Loitering Munitions:
Bridging Sensor to Shooter Voids in Artillery Fires by Precision

Ranjan Prabhu

Abstract

Artillery fires are aimed at crippling the enemy's war-waging machinery. Such operations are time-sensitive since they need to ensure that the enemy is engaged effectively and sufficiently degraded at critical points in time and space to achieve combat superiority. A robust, persistent and seamless sensor to shooter link ensures the shortest loop between acquisition and targeting. Loitering Munitions if inducted into the Indian Artillery will be a game-changer in this field and will fill the existing voids in surveillance-cum-precision engagement capability between 40-200 km. In view of this, the paper examines the capability voids to suggest a solution based on the employment of Loitering Munitions to fill such lacunae—both in lethal and non-lethal domains, taking into consideration the present and the future security paradigm in the region.

Introduction

Firepower has proved its dominance as a 'battle-winning factor' time and again over the years in all conflicts. Destruction of the enemy's combat

Colonel **Ranjan Prabhu** is an officer in the Indian Army.

potential and degrading his will to fight will always remain the foremost aim in all operational plans made by military commanders. Artillery fires are aimed at crippling the enemy's war-waging machinery so that it cannot utilise and put into effect its full combat potential for offensive or defensive actions as the case may be.

Such operations are time-sensitive, since they need to ensure that the enemy is engaged effectively and sufficiently degraded at critical points in time and space to achieve combat superiority. The main requirements of these types of operations are, therefore, to be able to build up real-time Intelligence Surveillance & Reconnaissance (ISR) picture which allows timely and precise targeting of enemy High-Value Targets (HVTs). The concept of 'Sensor to Shooter' link was born out of this very necessity of having the shortest time loop between target acquisition and targeting.

Artillery and the 'Sensor to Shooter' Link: Capability Analysis

Kinetic operations attempt to target static as well as moving targets. Both in offensive and defensive actions, any military force will need to concentrate its forces for maximum effect. To do that, it will mass its peacetime dispersed forces and move to the intended area of operations. It is at this massing and movement times, that the enemy forces will be at its most vulnerable moments. Therefore, early targeting of such forces as part of degradation operations will reap rich dividends.

Artillery has traditionally been the provider of the land component of long-range firepower for offensive and defensive operations. Combined with the reach and lethality of Air Force and Missile Forces, Artillery can cause havoc to the enemy's military as well as important civilian nerve centres. To be effective on the target, all means for precise acquisition and targeting is required to be put into place. As Dr. Jack Watling, rightly argues that in the next decade, while the range of artillery could double across most systems (155 mm howitzers would have a range of 70 km

Multiple Launch Rocket Systems with a range of 150 km and tactical battlefield missiles with a range of about 500 km), however, beyond the range of 40 km, these systems would need precision munitions.[1] Thus, most of the developments in the field of technology have been oriented towards R&D for precision delivery of munitions onto the target.

Precision Guided Artillery shells and missiles have been developed which can hit a target with pinpoint accuracy. While the accuracy has been catered for, however, the large time differential between the acquisition of the target, the decision to engage it and the engagement itself lends to missed opportunities especially, with time-critical targets and targets which are on the move. While the Air Force can take on such targets, the lethality of heavily contested airspace of the future may not allow the Air Force to operate with free will. Thus, capability development in the field of stand-off targeting with minimum time differential between acquisition to engagement is a key battle-winning factor, in so far as operations to destroy enemy forces which are massing or moving is concerned as they are time-critical targets. It is in this context that an extremely agile, highly networked and robust 'sensor to shooter' link is required by the long-range land vectors of the Artillery. The present technology available with our forces includes a variety of long-range surveillance assets like satellites, RPAS and Air force aircraft fitted with surveillance pods. While some of these assets are capable of acquiring and transmitting the target data in real-time; however, the targeting capability of time-critical and moving targets is still below the desired levels. Hence, it is this capability void that can be fulfilled by loitering munitions.

