Navigation Warfare Environment Situational Awareness

The sixth requirement for accurate long-range fires

by Mr. Paul C. Manz, Dr. Thomas J. Blenk Jr., Mr. James L. (Chip) Gibson & LtCol Brock A. Lennon

Revisiting "The Five Requirements for Accurate Fire in the 21st Century" in the *Redleg Update* by then-Capt Brock Lennon from Fort Sill's Gunnery Department, a title change to the Five Requirements is required to reflect the addition of precision and near-precision munitions (more commonly known as precision-guided munitions [PGMs]) into the firing unit's inventory.[1] While the Five Requirements are still: accurate target location and size; accurate firing unit location; accurate weapon and ammunition information; accurate meteorological information, and accurate computational procedures, the authors herein postulate that a sixth requirement, accurate and timely navigation warfare (NAVWAR) environment situational awareness, should now also be included within the foundational curriculum of the field artillery and employed as a standard practice of that professional trade.

As one of the Artillery Branch's top modernization imperatives, long-range precision fires infers extremely long-range engagement of enemy targets with PGMs. Such PGM guidance is necessary to overcome the increased accumulating errors in target engagement accuracy experienced over a long time of flight and distance traveled (e.g. range probable error, greater meteorological complication in range and apogee). The U.S. Joint Forces experienced significant success in long-range fires with the introduction of PGMs. It was quickly

>Mr. Manz currently serves as Chief Technology Officer for Joint Program Executive Office for Armaments and Ammunition at Picatinny Arsenal and oversees technology investments for a $10B+ portfolio. He was recognized as the Top Engineer in the DOD, the defacto Top Electrical/Electronics Engineer in the Federal Government, the Top Precision Weapons/Munitions Engineer in the United States, and is a recipient of the Ancient Order of Saint Barbara.

>>Dr. Blenk currently serves as the Director of the Assured Precision Weapons and Munitions Office for Joint Program Executive Office for Armaments and Ammunition. He has over ten years of navigation experience and made significant contributions to various precision-guided munitions and weapon programs.

>>>Mr. Gibson currently serves as the Capability Development Lead for the Army's Long Range Precision Fires Cross-Functional Team. He is an engineering graduate of the Virginia Military Institute and a Marine Artillery Officer.

>>>>LtCol Lennon currently serves as the Field Testing Branch Head in the Marine Corps Warfighting Lab's Experiment Division.

The induction of NAVWAR needs to be part of the field artillery curriculum and practice. (Photo provided by author.)

discovered that the last and vital link of a successful long-range fires mission included the ability for in-flight navigation, course corrections, and in some cases terminal engagement to physically deliver effects on the intended target. Long-range fires also emphasized the need to achieve intended effects on the target with the first shot or volley to avoid the escape of high-value targets, increase munitions delivery efficiency,

Compromises to NAVWAR will negatively impact fires, even when not firing precision-guided munitions. (Photo provided by author.)

and reduce the risk of counterfire exposure. While this last vital link is arguably the most enabling in the fires kill web, it also adds a risk vector that adversaries have gained proficiency in attacking. The most known and proliferated adversary attack against this last link is Global Positioning System (GPS) jamming/spoofing. While current fires operations include a navigation health check at the weapons system before firing a PGM, there is currently no consideration or assessment of the NAVWAR environment the PGM will have to contend with as it navigates and maneuvers to its target. Even when not firing PGMs, the NAVWAR environment may still negatively impact our conventional fires ability to obtain accurate target location and accurate firing unit location which, in turn, may impact accurate computational procedures and reliable common survey.

NAVWAR environment is defined as "the expected physical, electromag-

netic, and cyber conditions in which a Positioning, Navigation, and Timing (PNT) system operates."[2] Applying this definition to fires, accurate and timely NAVWAR environment situational awareness in practical terms means the operational impact on the PGM is understood from awareness of conditions which may impact the PGM's internal PNT ability to obtain (i.e. hear) and use accurate and truthful PNT information (i.e. know this information is truth).

PGMs use a combination of PNT reference knowledge; onboard realtime computation; guidance, navigation, and control; and available maneuver authority "budget" to remain on course as the munition flies towards the target. In addition, PGMs have expanded their role on the battlefield to include not only coordinate-seeking fire missions but imprecisely located and moving target missions as well. This expansion causes an increased dependence upon accurate PNT, making protecting access to PNT paramount to a PGM's success. To accommodate growing demands, PGMs continually seek to expand their available PNT tools to include not only GPS but inertial capability, terminal-flight seekers, alternative Space-based signals, and more. With the adoption of modular and software-defined solutions, fires should expect rapid expansion of PGM capability sets related to PNT.

