CENTRE FOR LAND WARFARE STUDIES (CLAWS)-INDIA STRATEGIC FIREPOWER INDIA – 2011 SEMINAR REPORT

General

The Centre for Land Warfare Studies (CLAWS), in association with *India Strategic*, organised a one-day seminar on 'Firepower India 2011' on 19 May 2011 at Gulmohar Hall, India Habitat Centre, New Delhi. Held in four sessions, the conference gathered noted experts on the subject to discuss various aspects of missiles and field artillery. The keynote address was delivered by Vice Admiral RK Dhowan, Deputy Chief of Naval Staff. A special address was delivered by Air Marshal DC Kumaria, AOC-in-C Western Air Command. Lt Gen Vinod Nayanar, Director General Artillery, delivered the valedictory address. The seminar was well attended by serving and retired officers of all three Services, and members of the strategic community; it also had representations from the media and private sector.

Inaugural Session

Opening Remarks
Brig Gurmeet Kanwal (Retd), Director, CLAWS

This is the third in the series of seminars that we have been organising with *India Strategic* on 'Firepower'. The concept of 'Firepower' goes back centuries; there is no need to go in to details on that. The main objective of this series is to look at the present debates on the subject. This edition is dedicated to missiles and field artillery. At the end of day, it is the ammunition that matters. We have two separate and dedicated sessions for the issues identified. And we have distinguished speakers to address them.

Welcome Remarks
Mr Gulshan Luthra, CEO, *India Strategic*

Our emphasis is to look at the best possible technology for our military. Annually, we conduct two seminars – one on aerospace and other on firepower. *India Strategic* also closely looks at C4ISR. *Operation Geronimo* is a perfect example of precision operation using high tech systems. In the coming days, we should be able to control weapons and missiles through small devices like cellular phones. I do hope that this seminar will address all pertinent issues.

Keynote Address
Vice Admiral RK Dhowan, AVSM, YSM, DCNS

Firepower and its application, has always been one of the most challenging aspects of warfare. This, in fact, has been the case since the origin of warfare. The existing global security environment in general and the constantly evolving one in the Indian Ocean

Region in particular, is fraught, unpredictable and can best be described as ‘fragile’. Our security situation is dynamic and covers the entire gamut from low intensity threats to all out war, always under the spectre of nuclear threat – from state as well as non-state actors.

The concept of firepower, therefore, needs to be seen in the light of the critical necessity for it to address the entire spectrum of conflict, from self-defence in peacetime to an all out, all encompassing war. Such a stipulation further compounds the problems that planners face when structuring firepower needs from scarce resources. The aim finally is to deliver ordnance and achieve victory. In other words, firepower of a fighting force should eventually translate into the fighting ability of the military force.

Fighting power is a much broader concept that constitutes three major components. The first component is combat power or the means to fight. This focuses on platforms, weapons and sensors and the ability of personnel to use them effectively, which would depend on their training and expertise achieved. The second is the ability of the military leader to get the soldier to fight willingly and is a function of levels of motivation, effective leadership style adopted and skills in administration and management. This component can be ignored only at our own peril. The third component is the conceptual part or the doctrine that determines how well the rest of the military’s fighting power is deployed. It is a great force multiplier and enables best use to be made of the limited resources since it develops force coherence, uniformity and reliability. This also incorporates refining training procedures and honing combat skills to enhance fighting efficiency. It also facilitates joint operations and inter-service cooperation. The application of firepower is much more than being merely the sum of the individual firepower of weapon systems and platforms and that application of joint planning will make the concept larger and stronger than its parts.

Firepower is an important dimension of military operations aimed at delivering accurate ordnance on designated targets to achieve desired effects within a given timeframe. In broad terms, depending upon the effects that are required to be achieved, firepower can be classified as Tactical, Operational and Strategic. Tactical fires such as Naval Gunfire Support, Close Air Support, and Artillery Cover are designed to support manoeuvre forces that are in direct contact with the enemy, by suppressing or destroying the enemy’s direct and indirect fire ability and air defenses. Normally, tactical fires are designed to accomplish tactical objectives. Operational fires are described as application of one’s lethal or non-lethal firepower for generating a decisive impact on the course and outcome of a campaign or major operation. In modern day scenario, they represent an inherently multi-service or joint function and are conducted in the operational and strategic depths of the enemy’s defences. In contrast to tactical fires, operational fires are planned to accomplish an operational objective. Strategic fires are intended to achieve a major effect on the course and outcome of a campaign or, in some cases, even war as a whole. Planned at the highest level, strategic fires usually take place outside the boundaries of a given theatre of operations where a major operation or campaign is yet to commence. They require the highest degree of joint planning effort. No amount of operational excellence exhibited in the field by the

operational commanders will be enough to undo the ill effects of poorly planned and executed strategic fires. It underscores the critical necessity of jointness at every stage. Earlier, firepower was not considered as having the potential to achieve strategic surprise, but was feasible on the operational and tactical levels. Today, the exact opposite is true. In today's world of modern warfare characterised by platforms with strategic mobility, incorporating stealth, reach and speed like strategic bombers and Ballistic Missile Nuclear Submarines and long-range delivery systems like missiles and strategic rocket forces, enable a nation to achieve strategic surprise. On the other hand, development of sophisticated satellite based sensors, early warning radars and other technical means like cyber warfare have made operational and tactical surprise difficult to achieve.

