical level.

Organization for combat:

- Six light reconnaissance vehicles (LRVs) (36 Soldiers);
- Four unmanned reconnaissance vehicles (URVs) (a section of two per scout section);
- Four unmanned mobile protected firepower (MPF) systems (two sections of two).

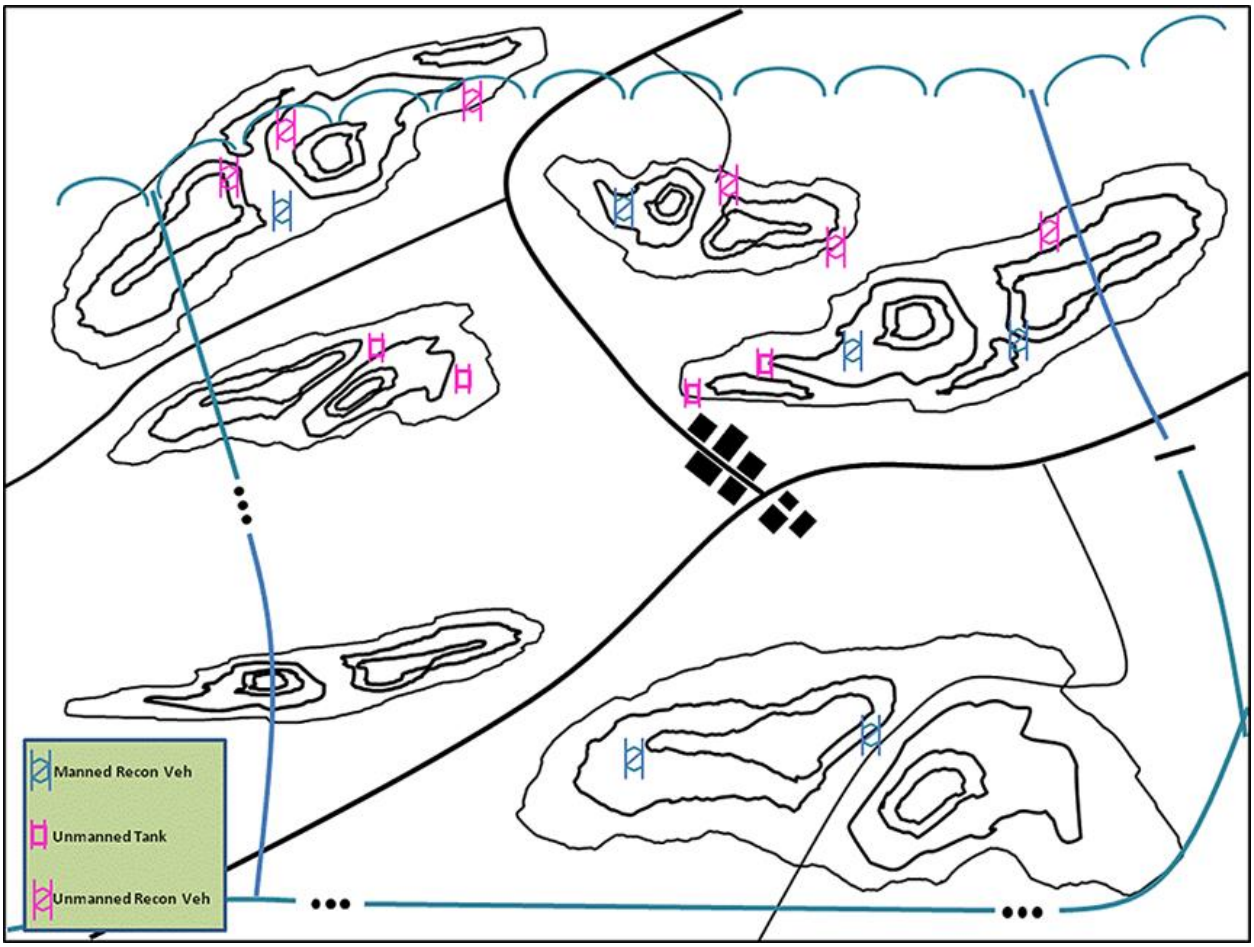

Figure 1. Guard mission.

Operational narrative: For this mission, the standard six-vehicle scout platoon has been augmented by four URVs, which are capable of autonomous tactical behaviors and equipped with sensor suites that include electro-optical (EO)/infrared (IR), seismic and acoustic capabilities. The platoon also has four autonomous MPF systems, which operate in two-vehicle sections just like a tank platoon. Given these additional capabilities, which operate for the most part without human interaction (beyond providing general guidance on where to move, establish surveillance locations and orient – the same guidance a platoon leader would give to a vehicle or section commander), the platoon has the combined-arms capabilities and density of surveillance assets (both manned and unmanned, to include dismount capabilities) to perform a guard mission equivalent to a task-organized company-team. As the enemy force – whether a traditional "Soviet-style" advance guard/security element or something less robust – moves into the sector, this platoon has multiple assets available to identify and then defeat threats up to main-battle-tank level.

Also, with unmanned systems, greater risk can be taken in having assets remain in place to observe and report, reducing the need to displace in contact as well as the potential for loss of contact or destruction of displacing elements. The doubling of mounted primary surveillance platforms (from four to eight; two of the vehicles are the platoon leader and platoon sergeant, who are not primarily surveillance oriented but are command-and-control focused), along with the ability to package a greater number of sensors into an unmanned platform (beyond the traditional EO/IR systems) allows this platoon to occupy a sector up to twice the traditional width for a platoon.

Combined with the immediate lethal precision effects of the unmanned MPFs (whose "human in the loop" is someone in the platoon-leader and platoon-sergeant vehicles), this platoon has now "returned" a maneuver company-team to the task force/battalion commander, who no longer has to take one of his four maneuver companies to provide security for the formation.

Vignette 2: zone-reconnaissance mission

Task/purpose: A *zone reconnaissance* is normally conducted over a large area to gain understanding of the complete situation within an area the larger maneuver force will later occupy/move through (depending on the higher unit's mission: offense or defense). Forces must be able to gain an appreciation of the details of the terrain, infrastructure, populace and enemy dispositions. The limitation with the six-vehicle/36-Soldier scout platoon is that the risk of contact with the enemy reduces the pace of movement through the zone; the addition of autonomous systems that can maneuver (not just move) forward of the manned platforms significantly enhances speed and reduces risk to the manned force.

Organization for combat:

- Six LRVs (36 Soldiers);
- Eight unmanned autonomous reconnaissance vehicles (UARVs) (a section of two per scout squad vehicle);
- 16 miniature unmanned autonomous sensor vehicles (two are carried within each UARV).

