Off the X

Artillery survivability in a persistent threat environment

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In "'Lessons Learned' from the Russo-Ukrainian War," Phillip Karber describes a brief, violent ground rocket attack in which "two Ukrainian mechanized battalions were virtually wiped out with the combined effects of top-attack munitions and thermobaric warheads."[1] He recounts similar attacks cued by small- to-medium-level unmanned aerial systems (UAS), counter-battery radars (CBR), and electromagnetic direction finding.[2] Karber's account brings to life in vivid detail the reality of a near-peer conflict. Russia, of course, is not the only threat—China among others is also observing and developing systematic approaches to defeat our decades-long military dominance.[3]

The Marine Corps cannon artillery community is neither trained nor equipped to operate in a threat environment characterized by persistent, sensor-netted target acquisition systems. The *Marine Corps Functional Concept for Marine Air Ground Task Force (MAGTF) Fires* acknowledges that our primary weapons system (the M777A2 155mm towed howitzer) was not designed with a near-peer adversary in mind.[4] Years of counterinsurgency operations with minimal counter-fire threat have created a generation of artillerymen unfamiliar with the tactics needed to survive in a high-threat environment.

While technological solutions are being developed, as a community we cannot give in to the tempting thought that the improved fires system of tomorrow will solve the problems of today. A typical battery command tour is nine to twelve months, whereas the development, acquisitions, and fielding process is measured on a scale of years. Training for the next big fight must be done with the equipment on hand.

The imperative is clear: *The Marine Corps cannon artillery community must adapt its approach to training in order to survive and win in a contested environment.* This article develops three recommendations for training based on a discussion of the "battle of signatures,"[5] and a review of historical and contemporary mitigation techniques. We conclude by providing a number of practical observations as well as considering future development of the recommended techniques.

Threat Systems in the "Battle of Signatures"

An artillery unit may be located by an enemy through three primary signatures: radar, visual footprint, and direction finding based on electromagnetic (EM) or auditory emissions. The radar signature is inescapable and, with currently fielded technology, impossible to mask or decoy. While this receives the primary attention in training, it is not the only way that a battery can be discovered.

The visual footprint of a battery is distinctive and difficult to conceal. Vulnerability to imaging spans multiple domains, including air (using manned and unmanned systems) and space. Edge detection and pattern recognition software can be used to speed up the

BM-21 Grad 122mm multiple launch rocket systems firing in Eastern Ukraine. These systems are maintained at the Russian brigade level. *(Image from YouTube.)*

imagery analysis process, which yields cues for realtime sensors such as UAS or reconnaissance forces.

Electromagnetic signatures can be used to produce either firing solutions or cues for visual sensors. A firing unit must communicate, and regardless of how disciplined the communications techniques used, an EM signature is inevitable. The auditory signature of a firing battery is, like its radar signature, inescapable and may be similarly used for location.

Signatures, once captured, will feed into a command and control system where attack decisions are made. To give one example, the Russian Army pushes assets and authorities down to the brigade level. A maneuver brigade commander has an electronic warfare company, a fire control battery (equipped with CBR), and group I and II UAS to capture signatures. Strike assets include 34 2S19 self-propelled 152mm howitzers and 18 BM-21 122mm multiple launch rocket systems.[6] Unclassified ranges for both of these systems are on parity with that of the M777A2.[7] To attack larger or deeper targets, more capable systems at the operational and strategic level are available but require further coordination with higher levels of command. Associated timelines are still very responsive. Observed fire strikes from the Ukrainian conflict indicate that massed fires covering a one square-kilometer area are well within the capability of Russian artillery.[8] Looking toward China, Jeffrey Engstrom provides a conceptual discussion of how multi-domain surveillance assets, command and control systems, and weapons platforms are highly networked as a firepower strike system within the People's Liberation Army's concept of system destruction warfare.[9]

Mitigation in Theory

To survive and dominate in such an environment, we need to create an asymmetric advantage using our existing, less than ideal systems. We must think like the insurgent described by Rupert Smith one who, "Learned to drop below the threshold of the utility of our weapon systems … not to present a target that favors the weapons we possess and the way we use them."[10] Applying this mindset against an enemy's threat system in the early phases of a contested fight, the challenge is to move within the effective cycle of an adversary's engagement window while simultaneously presenting a multiple-domain signature that is too dispersed for efficient engagement.