In the modern age, concentration of force has generally been referred to as 'concentration of effects'. This depends less on the number of troops and more on elements of firepower, mobility and technological prowess. Owing to rapid advances in technology, a great deal of convergence has been achieved especially in weapon systems. In other words, weapon delivery platforms are increasingly veering towards becoming highly mobile with supporting technologies that have tremendous firepower, which in effect is the Net Firepower. Concentration of effects can indeed be achieved by superior firepower. The concept of application of firepower also lends itself easily in support of some other principles of war such as offensive action, flexibility and morale.

The seas around us are gaining new found importance as each day goes by and the current century is the century of the seas. The medium of the seas provides the flexibility and manoeuvrability for platforms to operate under the sea, on the surface and in the air and provide them with the capability to launch firepower in all dimensions. The first attribute is the inherent stealth and enhanced reach that the submarine offers to planners. A submarine can cover large areas stealthily thus approaching the intended targets to suit the range of her sensors and weapons giving less reaction time to the enemy with regard to the incoming firepower. Similarly, the Aircraft Carrier is comparable to the Nuclear Submarine in extended reach. However, there are two clear advantages that carriers have over the submarine. At present, only an Aircraft Carrier can deliver large quantity of ordnance from sea on a sustained basis. The other attribute of carrier that scores over the submarine stealth is their visibility, which makes them ideally suited for maritime power projection. This gives the Carrier the flexibility and poise to remain over the horizon, in international waters and signal the intent to a likely adversary, which is the inherent threat that such a presence generates. On the other hand, since there are no boundaries in the high seas, the Aircraft Carrier like other surface ships could withdraw gracefully should the situation so demand. The Aircraft Carrier is, therefore, a versatile platform which can be deployed anywhere, any time, for any length of time to suit strategic and operational aims.

Mobility combines well with the characteristics of stealth and concealment of submarines that offer their own missiles complete security from pre-emptive attack. It means that no matter how skillful the aggressor's attack, he will be subject to devastating retaliation. If equations were nuclear, while we may consider our arsenal at

sea, safe from attack by the enemy, for the enemy this same arsenal is ‘immune’. If the enemy is to avoid a devastating second strike from the sea in retaliation to a nuclear first strike, he has to account for each and every sea-based platform beyond doubt. This is the entire basis of the concept of Mutually Assured Destruction and, thus, the most important factor in deterring a first nuclear attack by the enemy. Thus, second strike capability at sea clearly helps stabilise a dangerous situation.

Sea-based attacks can be launched from different dimensions, thereby, complicating the enemy’s defences. All available resources, when applied to generate maximum combat power at the decisive place and time, would eventually affect the adversary’s Center of Gravity. The spread of forces or, in our context, the spread of application of firepower from all dimensions and directions would also deny the enemy any knowledge of the actual distribution of our platforms at any given moment, thus complicating their plan of action.

Towards that end, the need to harness new technology and skills for achieving greater synergy in joint operations cannot be over-emphasised. A case in point is the concept of ‘Network Centric Warfare’ in which attention is focused on the combined actions of collective land, sea and air forces. NCW links sensors, communication systems and weapon systems over interconnected grids that facilitate seamless information flow to war fighters, policy makers and support personnel. In network centric operations, the focus shifts from individual sensor detection and firepower capability of geographically widely displaced platforms to the cumulative firepower which can be brought to bear on the adversary through seamlessly integrated sensor, information and shooter grids. This is achieved by multi-spectral data fusion, high speed data links and sensor to shooter grid integration. This ensures that a target picked up by sensor of one platform can be made available to the fire control system of another platform be it a ship, submarine, aircraft or land-based vehicle to carry out an attack by massing of effect on the enemy. This is when the platform ceases to matter and the true network-centric operations are achieved. In short, NCW will revolutionise warfare by synergising the collective firepower of forces on land, air and sea to bear upon the enemy simultaneously from different dimensions, and the massed effect so achieved would provide the much desired Battle Space Dominance.

The threat from ballistic missiles is increasing both qualitatively and quantitatively. With a choice of warheads available to an adversary such as nuclear, chemical or biological, the destruction created by these missiles could be colossal. An integral BMD system is, therefore, a security imperative in today’s scenario. BMD is a true network enabled system that includes sensors spaced out on ground, at sea and in space for early detection and a range of interceptors to engage incoming missiles at varying ranges. It is pertinent to mention that BMD capabilities have to be flexible enough to change as the threat changes. Case in point is the Anti-ship Ballistic Missile that is being designed as an anti-access weapon aimed at targeting an Aircraft Carrier at sea. This particular missile is reported to have a maneuvering re-entry vehicle to engage moving targets, one of the first of its kind.

There are a few critical requirements for cost-effective, yet efficient application of firepower. The first and foremost is jointness in operations or the need to orchestrate actions of the ground, sea, air and space-based elements to generate a synergistic effect. Recent events bear testimony to the fact that in today's age no single service can hope to fight and win a war on its own. The capabilities in various dimensions have to be integrated. The second requirement is the need to ensure precise targeting, thereby minimising collateral damage. Firepower application has to take due cognizance of the presence of innocent civilians and non combatants. The nature of conflicts as we see today is limited in area and objective and thus application of the firepower has to be that much more precise. On account of the revolution in information technology, monitoring operations during war is no longer confined to the limits of Military Operation Centres. In any case, the principle of natural justice and the law of Armed Conflict make it incumbent upon militaries to adhere to the principles of proportionality, graded response and ensure distinction between combatants and non-combatants. The long range and precision capabilities of munitions today will make it simple to isolate target specified areas only, thereby limiting the conflict in terms of all three operational factors of force, space and time. Yet, this will be enough to send necessary signals to the enemy. Our own Integrated Guided Missile Development Programme is moving from strength to strength and achieving ever increasing levels of precision, due to the intense efforts of our scientists from the Defence Research and Development Organisation (DRDO).