UARVs are deployed to maintain surveillance over areas as they are cleared to maintain the integrity of the reconnaissance.

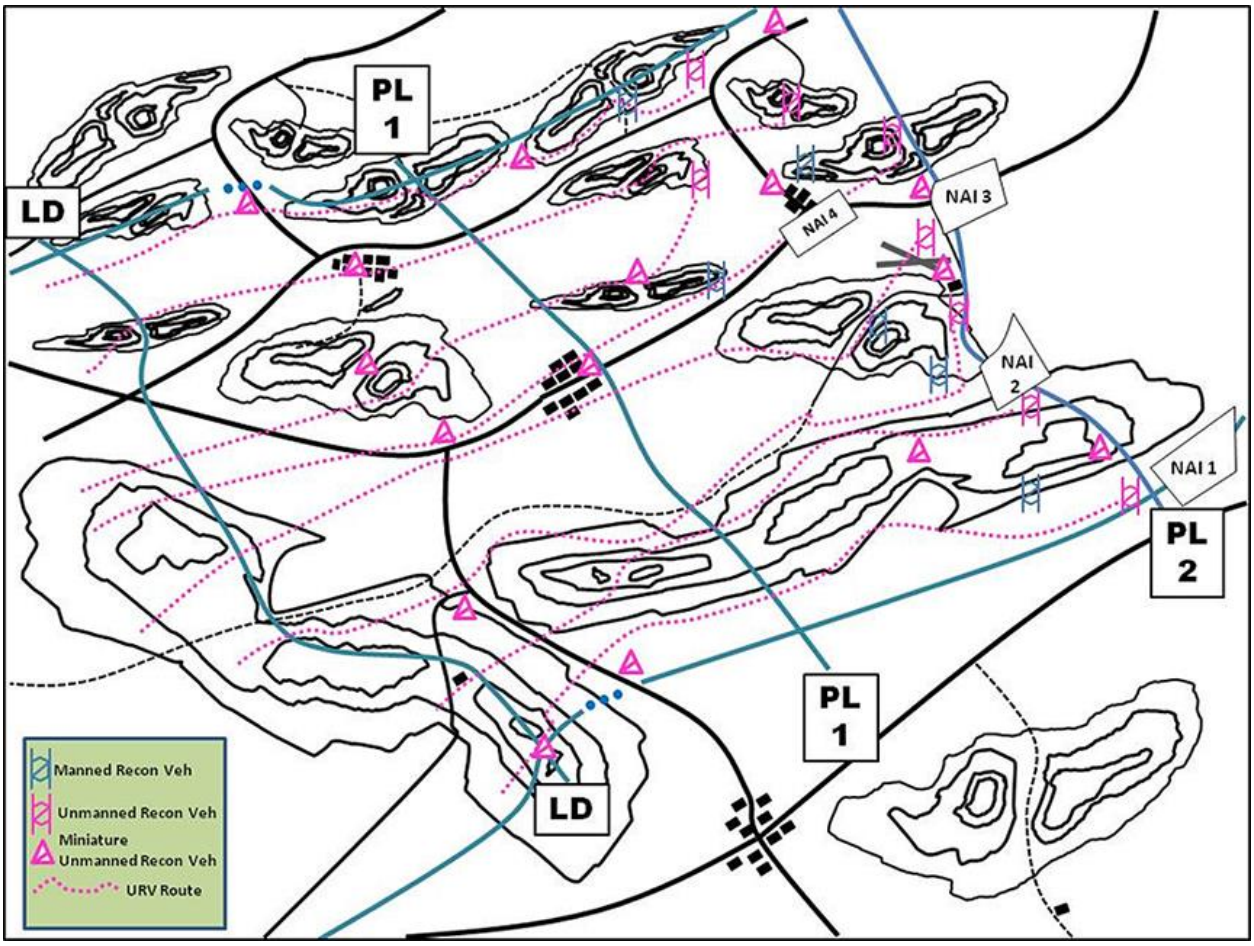

Figure 2. Zone reconnaissance.

Combined-arms maneuver (CAM) operational narrative: For this mission, the standard six-vehicle scout platoon has been augmented by four URVs, which are capable of autonomous tactical behaviors and equipped with sensor suites that include EO/IR as well as seismic and acoustic capabilities. Each URV also carries two small (less than 50 pounds/2ft^3) miniature URVs that can be deployed to establish remote surveillance (albeit with limited sensors). As in the previous example, the systems operate for the most part without human interaction, providing a force-multiplier effect. The platoon now has extended surveillance assets (from four primary scout vehicles to 28),

allowing a single platoon to conduct a zone reconnaissance across a width normally assigned to a troop (three platoons) or a squadron (six platoons).

Also, the single platoon now has a much greater ability to establish enduring surveillance throughout the zone, which is particularly important during WAS operations, where we want to maintain a high level of situational awareness throughout an operational area. This would allow each battalion to use only its organic scout platoon to conduct the mission, allowing the brigade combat team (BCT) commander the flexibility to focus his organic Cavalry squadron farther forward or to the flanks, or to conduct a security mission (such as the guard outlined previously), conserving his forces. The platoon would deploy across the zone, with the URVs moving ahead of the manned systems and deploying the miniature unmanned reconnaissance vehicles (MURVs) at locations the scouts identify.

Upon reaching the limit of advance (Platoon 2 in the example), the platoon would still have a full complement of assets to establish a screen across the width of the zone if necessary.

WAS operational narrative: In a WAS environment, this combination of manned and unmanned assets would allow a commander the ability to much more quickly gain a basic appreciation of the terrain and populace of the area in which the unit is going to operate. Also, the AS allow the manned assets to be focused more on the population to begin the engagement process while the AS continue to execute the reconnaissance of the entire area. Given the nature of WAS, it is very important to have at least a general understanding of the terrain (whether physical or human) of the area of operations, and the combination of manned and unmanned assets significantly increases the pace and level of detail of operations such as this.

Vignette 3: screen mission

Task/purpose: The purpose of the screen mission is to provide early warning to the main body and prevent it from being surprised by an enemy force. Unlike a guard, there is no expectation of the screen force engaging in extended combat with the enemy force; the critical task is to gain and maintain contact with enemy forces so that the main body can react as necessary.

Organization for combat:

- Eight URVs;
- 16 MURVs.