Employment of Loitering Munitions: Filling the Capability Void

In the early hours of 14 September 2019, Saudi Arabia suffered the deadliest attack on its oil facilities in recent times when a small army of drones attacked two major oil plants, destroying nearly 50 per cent of the

country's global supply of crude. The attack purportedly carried out by a Houthi rebel group based in neighbouring Yemen led to crippling effect on the global oil supply and oil prices for almost ten days, before Saudi Arabia's assurances on continued oil supply stabilised the situation. The attack which bypassed and circumvented the high-tech and networked US-supplied Saudi Arabian Air Defence environment shocked the world. The attack was unique in many ways: for one it was innovative in its application; second, it was carried out by a relatively mid-technology machine which was commercially available; and third, it was not a mature and tested warfighting machine for which countermeasures had been developed. It is to note that the Houthi's have been aggressively developing and employing this capability in the area of Drone Warfare for the larger part of the last two years with huge success.[2]

Drones have seen rapid development in the past decade as a disruptive technology in the field of modern warfare. They have developed from pure unmanned aerial surveillance objects to unmanned armed fighting machines. A loitering munition which is an offshoot of a drone is a type of unmanned aerial vehicle designed to engage beyond-line-of-sight ground targets with an explosive warhead. Such munitions are often portable and many are meant to provide ground units with guided precision. They are equipped with high resolution electro-optical and infrared cameras that enable the targeter to locate, surveil, and guide the vehicle to the target. A defining characteristic of loitering munitions is the ability to "loiter" in the air for an extended period before striking, giving the targeter flexibility to decide when and what to strike.[3] While the Artillery has in its inventory Precision Guided Munitions (PGM), which are artillery shells fired from 155 mm guns, they cannot still take on hidden/moving targets which provide only fleeting opportunities for engagement. In war or the preparation for it, most HVTs would fall under this category. The ability of the loitering munitions to substantially reduce the time differential between target acquisition and precision engagement can provide an

asymmetric force multiplication effect to the Artillery. Carefully chosen decisive precision long-range engagements beyond 40 km and up to 200 km can successfully take out adversaries' critical elements massing and moving to join the battle. It is within this battlespace that a variety of medium to long-range loitering munitions having ranges varying from 40 km to 200 km can form part of the arsenal of the Artillery. Such loitering munitions have already been developed in the world today and must be procured as part of the overall plan to strengthen the capability of the Artillery.

World over there has been a trend of optimising ISR assets by putting them under a single command and control structure for a better flow of information and resourceful employment of different types of ISR assets. This concept is being put to test in the Indian Army by transfer of RPAS assets to the Aviation Corps—the aim being to be able to smoothen the resource management of airfields and airspace.[4] While the move is in the best interest of the organisation, the large number of trained RPAS crew held on strength of the Regiment of Artillery is likely to be wasted in due course of time. Mediumisation of the Artillery which is well on track is going to enhance the ranges at which it can deliver its fire by up to 50 percent. This enhancement of ranges will require it to be capable of acquisition of targets well above its internal capability once RPAS are transferred. While targets may still be made available to it from the ISR resources held centrally, it is prudent for a force having a capability to fire in depth areas to have eyes which look in that distance.

Capability enhancement through procurement of Loitering Munitions having ranges varying from 40 km to 200 km cannot only augment the existing ISR resources (Certain types of Loitering Munitions which can be recovered or called back) but also allow precision targeting of time-critical targets. Loitering Munitions by design are smaller than MALE or HALE RPAS, therefore have greater survivability in contested airspace. These munitions will be able to fill the gaps in surveillance left by MALE/HALE

RPAS operating in greater depth and also would be capable of taking on targets under surveillance at critical junctures with greater precision. R&D in the field of electric motors and enhancement in energy storage of batteries in the near future will allow for use of electric motors on such munitions. Electric motors being 90 per cent more quieter than a gasoline engine will allow the loitering munition to become stealthier while attacking its target, thus exploiting the element of surprise. Loitering munitions in the inventory of the Artillery will help the Theatre Commander to influence the battle in the operational depth without having to look over his shoulder for assistance from strategic forces and the Air Force, thus freeing up these forces to carry out their strategic tasks.