There are a few modern trends that have the potential to be the game changers in enhancing Firepower. The latter half of the 20th century has witnessed the advent of precision guided weapons, advance robotics and unmanned systems, and most notably, entry of two new dimensions of operations, which are Space and Cyberspace. Integration of these two dimensions with air, sea and land assets has given a boost to Joint Fire Support Planning and Coordination that is so very essential in Network Centric Warfare.

One of the key enablers for surveillance and fire support tasks are Unmanned Aerial Vehicles (UAVs) that have evinced a large investment from all three services. A large number of UAVs are available in the world today that range from micro-size to large platforms incorporating multiple sensors and stealth features. One such UAV is Global Persistence, propelled by liquid hydrogen that can be employed to maintain station at any place on the globe for four continuous days. With three such aircraft, one can maintain continuous surveillance cover anywhere on the earth.

There is also talk of Global Strike, a new concept being developed to deliver conventional payloads anywhere in the world at hypersonic speeds in denied battle-space. These missiles would enhance joint power projection capability and are aimed to reduce reliance on nuclear weapons and hence avoid collateral damage. Global strike concept is followed by Global Persistence Attack (GPA) that provides a spectrum of capabilities for persistent and sustained operations to maintain battle-space dominance. In the field of artillery, conventional guns are being armed with Long Range Land Attack Projectiles (LRLAP), which are rocket propelled, and GPS guided shells with extended ranges. The precise ordnance cover by this ammunition provides close support at

extended ranges to troops. Another technology demonstrated in the field artillery is the Rail-Gun, wherein a projectile is propelled by a high power Electro Magnetic energy rather than gunpowder. A full capability rail gun would be able to fire a shell more than 200 nm at a muzzle velocity of seven mach with impact on target at five mach. This projectile destroys the target by kinetic energy, rather than conventional explosives. Elimination of propellants and warhead would also contribute to safety in stowage of these weapons.

The development in the present generation cruise missiles are accurate, low flying, stealthy weapons and can be fired from multiple air and sea based platforms. The use of Land Attack Cruise Missiles to engage high value targets with precision has made these missiles as weapons of choice for military planners. With minimal collateral damage and selective engagement, cruise missiles are increasingly being used as an instrument against well defined threats. Low flying trajectory with supersonic speed in cruise missiles makes them increasingly invulnerable to air defence.

In conclusion, in the prevailing security environment, the concept of firepower would continue to address a range of conflicts from self-defence against asymmetric attacks to an all encompassing war. Armed forces have to brace to much more complex situations, where they may be called to deliver anything from special operations to overwhelming ordnance payloads. Hence, they would need to acquire new skill sets and harness latest trends that technology has to offer. But let me remind you that technology is only a means to an end and a constant strategic reflection is required on our part to be reminiscent of this fact. Strategy with respect to firepower needs to be centered on objectives and what is necessary to achieve them rather than acquiring the latest technology, simply because it is available.

Getting a correct balance between strategy and technology would therefore continue to remain one of the most important factors in the 21st century. New inductions have to be based on effects desired to attain objectives and should seamlessly integrate in the fighting power. The three tenets of fighting power are combat power, will to fight and doctrinal concept that encompasses joint operations in both fire and manouevre. Finally, the current century is not just the century of the seas but also the century of cyberspace. The real force multiplier of firepower which will provide a decisive edge in future wars will remain network centric operation. Through network centric capability we should aim to achieve information superiority over the adversary and concentrate the massing effect of our firepower to achieve a decisive victory.

Special Address
Air Marshal DC Kumaria, AVSM, VM, VSM, AOC-in-C, Western Air Command

Firepower is the military capability to direct force at the enemy and is likely to be a decisive factor in any battle. Firepower is essential to destroy or undermine enemy forces. Firepower has come to mean offensive power applied form a distance to decimate or sap enemy forces.

The concept of firepower is as old as the Mahabharat. In that epic, there was the Brahmastra and Divyastra capable of delivering heavy firepower. The concept of firepower has not changed over the ages; only the means have changed. The objective of the battle remains destruction of the enemy or his key positions. In the near history, Tipu Sultan used rockets for the first time in India against the British. In modern times, the government formed the Defence Research and Developmental Library (DRDL) to develop guided missiles. In 1983, under the leadership of Dr Abdul Kalam, the programme was revived as the Integrated Guided Missile Development Programme (IGMDP). The developed missiles are fulfilling important strategic roles in India's defence. The proven Prithvi has been made as an air defence missile named Pradyuman. Besides the IGMDP, India has collaborated with Russia to develop, design and market the Brahmos supersonic missile capable of being launched from ships, submarines, aircraft and land.