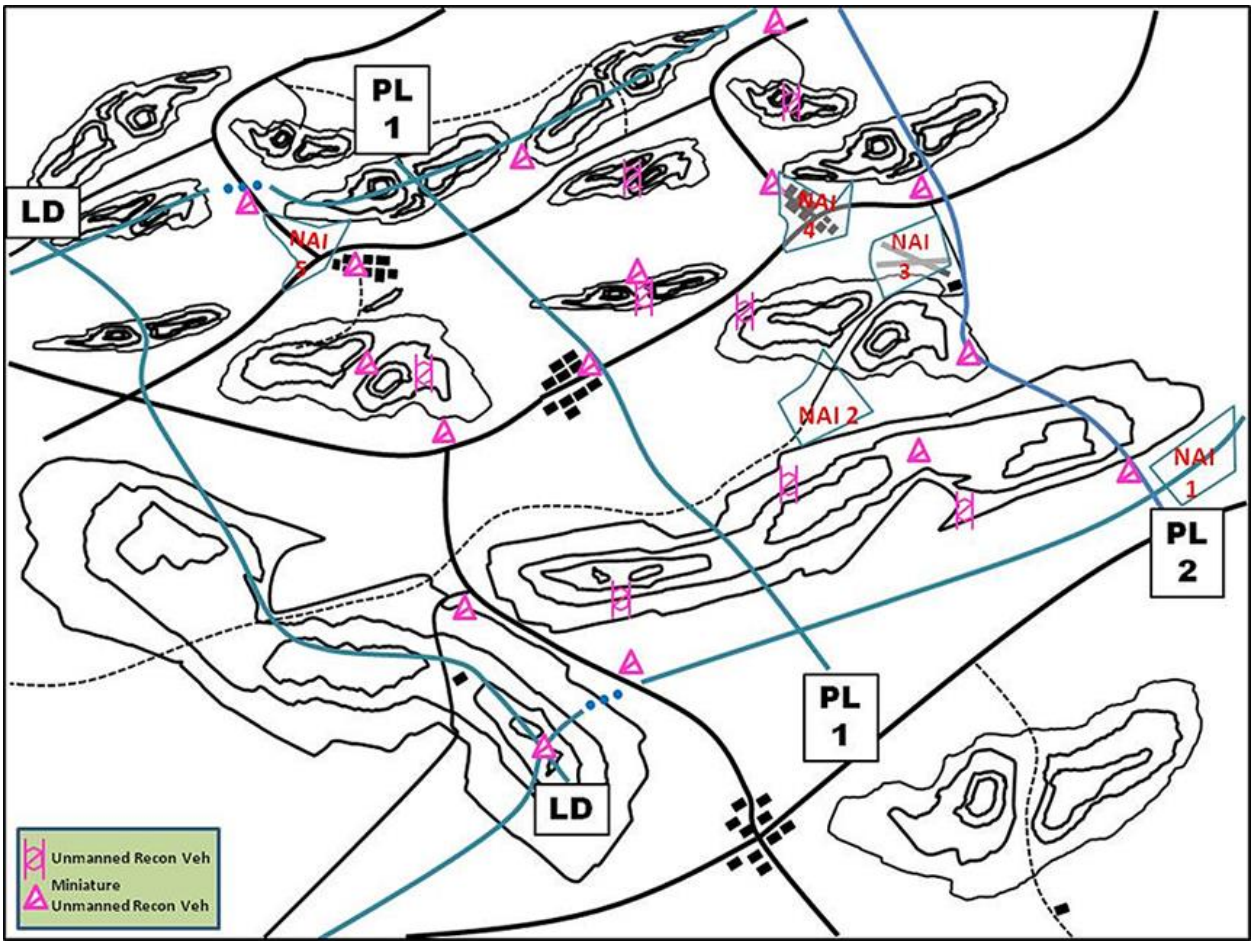

Figure 3. Screen.

CAM operational narrative: For this mission, the commander is able to employ only unmanned systems, as the mission only entails reporting on the enemy forces and not the need for engagement to delay, destroy or defeat any enemy forces. The battalion/task force operations team can develop the scheme of maneuver for the unmanned systems, and then they can self-deploy into the sector and establish the observation posts. The unmanned systems are able to establish surveillance, and the individual URVs and MURVs can move to track/maintain contact with enemy assets if necessary. Using only unmanned systems, which provide information directly to the tactical-operations center, allows the commander to focus his manned assets on areas where there is a greater likelihood of enemy presence or activity, or where he needs detailed reconnaissance or interaction with local populations that can only be provided by Soldiers.

WAS operational narrative: The use of only unmanned systems frees up manned systems to conduct the engagement operations with the civilian populations. The critical tactical tasks within a WAS mission set revolve around interaction with the local populations; the more Soldiers available to the commander, the more capable the unit is of accomplishing its mission. Also, given the ability of unmanned systems to execute persistent or near-persistent surveillance, there is a significant increase in capability through both the extension in time-on-station and in the elimination of "surveillance gaps" that would occur as manned assets have to transition with replacement forces.

Vignette 4: special reconnaissance/surveillance mission

Task/purpose: *Special reconnaissance* includes reconnaissance and surveillance actions conducted as a special operation in hostile, denied or politically sensitive environments to collect or verify information of strategic or operational significance. At this level, long-range surveillance units are often tasked to conduct this mission, but with the rise of A2AD capabilities, autonomous systems can provide a similar capability without risk of Soldiers'

lives. Unmanned aerial systems (UAS) or high-altitude high-opening (HAHO) parachute insertion can be used to deliver URVs into the operational area.

Organization for combat:

- Eight URVs;
- 16 MURVs.

