**CENTRE FOR LAND WARFARE STUDIES (CLAWS)**
**FIREPOWER INDIA 2012**
**30 AUG 2012**

# SEMINAR REPORT

## General

The Centre for Land Warfare Studies (CLAWS), in association with *India Strategic*, organised a one-day seminar on 'Firepower India 2012' on 30 August 2012 at the Manekshaw Centre, New Delhi. The seminar gathered noted experts on the subject to discuss various aspects of developments in missile technology and aero-space dominance. The keynote address was delivered by Lt Gen Ramesh Halgali, AVSM, SM, Deputy Chief of Army Staff (IS&T). A special address was delivered by Dr Prahlada, Vice Chancellor, Defence Institute of Advance Technology, Pune. Air Chief Marshal (Retd) P V Naik, PVSM, VSM, former CAS 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 defence industry sector.

## Inaugural Session

### Keynote Address – Lt Gen Ramesh Halgali, AVSM, SM, DCOAS (IS&T)

Space emerged as a new theatre of operations after Gulf War I. In the modern day battlefield, Firepower is the God of War. The emerging battlefield environment would require a massing of firepower resources by all arms and services. The impact of technology on firepower has greatly impacted the mobility, range, accuracy and lethality of weapons. The vectors or delivery vehicles have also undergone a revolutionary change. The parameters of firepower are to cover the entire battlefield, have precision strike capability and cause minimum collateral damage with controlled aggression. Integration of all firepower resources with modern technology is also an essential requirement of the modern day battlefield.

India's missile programme took off in the year 1986 and the Ballistic Missile Defence (BMD) programme was launched in 1999. Since then, seven tests of the BMD have been carried out. The objective for the future is to use solid fuel in launch missiles and augment the radar detection range to 1600 km. The BMD shield should also integrate features to locate and identify the target; strike; effect and restrike and carry out post-strike assessment. Due to the enhancement in missile technology development, a very short reaction time is available for detecting and neutralising an incoming missile.

Rapid strides are also being made in space warfare. China carried out its first Anti-Satellite (ASAT) test by destroying its own satellite in outer space on 11 Jan 2007. Therefore, the need of the hour is to develop our own space and defence industry and

gear up for space warfare. An integrated space cell can be established at HQ IDS to streamline flow of communications, surveillance, Electronic Warfare, Signals intelligence and Meteorological data. The IRS satellites could serve a dual purpose by supporting both meteorological applications and military surveillance. Integrated military mobile communication systems should also be developed.

The way ahead is to enter into Joint Ventures, Buy and Make, fast track our own R&D by harnessing existing capabilities. It is imperative to achieve supremacy in all kinds of warfare.

**SESSION I – Missiles: Development, Deterrence and Defence**

**Opening Remarks by Chairperson – Brig Gurmeet Kanwal, former Director CLAWS**

Armies in battles need massive doses of firepower. It can come from all sources and is required by all arms whether in deserts, plains or mountains. The future of firepower lies in the use of Precision Guided Missiles (PGMs). In Gulf War I, 30 per cent of the ammunition expended were PGMs, in Gulf War II the figure went up to 70 per cent. Preliminary estimates from the recent conflict in Libya indicate that nearly 90 per cent PGM munitions were used. In India, the usage is in single digits and there is a need to diversify our stockpile of PGM munitions to stay ahead in the emerging battlefield trends of conflict in the 21$^{st}$ century.

In recent years, Pakistan is investing heavily towards the development of Tactical Nuclear Weapons (TNWs). The Pakistani thought process is governed by the assumption that the threshold of use is lowered due to low yield and ability to cause fewer casualties. But the world community is aware of the pitfalls of such a mindset and there is a realisation that Pakistan's quest for TNWs must be stopped.

**Ballistic Missiles of Pakistan and China – Emerging Threats: Dr Manpreet Sethi, Senior Fellow, Centre for Air Power Studies (CAPS), New Delhi**

Ballistic Missiles are used for having a credible nuclear deterrence; for non-contact warfare over variable ranges; for power projection; for nuclear signaling and as symbols of prestige. They are also used to demonstrate the technological prowess of a nation.