Another class of weapons which has increased the effectiveness of firepower are the precision guided munitions (PGM). As a percentage of the total weapons used, PGMs were only 7 per cent in the first Iraq War, 68 per cent during the second Iraq War and 95 per cent in Afghanistan and Libya. Classification of PGMs could also be based on stand-off firing range from 100 km to 15 km for the laser guided bomb (LGB). The LGB could be a modular weapon manufactured as a PGM or a conventional dumb bomb with an attached guidance system. It is important to have weapons of all these categories to enable weapon-to-target matching. Besides stand-off range weapons, a number of smaller calibre weapons are also necessary for our future requirements. These are the small diameter bombs which can be used in urban warfare. For runway denial, the earlier generation bombs are no longer effective. 4^{th} generation weapons are being acquired for this now. Specialised weapons for future are the air launched Harpoons for the anti-shipping role.

The subject of firepower was highlighted in the recent desert *Exercise Vijay Bhava* where a lot of concepts were tested. The underlying aim is to deploy maximum firepower in the tactical battle area (TBA). One of the important lessons learnt was that taking advantage of ISR, communication, net centricity and air power there is no need for a sequential battle. The need is to use multi-dimensional firepower to maximise shock and disruption. The platforms used could be fighters, attack helicopters, UAVs and artillery guns. Special Forces could also be used to drop behind enemy lines. The firepower of all the services should be synergised for maximum effect. Because of transparency of battlespace and presence of media, weapons should be precise and collateral damage should be minimised. Operations of own aircraft have to be co-ordinated with ground weapons in the TBA. Core competency of each element has to be exploited.

For effective firepower the requirements are, firstly, availability of real time battle field sensors to increase battle field transparency to reduce sensor to shooter time; secondly, a common database and networks for all the participants and thirdly, weapons to target matching and a mix of PGMs and area weapons should be used.

Area weapons can be precise and a number of them are now available in the IAF for tactical attack aircraft. The details of one such bomb were given. These bombs also have self destruct capability to avoid injury to non combatants. These weapons were first used in Kosovo war and are now being procured by IAF. The stringent international norms against unexploded cluster bombs have led India to stop the use of cluster bombs.

In conclusion, our quest to induct aircraft and armament in the IAF is fully supported by the government. Increasing availability of advanced armament technology is now possible to the DRDO, ISRO and DRDL due to lifting of sanctions. In future, with a combination of the European MMRCA, Russian FGFA and indigenous LCA with Israeli weapons and American attack helicopters with American weapons, the IAF is fully equipped to effectively contribute to the firepower in future battles.

Session 1 – Missiles: Development, Deterrence, Defence

India's Guided Missile Development Programme
Maj Gen PK Chakravorty (Retd), former ADG Artillery

The use of missiles dates back to the thirteenth century. Possibly, the first usage of missiles was by Chinese against Mongols in 1232. Additionally, Tipu Sultan's Army used variety of rockets in supporting role. It was the world's first use of rockets for fighting modern wars which was later developed further by the British against French. The precursor of modern ballistic missiles was the German V-2, which were used extensively as V 2 rockets by Germans in the battle of Britain during Second World War. The DRDO was formed in 1958 and its initial project was development of first generation anti-tank guided missile. In 1970 two projects commenced namely, long range ballistic missile and surface to air missile but both were terminated.

The approval of IGMDP was given on 26 July 1983 by the Ministry of Defence and it aimed to simultaneously develop:-

- Trishul - Short range SAM
- Akash - Medium range SAM
- Nag - Third generation ATGM
- Prithvi - Short range SSM
- Agni - Intermediate range SSM

As a part of the programme, Interim Test Range (ITR) at Balasore was developed.

- Trishul was a technology demonstrator.
- Akash was a medium range SAM with a range of 30 km at Mach 2.5 with Ramjet technology supported by Rajendra Phased Array Radar and is being inducted in Army and Air Force.
- Nag was a fire and forget type missile with a range of 3 km to 7 km and is at the final stages of user acceptance.

- Prithvi I was developed in 1990 and has a range of 150 km and can handle a pay load of 1000 kg. and a CEP of 30 to 50m.
- Prithvi II was developed in 1990 with a range 250 km and pay load of 500 kg. The CEP is 15 m and the range was enhanced by 2004 to 350 km with a pay load of 500 to 1000 kg.
- Sagarika k 15 is a submarine launched missile with a range 700 km.
- Dhanush is a ship launched missile which achieved a range of 350 km in Dec 2009.
- Agni I is single stage solid propellant with a range of 700 – 800 km and a pay load of 1000 kg, and CEP of 25 m.
- Agni II is a two stage missile with a range of 2000 to 3000 km and a pay load of 1000 kg with CEP 30 m.
- Agni III is three stage solid propellant, with a range of 3500 to 5000 km and pay load of 2000 to 2500 kg.
- Agni V is yet to be tested and is expected to have a range of 5000 to 6000 km.

After achieving the goal of making India self reliant in Missile Technology, DRDO on 8 January 2008 formally announced the successful completion of the IGMDP. However, the development will continue.

Cruise Missiles

- Bramhos is a two stage, supersonic with stealth technology. It has a range of 290 km with a cruising altitude of 15 km. It is extremely accurate and was inducted in the Indian Navy in 2005 and thereafter in the Indian Army. It carries only conventional warheads.
- Nirbhay has a subsonic speed of 0.7 mach. The missile is 6 m in length, 520 mm diameter and has a range of 1000 km.

Ballistic Missile Interceptor, Pradyumna

- Prithvi Air Defense System, which has a maximum interception altitude of 80 km. It is capable of engaging 300 to 2000 km class of ballistic missiles up to speed of mach 5.
- Shaurya is a land version of underwater launcher k-15 which is stored in a canister and has a range of 600 km. It was tested in November 2008.
- Astra is an indigenously produced beyond visual range missile. It has a range of 80 km head on and 15 km tail chase. Inertial mid course guidance and terminal guidance with a speed of mach 4 and a solid fuel rocket.