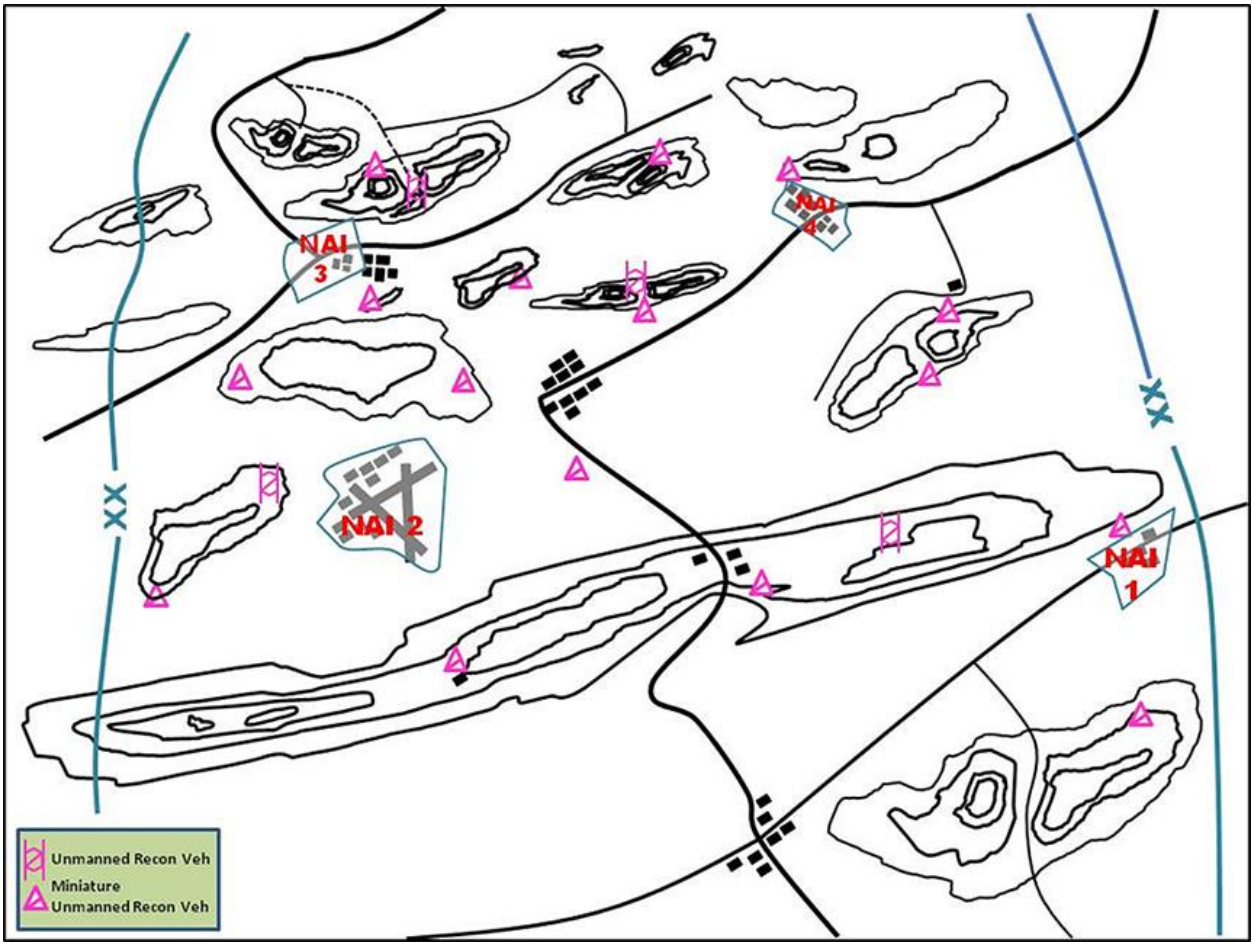

Figure 4. Special reconnaissance/surveillance.

CAM operational narrative: For this mission, the commander employs only unmanned systems, which are inserted by UAS or HAHO to overcome the risk posed by enemy A2AD capabilities. Using UAS for deployment into the operational area significantly reduces the potential for detection and counter-action by enemy forces; detection avoidance is critical during pre-deployment operations to avoid providing the enemy with intelligence on our likely deployment areas and to prevent potential national political issues (assuming a state of formal war does not yet exist). Such employment can provide low-risk intelligence collection that can help refine the operational planning for the employment of elements such as Pathfinder and Air Force combat-control teams that would be inserted to establish drop zones for conventional forced-entry units (generally an airborne-infantry BCT or battalion task force).

WAS operational narrative: In many respects, the roles are similar in that the friendly force can establish unmanned low-signature but long-enduring surveillance before committing manned assets – and before even letting the local population know we have an interest in the area. This capability, which emphasizes smaller, more static surveillance, may also set the conditions for commanders to decide whether they will choose to actually deploy forces into an area.

Vignette 5: route reconnaissance/autonomous resupply mission

Task/purpose: *Route reconnaissance* is a directed effort to obtain detailed information on a specified route and all terrain from which the enemy could influence movement along that route. In this case, we use a combination of manned/unmanned systems to complete all the tasks inherent in a route-reconnaissance mission, which include securing the route. Once the route has been reconnoitered, autonomous systems can transit it, providing as-needed resupply at any time, either individually or in convoys as required.

Organization for combat:

- Six LRVs (36 Soldiers);
- Four URVs (a section of two per scout section);
- Four unmanned tanks (two sections of two);
- Eight MURVs;
- Four UARVs;
- Two optionally manned cargo vehicles.