Pakistan has a first use nuclear doctrine with projection of low nuclear threshold to deter conventional military operations. Its BMD technology has primarily been acquired from China and is aimed at India. Pakistan has SRBMs for tactical use – counter-force targets and MRBMs for deterrence – counter-value targets. It mainly carries out testing for political signalling/ operational purposes and not for design validation. On an average it carries out 4-5 missile tests every year. It has increased numbers to counter threat of BMDs and cruise missiles from India. Nasr and Shaheen 2 have India-specific ranges.

On the other hand, China's doctrine advocates a no first use against non-nuclear nations. Additionally, it imposes deterrence by punishment by causing unacceptable damage. It has a mixture of acquired and indigenous capabilities and its primary targets include India, USA and Russia. China has a secure second strike force with mobile missiles dispersed over land. The DF series missiles have multiple ranges (DF11- 41). DF 31D, DF 41 and cruise missiles are counter-measures against BMDs. It has acquired both MIRVed and MARVed capabilities. Missile tests are carried out for design validation, for operational purposes and training with mobile missile units.

China is rapidly building up its numbers of Ballistic missiles and has the biggest arsenal after US and Russia. Pakistan is likely to be the eighth largest. Its arsenal is estimated to include the following:-

- DF 21s up from 19-23 in 2005 to 85-100 in 2011
- DF3 (2790 km) – 14-18 missile
- DF4/4A (5470 km) – 20-24 missile
- DF 11 & 15 (300-600km) – 800 total appx

The question that needs to be asked is whether China's changing technological capability will cause it to change its doctrine of NFU? It has more accurate, MIRVed missiles as first strike weapons. With new missiles, increased numbers, BMD and enhanced ISR for counter force targeting it has the capacity to impose intra-war deterrence. It could also use this capability for enhancing deterrence and not change NFU policy.

China's conventionally tipped missiles are under the operational control of SAC. It can exploit ambiguity for deterrence and cause huge psychological impact.

Pakistan's motivation for developing Tactical Nuclear Weapons (TNWs) lies in its Cold Start strategy. The message it intends to give out is – "not only will I use the weapon first but also get away with the use". It has a large enough arsenal for disarming first strike and small enough strike to remain under adversary's threshold of retaliation. It aims to send out a political message and not display military effectiveness – display of brinkmanship.

India's response option should be to convey certainty of punitive retaliation and for this it must have adequate capability and political resolve. India should therefore build missiles based on its own nuclear doctrine and focus on range, accuracy and reliability of missiles. It should also explore arms control and stability measures to influence missile force of the adversary. Ultimately, there is always the danger of being sucked into an offence-defence spiral.

**Emerging BMD Technologies Embracing Space Frontiers and India's Future Needs in this Context – Lt Gen VK Saxena, VSM, Commandant, Army AD College**

Adolf Hitiler had once remarked, “If we had these rockets in 1939, there would not have been World War II”. Today, ballistic missile technology has reached new heights with exponential increase in range, reach and accuracy. The Tactical Ballistic Missiles (TBM/SRBMs) have a range of 300-1000 km; the MRBMs between 1000-3000 km, IRBMs 3000-5500 and ICBMs have a range upwards of 5500 km. Therefore, the increased ranges have left no target which is beyond reach. US President Richard Nixon once reflected on this development, “If you have a shield it is easier to use the sword” and thus began the quest for developing missile shields. The US Strategic Defense Initiative (SDI) was created for this purpose.

Ballistic missile denotes growth of offensive as well as defensive capability of the country. It also demonstrates growth of defensive shift, shows growth and development of interception and performs function as an interceptor. Joint operations are required for an effective interception of ballistic missiles which today have intra-continental as well as global reach and global effects in nature and content. They carry multiple tiers for defence needs.

Conventional lower tier missiles were used during Iraq War 2003. Upper tier missiles carry high ranges. Boost phase missiles are detected by radiation for which space based radars would be required. China possesses Over the Horizon (OTH) system. She has developed and achieved demonstrated capability to destroy satellites. Trends continue to destroy weapons and satellites in space. Space-based sensors and interceptors are growing. There is a tangible progress in this regard. The challenges have emerged because of the growth of the sensors and interceptors. The US, China, Japan and Russia continue space weaponisation programme. For a country’s defence, space weaponisation is an emerging reality.