Thoughts for the future

- Development of precision guidance
- Satellite guidance
- Hypersonic velocity missiles
- Anti satellite missiles
- MIRV capability

- Cruise missiles defence; use space based IR sensors.
- Directed energy weapons.

Ballistic Missiles of Pakistan and China: Emerging Threats
Dr Manpreet Sethi, Senior Fellow, Centre for Air Power Studies

The value of missiles can be attributed to many aspects including the offer of non-contact warfare over variable ranges, for purposes of power projection, usage for nuclear signaling, as a symbol of prestige and technological prowess. The choice of types of missiles remains dependent on the nature of threat perceptions, range of targets, method of defence and/or vulnerability of targets. In this respect, understanding concepts such as nuclear doctrines, be it first use or counter-strike, deterrence by punishment or denial, targeting philosophy, counter force or counter value targets, availability of technology are of continuing significance.

As far as Pakistan's missile capability is concerned, the threat perception from India remains paramount. Pakistan's nuclear doctrine based on first use is primarily aimed at deterring India's conventional military superiority. There is projection of low nuclear threshold to counter risk of retaliation to proxy war along with a credible missile delivery capability. Pakistan is focusing on all ranges from Hatf 1 & 2 to Shaheen 2.

On the other hand, China's missile capability keeps the US BMD and GPS systems as its reference point especially in a Taiwan-like scenario. Moreover, the BMD cooperation between US and India is also being watched. China has announced a no first use nuclear doctrine to deter nuclear coercion, follows deterrence by punishment while imposing unacceptable damage. The question remains, whether China is likely to change its doctrinal strategy due to changing technological capability? China is focusing on all ranges from DF 11 (300 km) to DF 31A (11,000 km). Of these, the India specific missiles are DF 21, DF 3, DF4/4A, DF 11 and 15. China's missile capability reflects the goal of robust retaliatory force with an emphasis on survivability of missiles, being equipped with counter-measures against BMD and focusing on training with mobile missile units.

Both Chinese and Pakistan's missile capabilities signal few clear pointers for India. The technology push is likely to influence direction – especially in China. The increase in numbers will launch the offense – defence spiral. There is an increased likelihood for cruise missile proliferation. Operationalisation of SLBMs will be emphasised upon. There shall be less emphasis on improving ranges, more on accuracies with a move to counter force or mixed targeting. Sidestepping the offence – defence spiral, India should build a missile capability based on its own nuclear doctrine focusing on the range, accuracy and reliability of missiles. There should be an effort to try and influence the missile forces of the adversary and in a long-term context, consider and debate upon arms control and stability measures.

Emerging Ballistic Missile Defence Technologies Embracing Space Frontiers
Maj Gen VK Saxena, VSM, ADG, Army Air Defence Directorate

- Ballistic missile denotes growth of offensive as well as defensive capability of the country. It also demonstrates growth of defensive shift. Moreover, ballistic missile shows growth and development of interception.
- Ballistic missile also performs function as an interceptor. It should be result oriented.
- Joint operations require for an effective interception of ballistic missile.
- Ballistic missile has inter-continental as well as global reach and has global effect in nature and content.
- Ballistic missiles carry multiple tiers that require for defence of the country.
- Conventional lower tier missiles were used during Iraq War 2003.
- Upper tier missiles carry high ranges.
- Boost system requires for multiple engagement of ballistic missile and minimising damages. Missiles must hit target.
- Boost phase missiles are detected by radiation. Radars are used for hitting the targets. Space-based radars are required for it.
- China possesses Over the Horizon (OTH) system. Interceptors require for defence purposes and the trends continue to develop such systems. China has developed and achieved capability to destroy satellite as has demonstrated by destroying the targeted satellite.
- Trends continue to destroy weapons and satellites in space. Space-based censors and interceptors are growing. There is a tangible progress in this regard.
- The challenges have emerged because of the growth of the censors and interceptors.
- The US, China, Japan and Russia continue space weaponisation programme. For a country's defence, space weaponisation is an emerging reality.
- Missiles require for hitting the targets. Boost system enhances missile's accuracy and targets. Boost phase interception and other methods of interception require for defence.
- India seeks to induct such technology into its armed forces. Transfers of technology from the US to India require since India lacks such technology. The FMS-based transfers of technology and multiple types of transfers of technology are needed. Transfers of such technology to India will enhance its defence capability.

Operational Advantages with Combat-Proven Precision Weapon Systems
Mr Brad Barnard, Director, International Business and Strategy Solutions, Raytheon

From a US industry perspective, the objective is to provide a sustainable, operational advantage to the Indian warfighter. Achieving this transfer of capabilities requires three key activities:

- Identifying the operational capability that's required – in this case, precision solutions.

- Collaborating on a government-to-government, industry-to-industry basis for transfer of technology - more than just technology demonstration packages, but manufacturing expertise, programme management and life-cycle support.
- Identify the achievable first-steps, get some early victories, and build on that, over time, to establish this collaborative capability.

The three themes being examined are:

- To set aggressive standards that push the operational envelope for product development – then balancing it with the available technology.
- Precision weapons are not the end-all and be-all – they are force-multipliers, insofar as being a valuable 'arrow in the quiver' to what already exists in the Indian military.
- Ensure that synergy spreads to all three domains – air, land and sea.