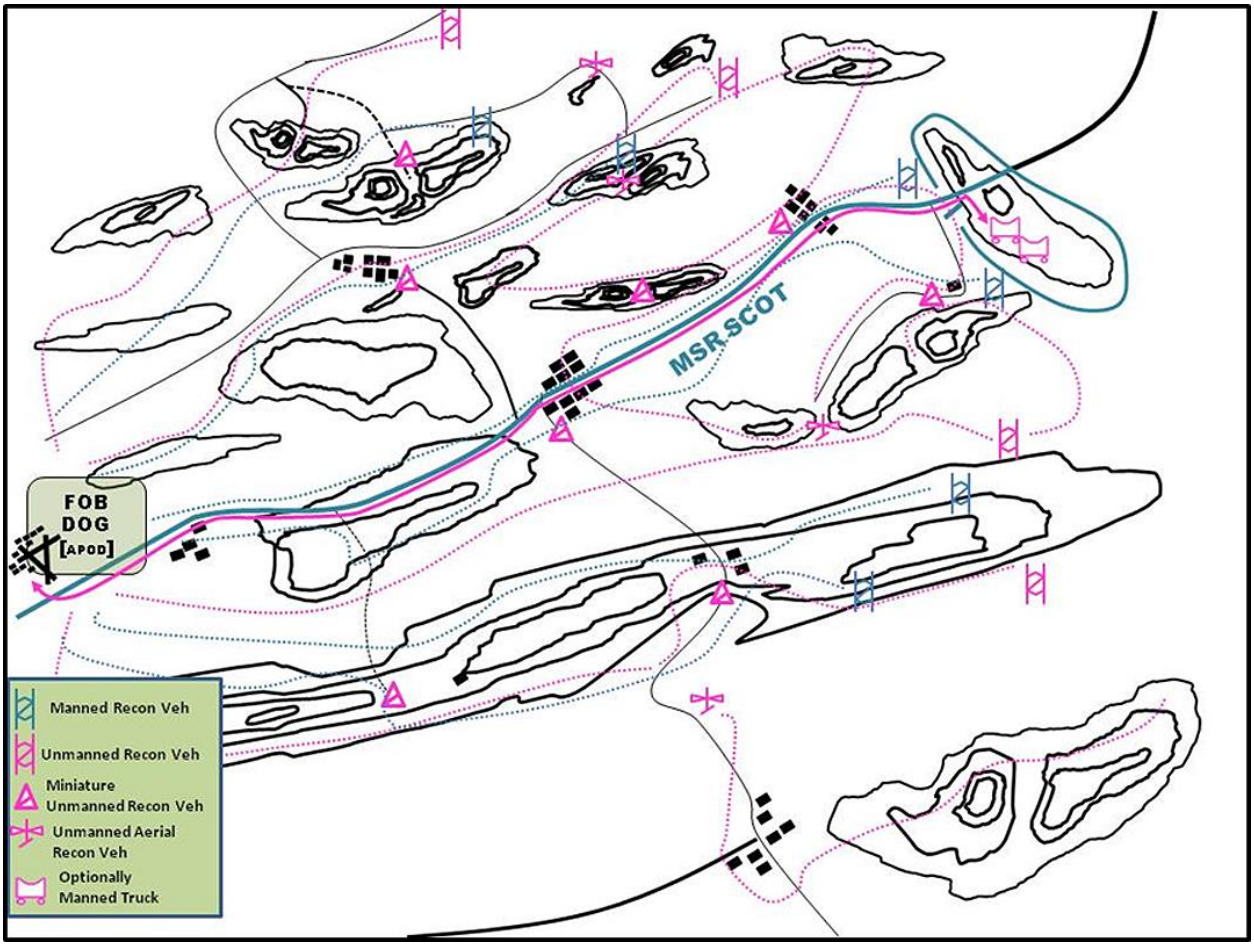

Figure 5. Route reconnaissance/autonomous convoy.

CAM operational narrative: For this mission, the standard six-vehicle scout platoon has been augmented by four URVs with a mix of MURVs and UARVs. Also, resupply of the company-team position once the route reconnaissance is complete is accomplished with optionally manned (in this case, unmanned) cargo vehicles. As part of the route-reconnaissance mission, the platoon and its attendant UARVs would conduct the normal tasks, with the unmanned systems preceding and operating to the flanks of the manned assets. This would allow the manned systems (scout squads) to deploy dismounts at specific locations (i.e., built-up areas, culverts, defiles) where there might be specific requirements for human action, such as talking with the local populace or investigating a suspicious item/activity that unmanned assets identified.

The use of the unmanned systems, particularly air assets, allows a faster and more comprehensive route reconnaissance. Also, the use of the MURVs allows the maintenance of security over the route once the moving reconnaissance assets (manned or unmanned) have moved forward.

As with the other vignettes, a platoon with augmentation by unmanned systems is able to accomplish a task that would otherwise require a troop or company-team, again allowing the higher commander to better manage his combat power.

WAS operational narrative: As we have seen in OIF and Operation Enduring Freedom (OEF), there may be longer-term situations where we are constrained to the repetitive use of fixed lines of communication. Using AS – probably with additional counter-improvised explosive device/explosive ordnance detachment capabilities to conduct the actual route clearance – significantly reduces the risks to our Soldiers. AS also provide the capacity for persistent surveillance so that, unlike OIF/OEF, we are not forced to use forces repetitively to "re-clear" routes; the persistent and overlapping AS sensors can be used to monitor the route continuously and identify potential or confirmed threats, and then guide manned reaction capabilities to the target(s).

Vignette 6: movement-to-contact

Task/purpose: *Movement-to-contact* is an offensive task to develop the situation and establish or regain contact with the enemy. It is normally used when the tactical or enemy situation is vague, when the enemy has broken contact, or when there is no time to reconnoiter extensively to locate the enemy. Contact results in initiation of another operation such as attack against a stationary or moving enemy force, defense, delay or withdrawal.

The fundamentals and techniques discussed here also apply to the approach phase of a hasty or deliberate attack; the main difference is the amount of enemy intelligence. In the approach phase of an attack, the enemy situation is clearer. Doctrinally, the force performing the movement-to-contact moves toward the objective in a way that avoids enemy detection and supports its deployment in the assault.

Organization for combat:

- Six armored multipurpose (reconnaissance/surveillance) vehicles (AMPVs) and four infantry squads (36 Soldiers);
- Three UAVs;
- Four optionally manned AMPVs;
- Six MURVs.