High power lasers, orbiting X Ray lasers, particle beam weapons and brilliant weapons form part of the BMD inventory. BMD systems are layered systems and can intercept an incoming missile at the upper, lower and strategic systems. THAAD is part of the upper defence system layer. The challenge now is to target missiles at the boost (which can already be done), post-boost and the re-entry periods. Future BMD technologies would seek a greater handshake between satellites and ground-based radar systems to acquire targets.

A trend in moving beyond KE interceptors is also being witnessed in BMD technology. Chinese ASAT test carried out on 11 January 2007 was a milestone achieved in space warfare. In the future, technology can be further harnessed whereby satellites, guided by high-powered lasers could act as reflectors to shoot down ballistic missiles.

**Trends in Naval Guided Missile Systems – Rear Admiral (Dr) S Kulshrestha**

*Torpedoes*

Self propelling torpedo is perhaps the most feared of underwater weapons against ships and submarines, since its invention in 1870s. Torpedoes are an embodiment of a synergetic mix of engineering disciplines ranging from mechanics, hydraulics, electronics, acoustics, explosive chemistry etc. to sophisticated software and computing. A practice torpedo is recoverable for reuse; this enables excellent weapon capability assessment, crew training as well as analysis of vital firing geometry.

The vagaries of the medium (underwater acoustics) leading to injection of uncertainties in the fire control solutions would ensure that the torpedo will continue to be in the weapon outfits of ships and submarines till the underwater threat exists.

*Missiles*

The trend towards hypersonic scramjet cruise missiles will continue to gather momentum and such missiles could be in the naval inventories by 2020. Coupled with hypersonic missiles would be real time target data updating and guidance by extremely fast computers and satellite based systems. The kinetic energy of hypersonic cruise missiles would be a lethality multiplier against targets at sea and therefore such a missile would be a formidable weapon without a credible countermeasure as on date. The proliferation of precision guided missiles would continue to increase with the spread of globalisation.

*UAVs*

One of the most salient military technology trends is the growing prominence of unmanned vehicles. The promising potential of unmanned technology has already reached fruition in the air domain, as witnessed in the recent wars in Afghanistan and Iraq. There would be similar impact in the undersea domain as in near future Navies aspire to acquire formidable sea denial and sea control capabilities. The terms Sea watch/denial/ control are likely to expand and transform in to *'Oceanic space watch/ denial/control'*. The term Oceanic space would embrace a cylindrical space in 3D+ dimensions; that is the sea surface, the atmospheric volume above, the outer space at least up to low earth orbiting satellite heights, the water volume up to the sea bed, the sea bed itself and also security of the deep sea mining assets in the EEZ.

*UUVs*

The role of Unmanned Underwater Vehicles (UUVs) in achieving these capabilities is going to be considerable if not spectacular, especially since most of the activities during peace time may centre on ISR far away from the shores and deep inside oceans.

The term UUV includes, remotely operated vehicles, Paravane, sea gliders and autonomous under water vehicles. It can be pre programmed to adhere to course, speed and depths as desired, and carry out specific tasks utilising a bank of sensors on the UUV. It carries out routine tasks unattended; once deployed the operator is relatively free. It is recoverable at the end of its mission and is available for reuse after maintenance.

*Bionic AUVs*

Bionic AUVs are AUVs which mimic nature. By introducing the buoyancy engine, the dependency on propulsion power package has been virtually eliminated. This engine functions by alternating between floating and sinking and uses wings for gliding up and down. The Bionic Manta by Evo Logics is a bionic AUV used for S&R missions, seabed survey, environmental monitoring etc. The biggest advantage offered by these systems is that they can operate for prolonged periods of time extending from months to even a year or more.

*Impact of Nanotechnology and Net Work Centric Warfare*

Usage of high energy nanomaterial's in batteries, propellants, fuels, triggering devices and warheads, will make the weapons faster, longer ranged and much more lethal. Nanotech in computing, communications, sensor technology, signal processing etc would see advent of much smarter weapons than today. The physical size would reduce leading to lower production costs; NCW will drastically cut down inefficiencies in the DATA cycle as NCW structured weapons would provide for sharing of real time target information between weapons and units engaging them. This would permit course correction of guided weapons even after their release and up to final impact.