The first step is to recognise the operational value of precision effects, which manifest in enhanced soldier survivability, single shot capability, lower logistics burden (which enables agility), and minimises collateral damage. The complementary move is to have a robust life-cycle support system; weapons that have been proven in combat previously; lessons which have been incorporated, i.e. soldier-driven enhancements. The flip side is the evolution of concepts of operational capabilities and incorporating new technologies within it accordingly, which results in high level of operational availability, stable engineering and manufacturing process, and the requisite training and support systems.

US companies are developing a new business model to support the Indian military customer. One of the key components of this model is pushing for transfer of technology, recognising its value to the Indian customers and policy-makers. There has been an unprecedented commitment by the US to support true transfer of technology (ToT) and co-production, in terms of engineering, manufacturing, and support expertise. There are endeavours in this regard to engage with local units, such as DPSUs, DRDO, MSMEs – towards the aim of reliability of supply and life-cycle management through localisation – either through prime-sub, joint venture or teaming. It also leverages capabilities and expands capacities, while at the same time, strengthening obsolescence management and depot support.

Advanced, combat proven solutions and effective indigenisation combine to provide a sustainable operational advantage for the Indian soldier in two dimensions: precision capabilities provide tactical and strategic benefits, and sustainable solutions will be realised via a long-term commitment to collaboration and partnering. Mission systems, in the end, are a critical element of modernisation – as they provide for diverse solutions with a lower programme risk and contain much of the performance-enabling technologies required.

Session II – Developments in Field Artillery

Firepower – Kargil Experience
Brig Devinder Singh, VSM (Retd)

Brig Devinder Singh who commanded a brigade in Batalik sector in *Op Vijay* recounted his experience of firepower application during the Kargil conflict. The effect of air power in the mountains was very limited. Mandate given to the air force was not to cross the line of control. This meant that the enemy fire bases across the Line of Control (LoC) could not be targeted by air power. The fighter aircraft were maintaining a safe altitude for flying, inhibiting precision targeting on the mountains. Nevertheless, the air force carried out several successful bombing missions. The destruction of an enemy arms dump at Muntho Dhalo was one such successful raid. The intruders had stockpiled ammunition on the feature on our side of the LoC.

The distance between intervening ridges in Kargil is at least 2-3 kms which was outside the range of Infantry small arms fire. As the operations progressed, fire was directed from fire bases established on the forward ridges. The Infantry would bring down harassing fire throughout the day and assaults were launched at night.

As the depth and extent of the intrusions were realised, more artillery guns was inducted from the plains. Gun Positions were established all along the National Highway 1 from Mushkoh to Batalik and the *sangars* and bunkers established by the intruders were relentlessly pounded. The volume of shelling was so high that the intruders could not get even get fresh water to drink as the ice had got polluted due to the exploding shells.

The 155 mm Bofors howitzer played an outstanding role in Kargil. At some places, it was even utilised in direct firing role. The Indian artillery fired nearly 50,000 rounds in the 50-day conflict. In addition MBRLs were fired on targets like Tiger Hill top. The relentless shelling broke the will and morale of the enemy and softened the targets for the infantry to launch their assaults and re-capture the features. The enemy whose supply lines were already cut and dominated by own fire catapulted in the face of massive artillery shelling and relentless onslaughts launched by the Infantry. The feat achieved at Kargil is perhaps difficult to replicate by any other army in the world and is testimony of the Indian soldier's grit, determination and valour.

Future Application of Firpower
Brig Gurmeet Kanwal (Retd), Director CLAWS.

The threat of conventional conflict cannot be wished away in Indian contest for times to come, as whenever the nation has downplayed this threat, she has been faced with one. In conventional war, firepower plays an important role as amplified by Kargil conflict. It may not deliver a victory but certainly can pave a way for it. The unresolved territorial dispute with China has kept the threat of boarder war alive. With respect to

Pakistan, India's threshold of tolerance may be exceeded in case Pakistan continue to wage a proxy war and a Kargil like misadventure remains likely with the prevailing situation along LOC and AGPL.

There is a 90 per cent probability of next war breaking out in mountains and 60 to 70 per cent probability of its remaining confined to mountains. In a conventional conflict the gaining, occupying and holding the territory, and evicting the enemy from territory held by him will continue to remain important military objectives. In future only a joint Air-Land campaign with massive firepower asymmetry in our favour will achieve desired military objectives.

Conceptual Aspects

Though Manoeuvre and Firepower are two sides of the same coin, however the emerging trend lines are showing a move from victory through manoeuvre to destruction through attrition. In the backdrop of nuclear overhang deep manoeuvre are no longer possible and political leaders are unlikely to approve the deep strike. Hence, future wars will be limited in aim, objectives, force levels, geographical area and time frame. The major attrition can be achieved only through generation of massive asymmetries of firepower. Today with the availability of long-range guns/ howitzers, rocket launchers and missiles, the artillery is capable of fighting the contact, intermediate and depth battles simultaneously. There is need to enhance the inventory of our Artillery to achieve complete fire supremacy on tactical battle field. There is also a need to switch from dumb to smart/ intelligent precision munitions. In the Gulf War-I, 4.3 per cent of total tonnage of munitions dropped comprised LGBs or other PGMs and they inflicted approx 75 per cent of the damage. In future conflicts, this is likely to go up to 90 per cent and in India, we have a long way to go.