While massed artillery fires will certainly not lose relevance in the future wars, ability to strike with precision in the enemies depth areas with minimum time constraints will add to the lethal punch of formations at the operational and tactical level. Such weapon system will afford a great deal of flexibility in the delivery of firepower on to the target due to its minimalist launch platforms (canister/rail launched), long-range, ability to guide the system with man-in-the-loop technology, precision engagement and non-effect of meteorological and terrain conditions (reverse slope engagements in mountainous terrain). These type of systems can also be employed as indirect support to the hunter-killer teams deployed for seeking out enemy Mobile Missile Launchers, which normally remain hidden and are only deployed for a short duration of time to launch missiles thus becoming time critical HVTs.

Specialised autonomous loitering munitions with radiation seeker heads can be employed for seeking out and destroying enemy Air Defence and Weapon Locating Radars thus hugely degrading his capability of defending his airspace and countering own artillery fires with Counter Bombardment (CB). Launch Canisters mounted on High Mobility Vehicles/Light High Mobility Vehicles would allow for deployment flexibility in any terrain, in a short duration of time, dispersed from enemy

air and ground attacks and exploit range to the maximum. As operations progress, there would be a greater requirement of impromptu degradation to seek and destroy mobile enemy columns/enemy targets which provide fleeting opportunities. In such cases also loitering munitions will play a key role due to its ability to attack in minimum time.

Thus, while massed artillery fires can be utilised effectively to degrade static enemy area targets like logistics dumps, HQs, Communication Nodes and Gun Areas, loitering munitions can be used to target moving convoys, hidden Missile/Rocket launchers and other time-sensitive targets. Degradation operations planned and executed utilising a delicately balanced combination of these two types of artillery engagements will create havoc in the enemies depth areas and will ensure that his combat power is sufficiently degraded by the time he bears it upon own forces, thus allowing for his piecemeal destruction.

The Utilisation of Loitering Munitions: Current and Future Security Paradigm

India has harsh mountainous terrain which it shares as disputed territories with its adversaries, namely China and Pakistan. While Artillery duels with Pakistan are common due to its continuous use of Cease Fire Violations (CFV) to assist in the infiltration of state-sponsored terrorists into India, the current standoff in Eastern Ladakh is also a potential flashpoint for artillery duels with China. The High Altitude region, harsh mountainous terrain and inclement weather conditions as obtained in such regions have a huge negative impact on the accuracy of conventional artillery munitions. Thus, in an artillery duel, the requirement of conventional munitions to effectively engage a target with a punitive effect requires more than four to five times the numbers than what is required in plains. In such stand-off duels, it is the effect on an intended target that puts pressure on the adversary to pull back its fire and therefore addressing his pressure points is the actual aim. While on the Western boundary

with Pakistan, years of conflict have ensured that both sides have built up highly fortified defences, on the Chinese side, the fortification is lacking, as the last shot ever fired in the region after the 1962 War was at Nathu La in 1967.[5] Since the need for conventional munitions to defeat such fortifications on the Pakistani side is thus quite huge, therefore, it is only precision munitions which can achieve the desired degree of effect with lower overall costs in the long run.

The present stand-off with China is a grim reminder to India, that the Chinese cannot be believed on their face value. While the present situation is tense, no clashes utilising weapon systems have taken place till date in the area. However, the fact that such stand-offs may lead to non-contact warfare with artillery duels like those that are common on the Pakistani side cannot be completely ruled out. It is such a scenario that, on the Chinese side, precision munitions like Loitering Munitions can give an asymmetric advantage as China has a stronger Missile and Rocket force, which will need to be sought out and destroyed in event of a future clash/artillery duel. With greater ranges, these missile and rocket forces would normally be out of range of own artillery, and hence would be an ideal target for precision systems like Loitering Munitions which not only can recce and acquire a mobile or hidden target but also can immediately engage it at long ranges. In addition to this, the fact remains that the terrain on the Indian side is much harsher, therefore the building of roads for move of heavy artillery is not only time consuming but also very expensive. In such cases also, the much lighter and mobile canister launched or runway independent rail launched loitering munition can overcome the issues associated with move of heavy artillery while providing the necessary edge without expending heavily on building of infrastructure. Precision targeting of specifically chosen targets can be of greater help in escalation control in a standoff like situation than conventional massed artillery fire which has higher potential to cause collateral damage and thus up the ante.