Only navies, with both nanotechnology and NCW enabled weapons, would be able to effectively accomplish 'limited oceanic space dominance.

**Precision Engagement Platforms / Weapons / Systems Technologies – Mr Arijit Ghosh, Country Head – Defence & Space, Honeywell**

Magnetics-based PN Module is used to determine a current location from a previous location with distance and direction information. Map and a Magnetic Compass are today being replaced by GPS, Mapping software and electronic sensors.

Honeywell's Light Weight North Finder (LWNF) replaces existing Digital Magnetic Compasses, providing precise, un-jammable azimuth in all environments**.** It has validated requirement to minimize collateral damage by improving the precision strike capability of munitions. It reduces far target locator errors caused by magnetic anomalies. It has been successfully field tested by US Army at Redstone, USA.

TALIN Performs a wide range of missions and has the following features: The TALIN interface provides accurate weapon/target location, weather information and can be

used for automating weapon and ammunition data and other accurate computational procedures. TALIN has the following advantages:

- Delivers best value (best performance at an affordable price).
- Enhances operational efficiency in a Battlefield environment.
- Provides full 3-D navigation and pointing solution.
- Graceful degradation - uses multiple aiding sources (GPS, VMS, ZUPT).
- High reliability - withstands howitzer and mortar gunfire shock.
- Battle proven hardware on many different types of platforms.
- Provides common operator training irrespective of platform.
- Logistic support can be provided in-country.

**Special Address: Precision Delivery of Firepower – Dr Prahlada, VC, Defence Institute of Advance Technology, Pune**

Accuracy, speed, agility, lethality, robustness and intelligence are the basic elements of firepower. India has test-fired the Akash ground to air interceptor missile which has Electronics Counter Measures and multiple maneuvering capabilities.

The elements of firepower essentially include the following components in the various stages. In the propulsion stage, the rockets use solid or liquid fuel with Ramjet speed for propulsion.

The Guidance stage of missiles has the following components: - IMU, Platforms, SDINS, EM, Laser, RLG and FOG

Seeker: - RF, Thermal, Non Imaging, Imaging, Dual Mode

Control stage: - EM, EP, EH

These components are compact and have a high Power and dynamic. Nano materials are used for developing these components.

In addition, a vast array of electronics and micro electronics of digital, microwave and MM wave are used. These components are miniaturized and have better dynamics (speed and agility).

The fuse of the weapon system are guided by laser, radio and WH signals and can operate in a unitary, directional, kinetic, fragmental or as PGMs. They are optimally integrated with algorithms, processing and intelligence.

The Prtihvi, Dhanush and Brahmos missiles can be launched by aerial, ground and sea-based platforms on enemy ground targets. These missiles are robust, have a shaped trajectory and can be guided by Indian National Satellites or GPS. They use features like moving, maneuvering, rolling, pitching and heaving to seek their targets.

The Astra is a beyond visual range air to air missile which uses directional warheads and data links. Another aerial delivery missile is the Helina or Helicopter Launched Nag

Anti-Tank Missile which can acquire IR imagery of the target and home on to it with the help of Radio Frequency data links.

DRDO has entered into collaboration with IAI for the development of Long Range surface to air missiles. Sub Sonic Cruise Missiles use stealth features for Retargeting and seeking imageries.

A vast array of firepower augmentors are used in building the missile canisters. Some of these include lattice structures with filament wounds and stiffened structures for inter stages and acting as heat shields. Navigation sensors and systems include RLG, FOG, MEMS GYRO, Aided MEMS INS and INS on Chips. The Mission Computers have open operating systems like Arch VME 64x, CPCI. They have multicore SOC with massively parallel architectures. PGMS, A3/PAD and Devil increase speed by achieving miniaturisation of software used for navigation.

Electro-Hydraulic systems are employed in Prithvi and Agni missiles. Akash, Trishul and LR SAM have electro-mechanic systems. Smart electro mechanics, fault tolerant and hot gas systems are some of the futuristic systems. The Hardware-in-Loop Simulation (HILS) uses visual simulation for virtual reality. The Radars have Ku & W Band seekers which have multi-beam klystron with configurable processors. Agile and Adaptable Waveform are used for Imaging and LPIR seekers. AESA and Conformal Array seekers have electronically steered beam and impregnated antenna elements. Un-cooled FPA seekers are used in PGMs, LWIR for ATGMs and MWIR for AD and ATGMs.