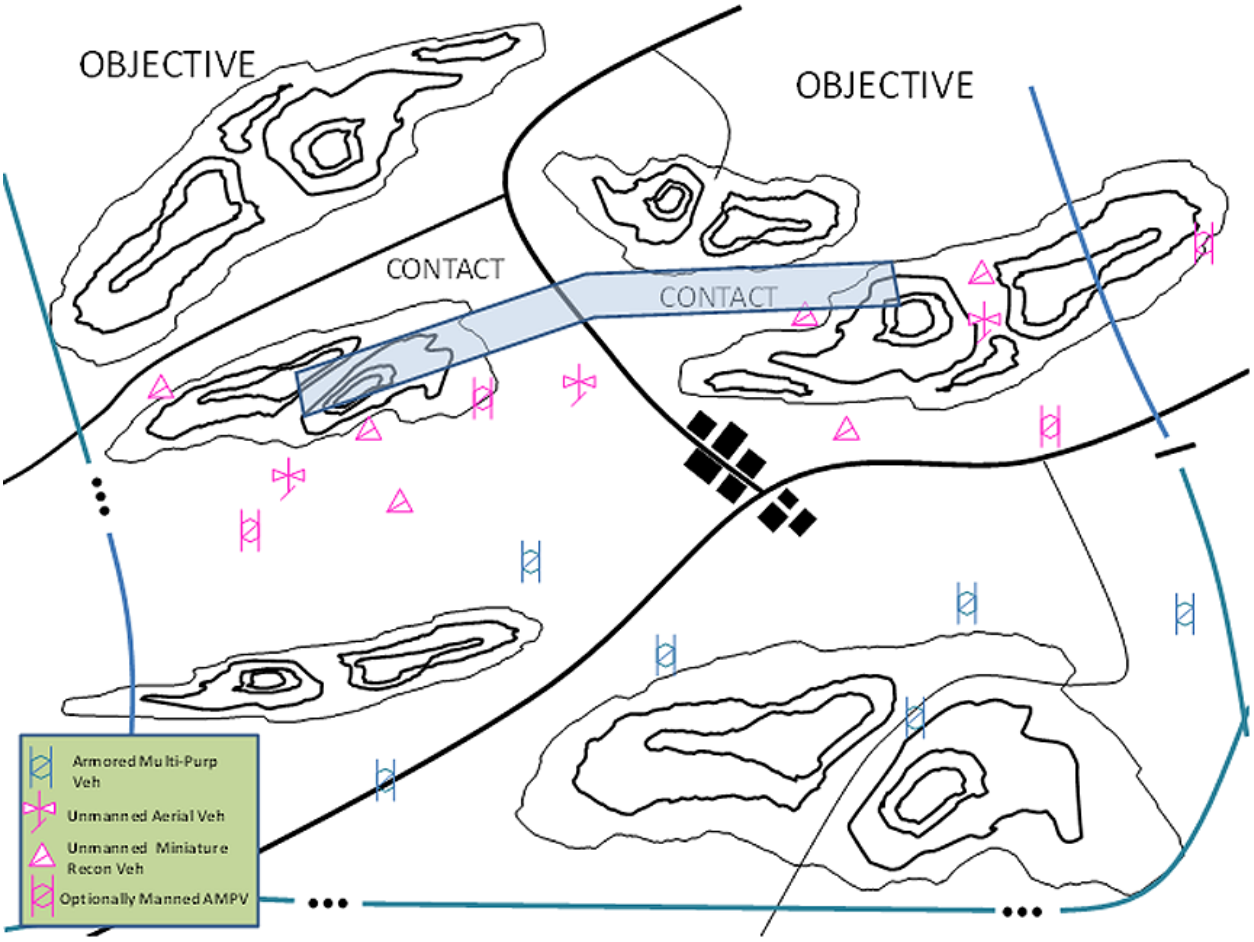

Figure 6. Movement-to-contact (traveling formation).

CAM operational narrative: Autonomous-system placement extends the observation and identification range of the enemy force. This economy-of-force operation enhances situational awareness while preserving flexibility and enabling options for fire and maneuver. In this operation, six miniature unmanned ground-reconnaissance vehicles and three UAVs are teamed with partially manned AMPVs. They move toward the objective while avoiding enemy detection. Upon contact, the commander uses his unmanned assets to collect disposition information about the enemy and fix it while directing his approach of follow-on forces to the objective.

WAS operational narrative: Here we can use AS to gain and regain contact with a withdrawing insurgent force while the manned assets perform recovery and assistance operations. Then we can use the unmanned assets to find and fix the enemy and have the manned assets engage them. Throughout WAS operations and in areas of special interest, AS can also help maintain local security. In this case, we integrate unmanned recon vehicles with other persistent stare assets and pair them with small teams to find enemy forces under cover.

Vignette 7: feint and demonstration

Task/purpose: A *feint* is an offensive task used to deceive the enemy of the location or time of the actual decisive operations or main attack. Its purpose is to deceive the enemy and cause him to react in a particular way, such as reposition his forces, commit his reserve or shift his fires. The feint seeks direct-fire contact with the enemy but avoids decisive engagement.

The *demonstration* is similar to a feint, but the friendly force does not seek to make contact with the enemy. One task would be to establish an attack-by-fire position beyond the enemy's direct-fire engagement range; the purpose would be to cause the enemy to commit a specific element simply by virtue of the positioning of the demonstration force.

Organization for combat:

- Six AMPVs (two control vehicles for unmanned tanks);
- Six manned tanks;
- Four unmanned tanks.

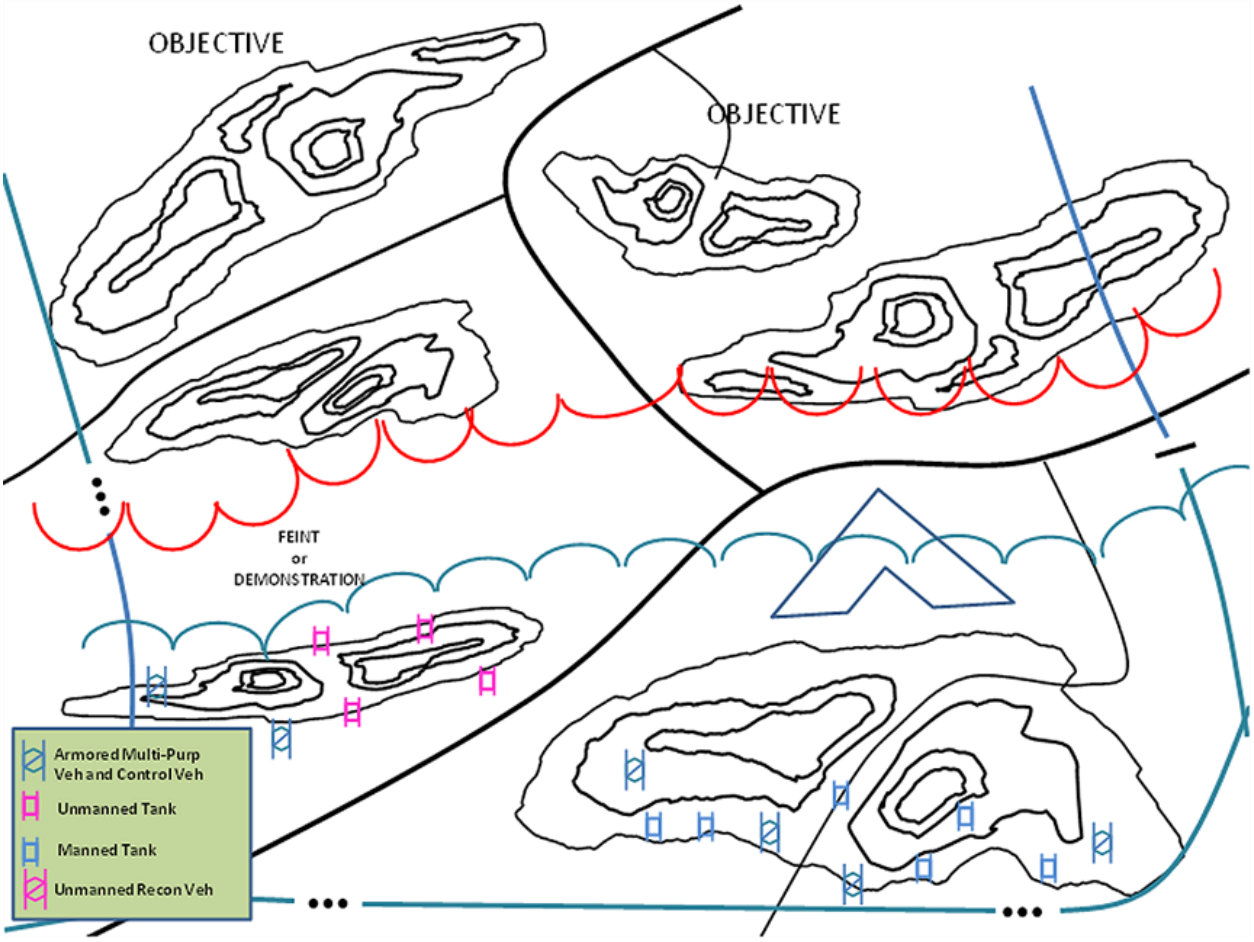

Figure 7. Feint and demonstration.