Suggested Organisation and Future Developments

While it is understood that such systems would not come cheap, the benefits far outweigh the costs. In addition to the tangible benefits of the induction of the system into the artillery, the intangibles would include the full utilisation of skill sets gained by a large number of officers and men presently trained to fly RPAS as part of SATA Regiments of the Regiment of Artillery. These men could be retained in the SATA Regiments at Corps level as part of a "Hunter-Killer" Troops (A SATA Regiment is presently holding two RPAS troops for surveillance duties) which can operate such systems on a '*Sensor cum Shooter*' concept. Being a canister/rail launched system and in some cases Para-recoverable, the systems are easier to operate as compared to MALE/HALE RPAS systems which require complex human motor skills. Thus, in due course of time, suitable JCOs/NCOs could be easily trained to operate such munitions and spare officers for other important tasks. This will also take care of cadre management issues while inducting better weaponry into the arm. The system which is planned to be inducted must be of two types of range capabilities, i.e. 40-60 km and 150-200 km. These two variants would allow for options for application with/without massed artillery fire. The system should also be capable of interchangeable warheads or varying weights/types (High Explosives, EFP, Fuel Air Explosives, etc.) up to a maximum designed capacity thereby affording the user the flexibility to target specific targets with the desired effect.

The initiative by the present government towards "Make in India" and self-reliance in the field of Defence Technology and Defence Manufacturing is likely to give a boost to indigenous R&D and manufacturing of the defence industry. Absorption of disruptive technologies especially in the field of drones is a necessity for building up asymmetric capabilities in modern warfare. The Indian private defence industry has rightly identified this field as an important area of focus. Even state governments are now giving impetus to the development of R&D and manufacturing in this

field.[6] The wide-scale proliferation of drone usage in civilian applications is promoting several motivated start-ups in India to enter into this field. This will certainly promote an environment conducive for the growth of both infra and research in drone technology in India. Indian companies have already formed joint ventures with foreign companies which are into the development and production of loitering munitions.[7] Seemingly, joint ventures are a starting point for technology absorption.

Such technologies will be disrupters in future warfare, simply because they can be developed along the entire spectrum of financial costs, i.e. from low-end systems to high-end ones. Low-end systems would be man-portable, short-range and low endurance munitions which would allow the Infantry to have the ability to converge its area of interest and area of influence in both defensive and offensive operations in all types of terrain. Low-end systems would find applications in the sub-conventional domain during anti-terrorist operations in an urban environment as it has the potential to reduce the risk of collateral damage manifold. Specially developed warheads with lethal/non-lethal compositions could be used with precise application to achieve permanent/ temporary neutralisation of terrorist in an encounter. Loitering munitions can also find applications in crowd monitoring and control. Precision application of non-lethal warheads on loitering munitions can also be a boon for crowd control measures by the CAPFs to take out leaders instigating a crowd without harming other individual forming parts of the crowd, thus preventing outcry amongst the local population against the use of current types of Non-Lethal Weapons. High-end long-range systems with longer endurance as brought out can form part of the arsenal of the Artillery to strike deep into the enemy territory with precision and speed both during conventional wars. Such systems could also find use in stand-off precision targeting of terror camps and non-state actors propagating terror from the shores of inimical neighbours. Non-Lethal loitering munitions may also find use in standoffs of the kind in which India and China are

currently engaged in at the moment. Not only will such munitions provide surveillance and intelligence but will also be able to deter intrusions by the Chinese by precision delivery of non-lethal warheads while keeping the escalation matrix well within the desired control of own forces. Lethal precision engagement capability is also a boon for future situations like the Ladakh standoff as it allows for a calibrated and decisive response to aggressive actions on part of belligerent adversaries by targeting specific targets which can keep escalation firmly in control.