Firepower technologies have undergone a revolutionary change in India and have the following acquired capabilities:-

- Thermal detectors and arrays.
- TR Modules. (GaAs, GaN).
- Multispectral Radomes (Radar, EW, Comn).
- Integration of Radar and EW Functions.
- High Efficiency Solar Devices.
- Cognitive radios with secure communication.
- Nano and energetic materials
- Nano sensors, fiber lasers.

Delivering intense fire power simultaneously at multiple geographic locations is critical in warfare. India, with DRDO, the academy, industry and the Armed Forces as an integrated entity, is ready for meeting this requirement.

In order to ensure minimum collateral damage, small warheads with high precision are required, which can also be used in urban warfare and for countering terrorists. These warheads would be capable of autonomous target recognition and homing to attack

multiple targets simultaneously. They would be modular in nature and can be easily attached to any carrier (missile, rocket, UAV, bomb etc). All the technologies like seekers, control components, warheads, ATR (Automatic Target Recognition), integration, simulation, mission planning and launching, are either already available or under development and will be achieved in the next few years.

**Session II – Aerospace Dominance and Deterrence**

**China's Space Programme and ASAT Capability – Air Marshal M Matheswaran, AVSM, VM, DCIDS (PP& FD)**

The maturation of aviation and space technologies coupled with the seamless integration of aerospace has highlighted the exponential increase in lethal capabilities that directly impact the conduct of war. Technology allows the integration of land, air and sea in a unified war. The third dimension also engenders information, reach, precision, penetration, command and control, which enables the armed forces to move away from massing towards appropriate networking and the optimal use of aerospace power. Technology, thus, is not a master, but an enabler for the fulfilment of policy objectives through war. To achieve material preponderance and definitive asymmetry, there must be a balance between technologies and force employment, aimed at an integrated unified war. Constraints and pitfalls in the development of firepower are mainly in the form of own policy limitations, import restrictions and global arms control regimes. Thus, the strategic roadmap should include a capability development process, a technological roadmap that decreases vulnerability of dependence on imported technology, in-house strategic think-tanks for technological mapping and the development of weapons keeping in mind time and capability factors.

Chinese space industry is independent and self-reliant. It pursues an innovative and a leapfrogging strategy. Between 2006 and 2010, it carried out 67 launches. 100 satellites are slated to be launched between 2010 and 2020.

Development of space assets allows China to carry out the following activities:-

- Environmental and disaster monitoring and forecasting.
- Three dimensional & multi-spectral, double satellite observation, networking.
- High resolution earth observation system.
- Communications (TT &C).
- NPS – Beidou 1 and Beidou 2.
- Manned Space Flight, Space docking (Tiangong-1 and Shenzou-8 ; Sep & Nov 2011), Lunar Probe.

It has three space launch sites at Jiuquan, Xichang and Taiyuan and a new site is coming up at Hainan. Space applications have a dual use and in the long-term China would integrate economics & military applications. The exploitation of the space frontier is an important constituent of China's military strategy and modernisation. The PLA is acquiring a range of technologies and space operations are integral to its Operational Campaign. Gen Xu Qilang said, "militarisation of Space was a historic inevitability".

The following critical aspects in exploiting space technology merits attention:-

- Space Situational Awareness
- Recce and Imagery- visible, infra red, multi-spectral, and SAR
- ASAT – hard & soft kills/immobilisation.
- ASAT hard – KE demo 2007 against 7km/sec tgt.
- Co-orbital ASATs, Microsat, Air launched (shenlang).
- Lasers – ground based & airborne
- Launch capability – LM 5 – 25 tons in NEO or 14 tons in GEO, LM 6 for high speed response launch, LM 7 for 5.5 tons in sun synchronous orbit at 700 km.

**India's Military Requirement in Space – Wg Cdr RK Singh, Research Fellow, USI**

China made a humble beginning in its space programme which was connected with economic and societal development. It has indigenous basic infrastructure for space launch and satellite manufacturing. Its technological capabilities are at par with the US and Russia. PRC launched 19 satellites in 2011(second only to Russia). China boasts of a robust space industry.