The emerging philosophy of employment of artillery firepower visualises the synergetic orchestration of all firepower resources to cause destruction and systematic degradation of the enemy's fighting potential in offensive as well as defensive operations.

Equipment Philosophy The following is suggested:

- 155mm as the standard calibre.
- Light-weight towed 155mm and 120mm mortars for the mountains.
- 52-calibre 155mm (towed, wheeled and self-propelled) for the plains.
- Grad, Pinaka and Smerch MBRLs.
- Conventionally-armed Prithvi and Agni SSMs and Brahmos cruise missiles.

Recommendations

In the post-Kargil scenario on the Indian sub-continent, firepower's contribution will clearly be decisive to achieve victory. To generate favourable asymmetries of firepower in future wars/the following is suggested:

- One artillery division for each "pivot" and "strike" corps in the plains by 2022.

- One (to two) independent artillery brigades for each corps in the mountains.
- One UCAV battery per division by 2022.
- PGMs to comprise 20 per cent of all artillery ammunition by 2022 and 50 per cent by 2027.
- Above all else, early acquisition of long-pending towed and self-propelled guns for the plains and the mountains.

Developments in Guns, Mortars and MBRLs
Lt Gen BS Pawar, PVSM, AVSM (Retd)

Technological advancements, particularly in the last few decades have changed the entire gamut of warfare across the world. Technological developments have been more pronounced in Artillery than the other arms .This has enabled increased ranges of guns and increased variety of ammunition leading to increased lethality. Even the surveillance capabilities have increased manifolds to complement the long range of the guns now available.

Indian artillery have 6-calibres of equipment in service which even though being very effective have become obsolete today. 122 mm, IFG, LFG, 130 mm have all stood well in the testing times but have outlived their life now. Even 155 mm (BOFORS) which is a very good gun but now requires upgradation. The availability of spares for 155 mm has been restricted. The number of guns/ tubes of 155 mm also need to be increased. Today we have reached a stage that if Indian artillery doesn't expedite its acquisition and modernisation programme, the situation is going to be critical.

All modern armies of the world today have graduated to and stabilised at 52-calibre/155 mm guns and therefore, we must also gradually adopt the same. Vendors of 155 mm towed guns have been blacklisted which has put our acquisition schedule on hold. The blacklisting policy of MoD and role of media needs to be deliberated. The blacklisting should not be done at the cost of induction of equipment. The firm may be blacklisted for a particular type of equipment but it should not affect the overall acquisition process. Heavy financial penalties can be levied but the trials should continue.

We have acquired the Smerch rocket but the development in the rocket launchers across the world has been more. Today a rocket launcher can fire rocket and missile both. Pinaka inducted into our artillery has a range of 39 km which can be further enhanced to 50-60 km with better ammunition and modification. The UAVS have time and again proved their necessity in today's battlefield environment. There has been tremendous improvement in UAV induction in our country. DRDO has been planning to develop its own UAV which is likely to complement modernisation schedule of Indian Army.

It is recommended that we can consider inducting Loitering Missile System selectively in our Artillery. The Loitering missile system is meant for one time use only. The precision Guided weapons (PGMs) are being used effectively by modern armies in the world today. As they can't be reused, accordingly, they are to be used against high value

targets only. However, the cost of PGMs is prohibitive; therefore, we must explore other options also.

Ammunition is the basic weapon of the artillery not the guns. Gun is the only means of delivery of the ammunition. The quality of ammunition also needs improvement. It is imperative that ammunition manufacturing policy is reviewed and we make a conscientious decision to involve private industries in the manufacturing process besides the Public Sector Units (PSUs).

It is also recommended to review the Artillery philosophy of our country. We have to take a considered view to decide the percentage of Guns and rockets in our equipment profile. It may be worthwhile to examine the prospects of increasing the percentage of rockets from what it is today as the silver lining of acquisition and modernisation process of Indian Artillery has been the rocket technology. We also have to consider and take a decision on percentage of mounted and towed guns in the overall equipment profile.

In view of the delay in acquisition of guns in overall modernization programme of Indian Artillery, it is recommended that we must go in for midlife upgrades of the existing guns. We must involve private industry and if required, foreign vendors to expedite this interim solution.

The modernisation programme of Indian Army in Guns and Mortars has not progressed with desired pace. The acquisition programme is running behind schedule due to procedural hurdles as discussed above. It is high time we took cognisance of the magnitude of the problem and take immediate remedial measures to address the core issues.

Discussion

On the issue of future of mortars in the backdrop of induction of PGMs, in mountains due to the nature of the terrain, artillery with its PGMs cannot reach and be as effective as the mortars' in certain areas due to its trajectory. More over the mortars have a better splinter effect at the target end due to its shell configuration. Therefore, mortars will continue to perform an important fire support role in mountains along with the other assets. However their role in plains will reduce considerably.
On the issue of adopting 52-calibre and not 39/45, it was highlighted that in today's world over more than ten systems are in service. It is an established system in the world market and future lies in it.