Indian companies must adopt this technology and take it forward towards the development of swarming autonomous loitering munitions. A swarm of autonomous loitering munitions which can interact with each other through IoT technology will be a lethal force in the future. The LOCUST (Low-Cost UAV Swarming Technology) programme of the US Navy is an apt example of such a system. This program is developing systems that enable tube-launched drones to fly in large coordinated swarms. The research effort, which is currently based on the Raytheon Coyote platform, seeks to create swarms of drones that can autonomously conduct a range of missions, including attack operations. The US Army is also in the process of development of a "cluster payload" consisting of smart quadcopters that can place Explosively Formed Penetrators (EFP) on targets, including tanks, fuel storage barrels, vehicles, and ammunition depots. Our R&D and academic institutions are capable of development of such systems given the right support in terms of infra and capital. Premier academic institutions like IIT-Kanpur which is well known for its Aerospace Engineering Branch is already carrying out a huge amount of research in the field of drone technology.[8] The Armed Forces must extend full support to such projects by taking ownership of consultancy through dedicated Project Development Teams. Such teams can be supported by volunteer officers who have a background of understanding military technology and are seconded to the researching institution as research associates on similar lines as study leave. Thus, there will be a

system of embedded military research associates in such developmental programs who can continuously provide valuable inputs from the tactical and operational employment point of view to the research team. This model of research inputs and the association may help R&D institutions to better understand the requirements of the Armed Forces, a grievance that most institutions and industries have about military projects.

Conclusion

Utilisation and employment of disruptive technologies give a clear asymmetrical edge to the armed forces of any nation against its adversaries. India is surrounded by inimical neighbours like Pakistan and China both of whom continue to challenge the territorial integrity of the nation. Preparing to face a two-front conflict is an extremely costly proposition because huge amounts of finances and logistics support are required to maintain a standing military capable of guarding the territory on both sides. India can ill afford such huge drain on resources, especially, at a time when it needs to focus its attention on economic restructuring and growth. Investments in disruptive technologies which provide an asymmetric advantage are, therefore, necessary to offset the military imbalances being faced by the nation due to conflicts on two fronts.

Notes

1. As stated by Dr. Jack Watling, Research Fellow at the Royal United Services Institute (RUSI)- UK, in his presentation at the *Pragyan Conclave* 2020 "Changing Characteristics of Land Warfare and its Impact on the Military," Indian Army International Seminar, held on March 4-5, 2020. Available online at https://www.claws.in/event/pragyan-conclave-2020-indian-army-international-seminar/, accessed on August 18, 2020.
2. Dion Nissenbaum and Warren P. Strobel (2019), "Mideast Insurgents Enter the Age of Drone Warfare," *The Wall Street Journal*, May 2, 2019. Available online at https://www.wsj.com/articles/mideast-insurgents-enter-the-age-of-drone-warfare-11556814441?shareToken=stb4d012f88e2d444f8a056823ae80ffca, accessed on August 13, 2020.
3. Dan Gettinger and Arthur Holland (2017), "Loitering Munitions," Center for the Study of the Drone, Bard College. Available online at https://dronecenter.bard.edu/files/2017/02/CSD-Loitering-Munitions.pdf , accessed on September 2, 2020.

4. Amrita Nayak Dutta (2019) , "Army plans to buy 350 helicopters over 10 years to modernise its Aviation Corps," *The Print*, October 7, 2019. Available online at https://theprint.in/defence/army-plans-buy-350-helicopters-10-years-modernise-aviation-corps/302506, accessed on September 3, 2020.
5. To note, in October 1975, a firing incident took place at Tulung La (Arunachal Pradesh).
6. "Chennai soon to become Drone Manufacturing Hub," Geospatial World, June 12, 2020, https://www.geospatialworld.net/news/chennai-in-india-soon-to-become-a-drone-manufacturing-hub/, accessed on September 4, 2020.
7. Alexandre Rocchi (2020), "India: Creation of a Joint Venture for Loitering Munition," Air & Cosmos- International, February 20, 2020, https://aircosmosinternational.com/article/india-creation-of-a-joint-venture-for-loitering-munitions-2820, accessed on September 3, 2020.
8. "BEML Teams up with IIT Kanpur for Pilotless Aircraft and UAVs," *The Economic Times*, August 14, 2020, https://economictimes.indiatimes.com/news/defence/beml-teams-up-with-iit-kanpur-for-pilotless-aircraft-unmanned-aerial-vehicles/articleshow/77548921.cms, accessed on September 3, 2020.