CAM operational narrative: Autonomy-enabled systems and robotic decoys are well suited to deceive the enemy and support a deliberate attack. These systems serve in an economy-of-force capacity, as they require little supervision and allow the commander to weight the main effort with manned formations. In this operation, four unmanned tanks on the graphic's left side are under the control of two supervision vehicles. These unmanned tanks occupy positions that permit enemy observation, support deception and cause the enemy to react. This enemy reaction allows the commander to adjust his main effort of six manned tanks and four AMPVs accordingly and to attack in the most effective way.

WAS operational narrative: The opportunities for using these around an enemy organization or high-value target of interest are significant. Here we can use AS to either feint or demonstrate while friendly forces, as an example, are doing a snatch operation. In this case, we would use AS to move into the area of nearby building complexes to conduct the feint and defeat enemy surveillance and counter-surveillance systems.

In these types of operations, AS can send multiple messages, but the intent and object remains the same: to cause the enemy to react.

Vignette 8: deliberate or area defense

Task/purpose: A *deliberate* or *area defense* concentrates on denying enemy forces access to designated terrain, limiting their freedom of maneuver and channeling them into killing areas. This allows the defender to retain

terrain the attacker must control to advance. The enemy force is drawn into a series of kill zones, where it is attacked from mutually supporting positions and destroyed, largely by fires. Commanders use the reserve to preserve the integrity of the defense through reinforcement or counterattack.

Organization for combat:

- Four AMPVs (one manned recon supervision vehicle teamed with one optionally manned recon vehicle) (two platoon leader vehicles);
- Two UAVs;
- Eight manned tanks;
- Four unmanned tanks;
- Two tank supervision vehicles (one with platoon leader).

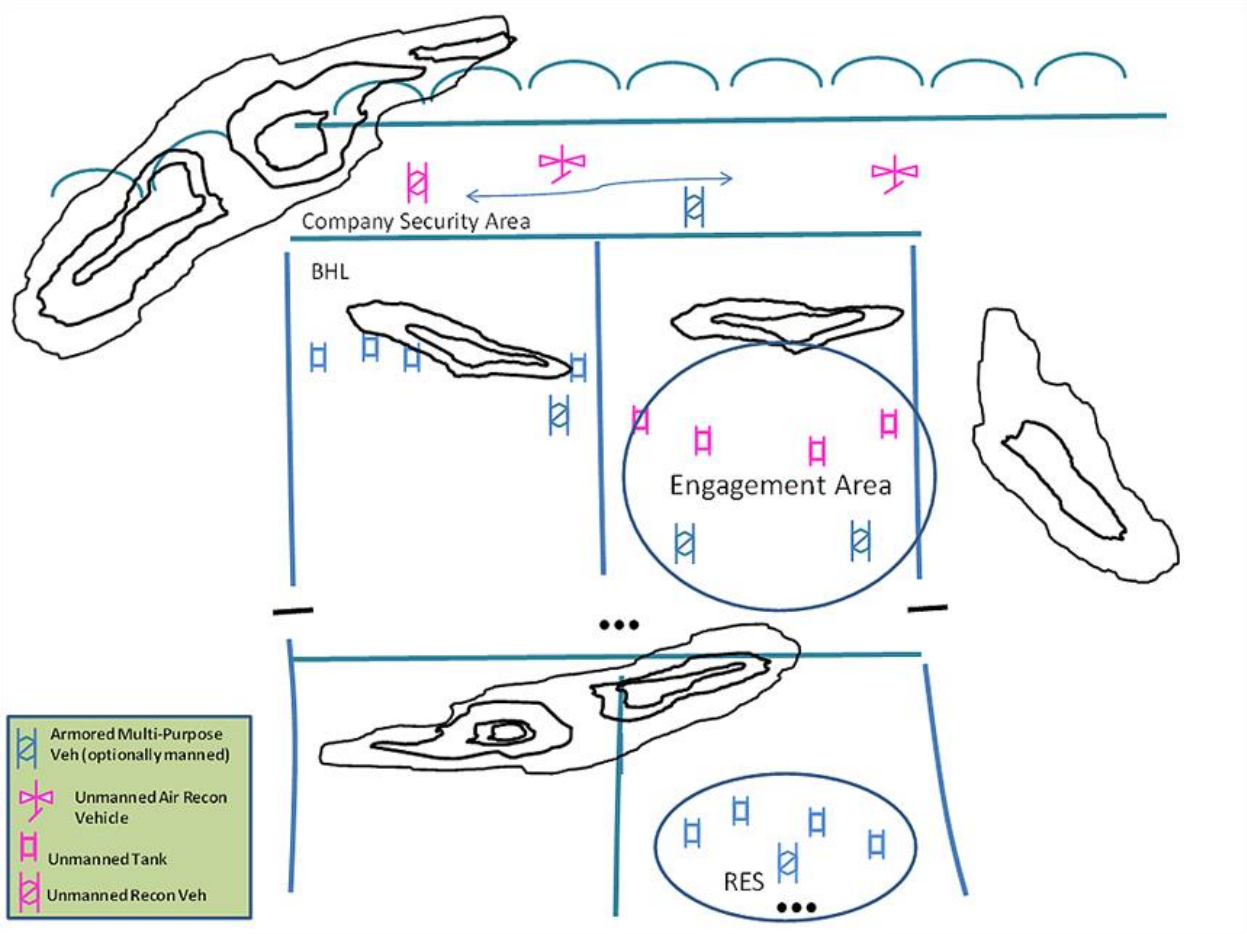

Figure 8. Deliberate and area defense.

CAM operational narrative: Autonomy-enabled systems are well suited in a deliberate defense to help draw the enemy into a kill zone. In this scenario, the AS "delay in sector/draw enemy forces into" the engagement area, where they will be met with fires and a manned tank platoon in reserve if necessary. Initially, in the company security area, a manned AMPV (supervision vehicle) is teamed with an unmanned AMPV recon vehicle that is outfitted with imagery, radar, acoustic detection and signal sensors. The manned AMPV is also teamed with two imagery-recon UAVs. The security force withdraws across the battle-handover line (BHL). The manned platoon is forward and heavily engaged while the manned-unmanned team draws the enemy into the engagement area.