Frequent, rapid displacements are key to survivability in a persistent threat environment. *(Photo by LCpl Nghia Tran.)*

This is not a new concept—as Jonathan Bailey writes in *Field Artillery and Firepower,* dispersion and movement techniques to break up a firing unit's signature were developed and practiced on both sides of the Cold War. By the 1980s, U.S. Army practices included moving as frequently as ten times a day.[11] Current threat analyses support the conclusion that mobility is again

BM-27 Uragan 220mm multiple launch rocket systems firing during a Russian military exercise. Timelines associated with coordinating fires using such longer range systems are still very responsive. *(Image from RT.)*

critical for survival against a high volume of sensor-networked, long-range artillery.[12] Camouflage when in position is also vital to delay discovery by overhead sensors.

Time-tested techniques for EM signature masking are well-known and include low power settings, reduced communications time, and antenna remoting.[13] Modern techniques use lower-powered mesh networks to pass digital traffic as opposed to heavy reliance on high-powered, point-to-point voice networks.

Mitigation as Practiced

While survivability movement techniques are referenced in detail throughout a number of current artillery publications, in practice these are typically planned for as contingencies that are rarely executed in training.[14] Rather, "shaping fires" are nearly universally successful in removing enemy counter-battery threats from the scenario, and after a few minutes of preparatory fires, the battery remains a static training aid for hours if not days of operation. Worse, headquarters units—with all of the attendant visual and EM signatures—typically remain in place for days at a time.

On a positive note, Tactical Training and Exercise Control Group has begun to include planned survivability movements into the initial fire support control exercises at the beginning of integrated training exercises. The final exercise also incorporates hostile counter-fire considerations. Unfortunately, these measures do not go far enough to address the reality of operating in a persistent threat environment where the enemy's sensing capabilities are far more than a single CBR, his long-range strike capabilities are mobile and numerous, and the assumption that intelligence will have located all of the threats is unfounded.

Techniques of thermal breakup, vehicle camouflage, and integration of micro-terrain as practiced by light armored reconnaissance units should be adopted to reduce visual and infrared signatures while improving speed and flexibility. *(Photo by LCpl Holly Pernell.)*

Decisions need to be made about where and when the maneuver commander will accept the risk of taking an artillery unit out of action in exchange for the decisive effects of fires. *(Photo by LCpl Ryan Kierkegaard.)*

Regarding visual and EM mitigation techniques, the typical camouflage practice of leaving the gun outside the nets is not effective at avoiding aerial observation from the enemy's perspective. Nor is the typical practice of headquarters units booting numerous Base-X tents together and running up a tactical elevated antenna mast system (TEAMS) in the middle of an open field. From our experience across all three Active Component artillery regiments, the use of remoting has declined over the past ten years. Remoting gear (to include the necessary wires, cables, and junction boxes) is no longer replenished or maintained, if on hand at all. Few of the other EM mitigation methods are consistently employed.

Recommendations

We make three recommendations. First, batteries need to return to practicing internal survivability movement techniques as detailed in *The Field Artillery Cannon Battery*. These include frequent movements of widely dispersed

guns or sections (ideally, at distances of 800 to 1,000m) within a large position area for artillery, all while maintaining battery-firing capability. *The key to this technique is that the guns are frequently moving "Off the X," meaning that the radar signature leads back to a vacated location, while the battery maintains firing capability throughout.* This should be practiced along with frequent planned moves of the entire battery, for example after periods of heavy firing.