Valedictory Address
Lt Gen Vinod Nayanar, AVSM, DG Artillery

The relevance and importance of firepower in the modern battlefield is ever increasing, with its reach, lethality, precision and assortment of warheads increasing exponentially with each passing day. The basic cause of conflict continues to remain territorial

disputes, historical and ideological biases, economic disparity, energy security, water sharing and so on. But the difference is the paradigm shift in the manner in which conflict is conducted these days. Victory is no longer clearly defined in terms of territorial gains, not even in terms of enemy military potential. Effects-based operations today aim at achieving the desired effect by forcing the adversary to respond in the manner we want him to. In the area of modernisation and innovative application of force, modern armed forces in the world are primarily banking on increased battlefield transparency and network-centricity to destroy specific targets with minimum collateral damage. The most vital tools for achieving victory, besides strategy, operational art and tactical skills, are undoubtedly precise firepower and battlefield transparency and omniscience.

In any discussion on firepower, the relative importance of manoeuvre vs. firepower does come up. Undoubtedly, both are complementary and equally important. There can be no successful manoeuvre without firepower, and the reverse is true as well. In our context, however, conventional operations would be limited in time and restricted in space, on account of the nuclear overhang, and other such factors. While manoeuvre would always be restricted by the nuclear threshold, firepower would be relatively less constrained. Hence, in the short time available, firepower would have to reach out to the depths and flanks to do the necessary damage and achieve the necessary effects. Hence, all applications of firepower, in effect, need to be and would be manouevrable in design. Seamless application of joint warfare and integrated firepower is vital – not just in conventional operations, but also in out-of-area contingencies and low-intensity conflicts (LICs). Joint operations necessarily require detailed, integrated joint planning, coordination, and application for all probable manoeuvre, firepower, surveillance and target-acquisition capability. There is no substitute for such synergy in modern war-fighting.

One of the tenets of network-centric warfare (NCW) is precision in the application of firepower assets. NCW inherently reduces attrition beyond a certain point and collateral damage, other than to the intended targets. Precision, i.e. employing surgical strikes, or even special forces at the strategic level, and artillery and air-delivered precision-munitions at the tactical level, are the need of the hour. In this context, the tri-services inventory of BrahMos, and other such precise weapons systems are indeed a real force-multiplier. As long as a target can be accurately acquired, it can be struck precisely. Precision technology is available. The main challenge, however, lies in producing these at reasonable cost, so as to have them in adequate numbers. The cost of present-day precision munitions is prohibitive – more than a hundred times the cost of conventional munitions.

The synergy of joint application would require a greater deal of concentration on joint training. Currently, there is very little institutionalised training when it comes to the 'decide, detect, deliver and assess' functions in the targeting processes of the three services. True flexibility in the orchestration of firepower will only be achieved when a company commander or an FO can communicate seamlessly with a surveillance sensor, a GPO at the gun position, a multi-role combat pilot, a naval ship or attack

helicopter pilot. In a network-centric operations scenario, the relevance of this synergy, which would require robust communications network and infrastructure, needs no emphasis.

As far as the artillery is concerned, phenomenal developments have taken place in land firepower systems. Artillery now is no longer restricted to the contact battle alone. It can effectively influence the battle beyond. With guns ranging to more than 40 kms and rockets to more than 100 kms, the role of artillery is ever expanding. In fact, the current thought is to have approximately 25-30 per cent or even more of the artillery as rocket artillery. Enhancement in accuracy, with precision munitions, initial navigation systems, GPS-assisted survey systems, modern met and muzzle velocity measuring systems and an array of target-acquisition systems have vastly increased the hit probability of artillery systems. The lethality and terminal effects have also been enhanced, with a variety of munitions, resulting in high-kill ratios. Artillery shelling was always the biggest producer of casualties – now it will be even more so. Current operational design no longer advocates fighting sequential battles. The battlefield would be non-linear – close targets, targets in depth, and to the flanks are required to be engaged simultaneously. Modern artillery has such capabilities and together with the air force, can deliver devastatingly effective firepower across the battlespace and in effect, across the spectrum of war.

Another major development in artillery has been its ever increasing surveillance capability. From simple target acquisition systems for counter-bombardment in the past, it has now advanced ground and aerial surveillance systems, making the battlefield virtually transparent. Unmanned aerial vehicles (UAVs) with satellite communications and excellent sensors, and even armed with smart weapons, can now fly and strike almost anywhere. This capability to search and strike has indeed added to the potential of the artillery. The challenge is now no longer weapon capability or firepower potential. It is having the operational ingenuity to use such capability to the best advantage.

As far as Indian artillery is concerned, we are in the process of modernising, to upgrading to 155 mm gun systems. The procurement process is necessarily slow, but we will have the required capability in a reasonable time-frame. We are looking at building up indigenous capabilities in guns and rocket systems, as also in munitions. It is indeed encouraging to see the interests displayed by DRDO, ordnance factories, PSUs and even the private industry in this regard. Realistically, in the areas of high-technology, we are encouraging joint ventures with reputed foreign vendors, with the requisite technology, to help speed up the induction of such weaponry in our systems.

It’s often said that the probability of the occurrence of conventional war is very low, and nuclear war even lower, and that we need to be prepared for LICs, with more emphasis on special forces and lesser on nuclear and conventional warfighting capabilities. However, this statement is only true when conventional and strategic capabilities are adequate. One may argue about the theory of deterrence, but one cannot afford to be wanting in one's nuclear and conventional fighting capabilities.

There have been delays in the acquisition of modern firepower systems and there needs to be acceleration in this direction. We certainly need to take longer strides and redouble our efforts in this direction. We need to find better ways to incorporate and synergise all the technological and industrial expertise at our disposal, both in the public and private sectors.

In conclusion, one can't help but agree with Napoleon, when he said that firepower is everything – the rest really does not matter.