WAS operational narrative: Put in the context of establishing layered defenses around forward operating bases (FOBs) and combat outposts (COPs) simultaneously, we can use unmanned assets to establish and maintain

security while manned forces are establishing and maintaining the FOB/COP. Their ability to enhance detection of enemy forces helps free up manned assets to engage the enemy with responsive fires.

In all these vignettes, AS is a force multiplier.

Conclusion

The operating and fiscal environments the U.S. Army will have to navigate in the future will place an ever larger premium on our ability to increase the individual and collective capabilities of our Soldiers and formations while reducing the risk to our deployed Soldiers and the resource cost to deploy, employ and sustain our forces. Autonomously-enabled formations provide a feasible way to achieve what are traditionally the competing and contradictory demands of increased capability at reduced cost (whether in terms of Soldiers or dollars).

The technical and the operational community operating collaboratively must develop a cohesive and comprehensive framework for working to the future to deliver greater capability per Soldier. Also, that objective capability must be viewed as a strategic objective, and we must determine how to move from the current construct (in DOTMLPF terms) to a future construct – and to what the intermediate constructs should or might be. Only through this collaborative, fully integrated approach can technology be focused well enough to provide our Army and our Soldiers with the capabilities needed to allow Soldiers to focus on tasks only Soldiers can do.

We can no longer hide behind bumper stickers such as "dirty, dull or dangerous" to describe what we want from autonomous systems. It requires the appropriate intellectual energy to be expended in both U.S. Army Training and Doctrine Command (TRADOC) and Research Development and Engineering Command to ensure we are achieving disruptive capabilities. Something that is "disruptive" eventually becomes "the norm" (for example, the iPod, which drove the MP3 player revolution), so timing is key. But we must be able to deliver capabilities (whether incrementally or in substantial tranches) that present our adversaries with seemingly insolvable problems and that reduce the physical and cognitive burden on our Soldiers.

Retired COL Michael Smith is a science and technology advocate for TARDEC to the Maneuver Center of Excellence, Fort Benning, GA. He previously served as director, Training Doctrine and Combat Developments, U.S. Army Armor Center, Fort Knox, KY; chief, 3rd Iraqi Army Military Transition Team, Al-Kasik, Iraq; director of training, U.S. Army Europe and 7th Army, Grafenwoehr, Germany; commander, 5-15 Cavalry, U.S. Army Armor Center, Fort Knox; and brigade S-3, 1st Brigade, 2nd Armored Division and 1st Brigade, 4th Infantry Division, Fort Hood, TX. His military schooling includes a Senior Service College Fellowship with Queen's University in Kingston, Ontario, Canada, plus Naval College of Command and Staff, Army Strategy Course via correspondence from the Army War College, U.S. Army Command and General Staff Officer's Course (correspondence), Combined Arms Services Staff School, Armor Officer basic and advanced courses and Basic Airborne Course. COL Smith holds a bachelor's of arts degree in history from the University of Montana in history and a master's of science degree in national-security studies from Naval War College. He is working on a doctorate of education from Grand Canyon University. His awards and decorations include the Defense Superior Service Medal, Legion of Merit with oak-leaf cluster, Meritorious Service Medal with four oak-leaf clusters and Frederick M. Franks Award in 2012.

Retired COL R. Craig Effinger III is a program manager for TARDEC. Previous assignments include training developer, North American Defense Command-U.S. Northern Command, Joint Staff, J7, Joint and Combined Warfighting Center, Suffolk, VA; chief, Science and Technology Division, Army Capabilities Integration Center (TRADOC), Fort Monroe, VA; chief, Leader Development Division, Army G-3/5/7, Pentagon, Washington, DC; instructor, Joint Forces Staff College, Norfolk, VA; and commander, 3rd Military Intelligence Battalion (Aerial Exploitation), Camp Humphreys, Republic of Korea. His military schooling includes U.S. Army Engineer Officer Basic Course, Army initial-entry rotary and fixed-wing courses, U.S. Army Aviation Officer Advanced Course, U.S. Army Command and General Staff College and U.S. Army War College. COL Effinger holds a bachelor's of aviation-management degree from Auburn University, a master's of science degree in administration from Central Michigan University and a master's of strategic-studies degree from U.S. Army War College. His awards and decorations include the Defense Superior Service Medal, Legion of Merit, Bronze Star and Defense Meritorious Service Medal.

Dr. Paul Rogers is TARDEC's director and commands 177th Regiment, Regional Training Institute, as a member of the Michigan Army National Guard. Previous assignments include deputy program executive officer for ground combat systems; TARDEC's executive director for research and technical integration; commander, 507th Engineer

Battalion (Iraq), Michigan Army National Guard; and National Guard brigade and battalion operations officer, company commander and platoon leader. His military schooling includes U.S. Army Engineer Officer Basic Course, Engineer Officer Advanced Course, Combined Arms Services Staff School, Army Command and General Staff College and U.S. Army War College. Dr. Rogers' doctorate is in mechanical engineering-engineering mechanics from Michigan Technological University (MTU). He also holds a master's degree in strategic studies from U.S. Army War College, a master's of science degree in engineering-mechanical engineering from University of Michigan-Dearborn and a bachelor's of science degree in mechanical engineering from MTU. His military awards and decorations include the Bronze Star, Meritorious Service Medal and Bronze Order of the de Fleury Medal.

Acronym Quick-Scan

A2AD – anti-access/area denial
AMPV – armored multipurpose vehicle
APOD – aerial port of debarkation
AS – autonomy-enabled system
BCT – brigade combat team
BHL – battle-handover line
CAM – combined-arms maneuver
CONUS – continental United States
COP – combat outpost
DOTMLPF – doctrine, organization, training, materiel, leadership and education, personnel and facilities
EO/IR – electro-optical/infrared
FOB – forward operating base
HAHO – high altitude high opening
LD – line of departure
LRV – light reconnaissance vehicle
MPF – mobile protected firepower
MSR – main supply route
MTU – Michigan Technological University
MURV – miniature unmanned reconnaissance vehicle
NAI – named area of interest
OEF – Operation Enduring Freedom
OIF – Operation Iraqi Freedom
PL – platoon
RES – reserve
TARDEC – (U.S. Army) Tank Automotive Research, Development and Engineering Center
TRADOC – (U.S. Army) Training and Doctrine Command
UARV – unmanned autonomous reconnaissance vehicle
UAS – unmanned aerial system
UAV – unmanned aerial vehide
URV – unmanned reconnaissance vehicle
WAS – wide-area security