Given the enemy knows our current indirect fire capabilities are highly dependent on PNT information, they will seek to disrupt, jam, and/or spoof these predominately space-based PNT reference signals as evidenced during the ongoing Russian-Ukraine conflict.[3] Such threats can correspondingly degrade and prohibit the effective use of our long-range PGM assets. With continual improvements to PGMs and adversary advancements in countering the same, the efficient deployment of PGMs on the battlefield has become a difficult challenge from a munitions' effectiveness perspective as well as firing safety, collateral damage, and air space coordination constraints. Fires will need to navigate continuously through complex battlespaces, balancing PGM capability mixes with adaptive threats. Automated NAVWAR assessment is not only needed to keep fires ahead of the threat but will be required to also mitigate the cognitive burden of the fire support and fire control officers in support of the commander.

Thus, accurate and timely NAVWAR environment situational awareness knowledge (more simplistically, "What is the NAVWAR 'weather' like?") is essential to ensure both the weapon and PGM know what PNT signals can be used with confidence at any particular time and point in space throughout the execution of the indirect fire mission.

Knowing about NAVWAR weather conditions and how they can impact the potential choices to engage a long-range enemy target is a fires system-of-systems problem set.

Similar to measuring the meteorological conditions, there are a host of potential NAVWAR weather sensors on and above the battlefield whose outputs must be integrated to characterize the operating environment as well as detecting, identifying, and geo-locating sources of intentional and unintentional interference.[4] Systems, such as the TITAN Terrestrial Layer System and the Electronic Warfare Planning and Management Tool, are currently under development to close this gap. Such systems will enable the aggregation of ground, air, and space-

based sensor information to provide the NAVWAR Common Operating Picture. The first generation of these systems will be capable of providing timely, specific knowledge of enemy jamming of GPS signals across the entire three-dimensional battlespace. Future generations of these systems should be able to keep pace with fires plans for multi-modal PNT sources and provide predictive analysis to influence the same.

The Joint Program Executive Office for Armaments and Ammunition is currently partnering with its fires kill-web counterparts to establish a related system-of-systems capability called Network-Assisted Assured PNT and NAVWAR (where this integrated NAVWAR weather information is passed to and consumed by the Advanced Field Artillery Tactical Data System (AFATDS). AFATDS (or future Artificial Intelligence-driven Battle Management software) would then use this Network-Assisted Assured PNT and NAVWAR-provided information to perform an automated operational assessment as part of its technical fire-control-decision solution regarding various PGMs based on their resiliency to effectively operate in the given NAVWAR threat environment. This means that AFATDS could not only provide a current operating picture but could also provide the capability to consciously not pick a specific firing unit nor a specific PGM available at that firing unit to engage a target unless that specific weapon/PGM paired capability can overcome all the potential NAVWAR threats between the weapon and the target and still effectively prosecute the target. Additionally, AFATDS would send an essential subset of this information down to the weapon platform to hot start (i.e. preload) these PGMs with the right specific information (including the NAVWAR weather conditions throughout the post-launch flight) so the PGMs will know what PNT information to listen for and use (and what not to listen for and use) along their flightpath to the target.

Adopting this aforementioned system-of-systems solution for accurate and timely NAVWAR environment situational awareness will enable fires to continue to enjoy the operationally necessary advantage afforded by PGMs in an effective, efficient, and safe manner. This solution will offload some of the computational burden from the PGM, allowing the PGM to focus its limited on-board resources on acquiring and using PNT sources it knows are available. It will reduce the fire support and fire control officers' cognitive burden and provide confidence in planning and executing PGM fire missions in complex contested environments. Lastly, it will enable rapid adoption of new technologies within long-range fires, allowing Marine Corps and joint fires to pivot to available PNT sources regardless of adversary attack vectors.

Notes

1. Brock Lennon, "The Five Requirements for Accurate Fire in the 21st Century," *Redleg Update: The United States Army Field Artillery Branch Newsletter*, (2014).

2. U.S. Department of Defense, *DOD Issuance 4650.08, Positioning, Navigation, and Timing and Navigation Warfare*, (Washington, DC: 2020).

3. Alex Marquardt et al., "Russia's Jamming of U.S.-Provided Rocket Systems Complicates Ukraine's War Effort," *CNN*, May 6, 2023, https://www.cnn.com/2023/05/05/politics/russia-jamming-himars-rockets-ukraine/index.html.

4. Jaspreet Gill, "Army Approves NAVWAR Situational Awareness Abbreviated Capability Development Document," *Inside Defense*, March 29, 2021, nges.insidedefense.com/insider/army-approves-navwar-situational-awareness-cdd.