At a battalion level, the principle of "two up, one back" (referring to active firing, not physical location) allows massing the battalion (minus) on high-payoff targets while keeping an unmasked battery in reserve for reactive fire if needed. Regimental plans that place entire battalions in single position areas a few kilometers square, rather than assigning a battalion to the zone of a supported maneuver element, needlessly concentrate lucrative targets. While not vulnerable to CBR, long-range direction finding and overhead observation platforms mean that even headquarters and support units should move more frequently than typically seen during training.

Our second recommendation is that artillery units at all levels need to rethink their visual and EM footprints. Having a row of 4 to 6 visible guns, 50 meters apart, and in close proximity to large clusters of camouflage nets and antennas is unacceptable. Techniques of thermal breakup, vehicle camouflage, and integration of micro-terrain as practiced by light armored reconnaissance units should be adopted to reduce visual and infrared signatures while improving speed and flexibility. A layered application of EM masking techniques need to be practiced to mitigate the EM signature. As an important first step, the lost art of remoting should be revived at the battery level on up. The use of mesh networks employing wideband waveforms should be adopted on a wide scale to further disperse the communications signature.

Finally, conversations need to be had at all levels between artillery units and supported infantry echelons. The unrealistic expectations of fire support developed over the past ten years need to be tempered with the realities of the above signature mitigation techniques. Fire support teams should not plan to receive 45 minutes of continuous suppression from a single unit—no battery can expect to survive such a mission. Decisions need to be made about where and when the maneuver commander will accept the risk of taking an artillery unit out of action in exchange for the decisive effects that are produced by concentrated, high volume fires at discrete points of time.

Practical Considerations

Two of the authors have practiced or observed these techniques during live fire training, both internally and in support of maneuver. The tactical and technical problems are not trivial. Successful implementation requires the full use of the digital capabilities of the M777A2 howitzer, as well as advanced levels of troubleshooting. A fresh approach to local security and crew-served weapons employment is also needed. Each battalion is different and will solve these problems in unique ways—the point here is that these techniques must be practiced to identify and work through the friction points.

While preferred, practice does not necessarily require live fire. The authors recognize that live fire implementation of survivability movement techniques is currently only feasible using minimum safe line procedures and safe fire areas[15] at venues such as Twentynine Palms or the National Training Center. Pendleton, Hawaii, and Lejeune pose increasingly significant difficulties.[16] However, with proper communications and range safety officer plans, a battery can conduct live fire in centralized mode from multiple gun positions simultaneously. This is a realistic employment technique in a wooded, mountainous, or otherwise restricted environment.

Maneuver and fires planners should work closely to provide the necessary space for survivability movements. Depending on the training venue, larger pre-coordinated movement boxes encompassing multiple firing points may be feasible. Even at the more restrictive training locations, assigning a battery multiple gun positions and pre-coordinated routes between them will reinforce the mindset of dispersion and frequent movement.

Artillery battalion intelligence officers should be heavily involved in exercise development to drive realistic scenarios based on current threat templates. At appropriate classification levels, these exercises should be used to educate all members of the battalion on threat capabilities. Additionally, the intelligence officer should be coordinating observation from the enemy's perspective using all assets available within the MEF. One method is to request overflights and aerial imaging in both the visual and infrared spectrum from supported close air support platforms during the course of routine firing exercises. Similarly, we recommend coordinating EM collections for signature development through the MEF Information Group—specifically through the signals search team.

Future Developments

Further development of these movement techniques—if applied in a nonlinear fashion at the battalion level and below in movement zones rather than restrictive position areas—begins to approach what John Arquilla and David Ronfeldt term "swarming." The basic principle is "the ability to repeatedly strike the adversary—with fire or force—from all directions, then to disseve from the attack, redisperse, and repeat the cycle as battle conditions require"[17] Successful swarming will require large numbers of small, dispersed, highly connected units, integrated sensors, and command systems to provide "topsight," and a highly flexible level of task organization and mutual support of units.[18] The *Marine Corps Operating Concept* similarly refers to an ability to aggregate, disperse, and re-aggregate at a tactical level.[19]