The Chinese philosophy for war is 'winning before fighting'. Therefore it aims to gain information advantage in war through application of space technologies. Space is the ultimate high ground. Due to the aggressive Chinese posture in space, India has to militarise and weaponise the space frontier for its national security and to secure its vulnerabilities in this domain. A space race in the near future seems inevitable.

The launch of Chinese KKE ASAT in January 2007 to shoot down their defunct weather satellite FY-1C came as a shock for the entire world as it was carried out without any prior intimation and with scant regard for space debris. China's recent accomplishments have provided merely the opening salvos in a modern-day Asian space race. It had for several years successfully used ground-based lasers to blind US reconnaissance satellites. These blinding tests seem intended to demonstrate the capability to pinpoint, track, and "illuminate" American spy satellites. Blinding a spy satellite's optical and infrared imaging systems could result in either temporary or permanent damage, depending upon the delivered power of the beam and the sensitivity and protections built into the satellite's sensors. As one arms-control advocate told the *Washington Post*, the Chinese were responding to US space policies and sending a signal to the Pentagon: "We can play this game, too, and we can play it dirtier than you." According to *Jane's*, *Shenlong* satellite may have INS/GPS navigation. It is reportedly designed to be launched from an H-6 bomber at an altitude of ~10 km. Following ignition, a first-stage motor would take the 13,000 kg spacecraft to 490 km in les than 8 minutes before a second stage burn would take it to 600 km altitude. A third stage would then accelerate the spacecraft prior to dispensing a satellite of less than 50 kg into sun-synchronous orbit before landing on a runway in its return to Earth.

China is moving from militarising and weaponising the space to gaining asymmetric advantage in space warfare. A more important motivation for China's investment in civil

and military space is the country's perception of its security environment and its understanding of the evolution of modern warfare. The Chinese have concluded from observing recent wars—including Operation Desert Storm, NATO operations in the Balkans, and the present wars in Afghanistan and Iraq—that "the PLA's past approach to wars, which relied heavily on mass mobilization and preparation for all-out warfare, are frankly no longer appropriate," according to China scholar Dean Cheng of the Center for Naval Analyses.

The military applications of space need to be accelerated and incorporated into space doctrine of India's armed forces. The development and validation of technology intensive space weapons has to be carried out for which ISRO, DRDO and the armed forces must work in tandem to acquire asymmetric capabilities over the Chinese space programme. A Space Security Co-ordination Group (SSCG) under the NSA and with representatives from DRDO, NTRO and IAF was created in 2010 which lays down the government's space policy. For the future, India has to acquire both offensive as well as defensive capabilities in space warfare. A 'Space Task Force' to optimise India's space programme development should be created. There would also be a requirement of a National Space Command to review and recommend the nation's strategic needs of space assets and its management for national security. We need KKE ASAT for ensuring strategic balance in Asia and this should be put on the fast track. Space assets with military applications should also be concurrently taken up.

**Helicopter in Combat: Today & Tomorrow – Lt Gen BS Pawar, PVSM, AVSM (Retd), former Commandant, School of Artillery and ADG Army Aviation**

Armed Helicopters/Gun-ships are military helicopters modified with weapons to attack targets on ground. They differ from attack helicopters as they were designed for other tactical uses, such as utility, cargo, recce etc. Weapon mounts are modified rather than being a part of the design of the helicopter. Attack Helicopters - Military helicopters specially designed & built to carry weapons for engaging targets on ground and in air. Weapons include machine guns, auto cannons, rockets and guided missiles for air-to-ground & air-to-air engagements. Modern day attack helicopters have 2 main roles; providing direct & accurate closed air support to ground troops and anti-tank role to destroy the enemy's armoured forces.

Historically, the fire support delivered by weapons mounted on helicopters began during the Korean War. The concept further evolved with the French during the Algerian campaign & first Indo-China wars in the form of armed helicopters. Until Vietnam War, military helicopters were mostly used for troop transport, observation & casualty evacuation. Due to ground fire on helicopters during troop lifting, the need was felt for arming them. The utility helicopters were cumbersome for use in field and USA developed a dedicated gunship (AH-1 Cobra). In 1960's, the Soviet Union also felt the need for armed helicopters. They equipped the MI-8 helicopters with rocket pods. Armed Helicopters with gun-ships continue to be relevant despite the development of modern day attack helicopters. In Indian context, we earlier had the MI-8 and Ranjits (a Cheetah helicopter modified with MMG), and presently have the MI-17 armed helicopter and Lancer (Cheetah armed with MMG and rockets).

The dedicated attack helicopter was developed in late 70s and early 80s. This led to the advent of Apache, upgraded Huey Cobras, Italian Mangusta and the Soviet Mi24. The cost of development was high but 1991 Gulf War put at rest any doubts about the relevance of attack helicopters. Post 9/11, The Afghanistan War took the attack helicopters into battle once again and the 2003 Iraq Invasion saw the deployment of attack helicopters but in a changed environment. As regards, modern day attack helicopters, Apache has been further refined in the form of AH-64D Longbow, the Russians are currently deploying the KA-50 and MI28 and the Chinese have developed Zenshing-10. In our context, the development of the light combat helicopter (LCH) is in progress.

The employment of Combat helicopters in future can be divided into:-

- Nature of future wars and Conflict Scenarios – wars will be short, swift and intensive with deeper and wider combat zones. There will be Low intensity conflicts with sophisticated weapon systems and out of area contingencies.
- Employment Philosophy – attack helicopters are capable of fire power and manoeuvre. They should be used with detailed planning and coordination. Their employment is very important in the first twenty four hours of battle, especially in the cold start strategy.
- Roles/ Missions – are similar for all armies all over the world. These are anti armour, escort to SHBO, area domination, anti – UAV, armed reconnaissance, fire support missions and Counter Insurgency/ Counter Territory operations.
- Kargil – the situation was tailor made for combat helicopters but they could operate at those heights.
- Air Space Management – is essential in a dense air defence scenario.

**Evolving Future (Precision) Warfare Capability through Defense Experimentation –** Cmde Rajeev Sawhney (Retd), Director, Strategic Development & Experimentation, Phantom Works, India

The future wars are likely to be marked by Battle space transparency through enhanced persistent C4ISR and smaller composite forces networked to achieve “Mass”. It would entail a series of short encounters rather than large battles. Owing to the emerging trends, precision systems will require extended ranges. The future warfare will see asymmetric warfare coupled with increased importance of space and cyber domains and use of unmanned systems and robotics. The Indian Security Scenario will include a wide spectrum of conflicts ranging from conventional conflicts to internal security challenges and space and cyber conflicts. Modernisation is underway and will continue over the next decade. The major focus is currently on implementing NCW leveraging IT and building ISR capability. Other areas of focus are joint capability development and countering asymmetric warfare.

Boeing has been working on defence experimentation projects which will help the Indian armed forces to a great extent. The systems refers to application of the experimental method to the solution of complex defence capability development problems, potentially across the full spectrum of conflict types, such as war fighting, peace enforcement,

humanitarian relief and peace-keeping. Preparing for the future warfare presents many challenges and major decisions in capability development are costly. The financial constraints would remain a constraint and it is important to ensure cost effectiveness of selected option. In view of these scenarios, defence experimentation provides proven option to reduce risk and enable informed decision making.

**Valedictory Address – Air Chief Marshal P V Naik, PVSM, VSM (Retd)**

Warfare today is not just limited to the battlefield; it has reached our bedrooms through television sets. The focus of the media on issues related to defence, war and humanitarian intervention has highlighted many issues which were not always pertinent to warfare. Today it is important to question if any war that is waged on a country is just in terms of the cause and the objectives. One cannot simply attack a country without a justifiable reason owing to various other issues that govern it today regionally and internationally. It is equally important to restrict collateral damage or civilian deaths caused during wars/conflicts as the suffering are not just limited to the national borders of that country but travels across to other continents.

In India, we rarely place loss of human lives at a top priority probably because we have a lot of population in the country. In contrast, western countries especially the USA value human lives. Though precision guided munitions (PGM) are never seen in this light, it is important one does so. With better precision, the collateral damage and civilian deaths are bound to minimise. PGMs are not only important for better targeting but ensuring that non-combatants do not get affected by military actions. Therefore it would not be wrong to state that PGMs are here to stay and would only command more importance as countries focus on better targeting and lesser civilian deaths in future wars.