Large-scale adoption of true swarming is beyond the scope of this article. However, tactical application of some of its elements within the artillery battalion is instructive. In this hybrid application, topsight is provided by networked CBR, UAS, and target acquisition networks from across the MAGTF or

joint force. Given a large, not necessarily contiguous area to maneuver within, the signature of a battalion moving at random by small elements presents a challenging targeting problem for any fires planner. Further development will be needed to solve problems of logistical resupply (hours-long "rapid" resupply points are clearly a no-go) as well as fires clearance procedures.[20]

In the near term, what is important is to develop practices at the battery and battalion level that will support distributed and highly mobile operations. This can be done (albeit in a limited fashion) using current tactical constructs and existing range and safety restrictions. Moreover, we must begin developing these skills when we have the luxury of trial and error rather than learning these lessons the hard way—underneath the steel rain of an enemy artillery volley.

Notes

1. Dr. Phillip A. Karber, "'Lessons Learned' from the Russo-Ukrainian War," conference paper presented on 8 July 2015 at U.S. Army Capabilities Integration Center's Historical Lessons Learned Workshop, Ft. Eustis, VA, revised 29 September 2015, available at https://www.researchgate.net/publication/316122469_Karber_RUS-UKR_War_Lessons_Learned.

2. Ibid.

3. Jeffrey Engstrom, *Systems Confrontation and System Destruction Warfare: How the Chinese People's Liberation Army Seeks to Wage Modern Warfare*, (Santa Monica, CA: RAND, 2018).

4. Deputy Commandant, Combat Development & Integration, *Marine Corps Functional Concept for Marine Air Ground Task Force (MAGTF) Fires*, (Washington, DC: 2017).

5. Headquarters Marine Corps, *Marine Corps Operating Concept*, (Washington, DC: 2016). The *Marine Corps Concept for Signature Management* classifies signatures as physical, technical, and administrative. We consider only the physical and technical signatures within this article.

6. Dr. Lester W. Grau and Charles K. Bartles, *The Russian Way of War: Force Structure, Tactics, and Modernization of the Russian Ground Forces*, (Fort Leavenworth, KS: Foreign Military Studies Office, 2017).

7. Asymmetric Warfare Group, *Russian New Generation Warfare Handbook Version 2*, (Fort Meade, MD: 2017).

8. *Russia New Generation Warfare Handbook*.

9. *Systems Confrontation and System Destruction Warfare*.

10. Gen Rupert Smith, *The Utility of Force*, (New York, NY: Vintage Books, 2008).

11. MajGen Jonathan B.A. Bailey, *Field Artillery and Firepower*, (Annapolis, MD: Naval Institute Press, 2004).

12. *Russia New Generation Warfare Handbook*.

13. DTIC Threat Handbook, Battlefield Survival and Radioelectronic Combat, (Fort Belvoir, VA: DISA, 1983). Additional techniques still applicable today include mobile antennas, directional antennas, decoy antennas, and antenna masking.

14. Survivability movement techniques at the battery level are detailed in the July 2015 publication of *MCWP 3-1.6.23, The Field Artillery Cannon Battery*. Survivability moves as a battalion planning consideration are also mentioned throughout the May 2002 publication of *MCWP 3-16.1, Artillery Operations*.

15. Artillery safety as currently practiced hampers the live fire training of these procedures. However, a full discussion of the safety implications of the M777A2 howitzer firing with a fully digital loop in the ready mode, with dry-fire verification procedures complete, and safe fire area geometries verified, is well outside the scope of this article.

16. Having collectively fired at all of these locations we also know that these can be practiced non-live fire at positions such as Lejeune's Gun Position 13, or any number of large landing zones at Fort Bragg, to give just a few examples.

17. Dr. John Arquilla and Dr. David Ronfeldt, *Swarming and the Future of Conflict*, (Santa Monica, CA: RAND, 200).

18. Ibid.

19. *Marine Corps Operating Concept*.

20. One possibility is to use gun-target cones drawn from an artillery maneuver box rather than gun-target lines from an aggregated battery position, akin using final attack cones versus headings when coordinating close air support.

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