# CENTRE FOR LAND WARFARE STUDIES

## NIGHT VISION INDIA- 2014

## ASHOKA HALL, MANEKSHAW CENTRE, NEW DELHI

## 21-22 JANUARY 2014

## SEMINAR REPORT

### General

The Centre for Land Warfare Studies (CLAWS) organised a seminar on Night Vision in collaboration with Indian Military Review on 21 & 22 January 2014 atManekshaw Centre. The seminar focussed on critically analysing components of night vision capability which are imperative for national security capability development. The seminar was well attended by serving officers of the Armed Forces, distinguished veterans, officers from the Central Armed Police Forces (CAPF), members of the strategic community and representatives from defence industries.

### Inaugural Session

**Welcome Address: Maj Gen Dhruv C Katoch, SM, VSM (Retd), Director, CLAWS**

Velocity and momentum are key facets of conflict, which in the modern age has even greater salience. The ability to progress conflict through the night contributes to the above as also to increased battlefield transparency, giving the side with better night vision capability a tremendous advantage over its adversaries. Night vision devices are vital for operations against terrorists and insurgents who tend to move and operate by night and constantly resort to using the terrain for camouflage and concealment.

**Keynote Address: Dr SS Negi, Outstanding Scientist & Scientist H, DRDO, Head, Vision Instrumentation Laboratory, IRDE**

It is the duty of DRDO to provide night capability to the forces and IRDE is one of the labs of DRDO working in the visible and the infrared regions. Today a single sensor will not serve the purpose, so we need to have multiple sensors. We can divide the Imaging Sensors in three categories:

- Night Vision Devices (NVDs) based on **Image Intensifier (II) tubes** that can be employed for short-range surveillance and reconnaissance, night patrolling, vehicle driving, map reading, and acquisition and engagement of target at short ranges.
- In infrared, there are two wavebands; Mid Wave Infra Red (MWIR, 3-5µm) and Low Wave Infra Red (LWIR, 8-12µm) which are being used in making thermal imagers. There is a new window which is coming, the Short Wave Infra Red (SWIR, 1-3µm) and is becoming popular.
- Thermal Imagers (Cooled and Uncooled). They are used for target acquisition and engagement at long ranges and for missile guidance and warning.

**Image Intensifier (II) tubes**

Four types of Night Vision Devices based on II tubes that are finding applications are the goggles, monoculars, binoculars and sights. The building block of the II tube has a photocathode which converts the incoming light into photo-electrons, a Micro-Channel Plate (MCP) that multiplies the electrons, a phosphor screen which converts the electron into green light which is then displayed out

of the output fibre optics.The Figure of Merit (FOM) is calculated as the product of the resolution and the signal-to-noise ratio and the Indian Army desires tubes with higher FOMs.The American technology has moved from Gen-III tubes to Gen-III$^{+}$ and Gen-IV which have a FOM of 1400-2130.These tubes are not so reliable and have a large halo, but the advantages include better performance in low light and in green vegetation. Photonis from France using the Multi-Alkali photo-cathodes has moved from Supergen tubes (FOM of 1050) to Hypergen tubes in form of XD-4 (FOM=1250-1400) and XD-5 (FOM=1400-2100).The advantages of these tubes include better vision in desert and snow, higher shock resistance and low halo.

India imported the Gen-II tubes with a FOM of 464, which improved to 969 in 2009 with DRDO participation. In 2011, XD4 technology was transferred from Photonis with FOM of 1250 while the transfer of technology for XR5 is under consideration for 2014.FOM of XR-5 ranges from 1400-2100 and the Indian Army has asked for tubes with FOM of 1700.Improvement in range and other factors has to be weighed against the cost factor for optimum benefit.Future technological advancements include -

- Use of processors and software to improve the FOM.
- Auto gate facility to reduce blooming.
- Increasing the dynamic range of the tube and improvinghigh-light imaging resolution.
- Improved reliability, photo response, reduced signal to noise ratio and halo diameter.
- Fusion of II and uncooled TI images in weapon sights.
- Digitisation of image externally and silicon-based technology for lower costs.

**Thermal Imaging**

The building block of a thermal imager consists of an optic system, detector, amplifier, signal processing, and display. The heat that is emitted from the target is distorted in the atmosphere thus requiring signal processing. Thermal imaging allows night viewing in pitch darkness and is less affected by smoke, dust, haze and light rain. It penetrates light camouflage and cannot be blinded by search lights and flares. TI reveals the thermal details of the scene, detects thermal footprints and allows for long-range detection. However, the performance of thermal imagers degrades in atmospheric turbulence, fog and rain.There are two bands in the infra-red spectrum where TI devices are being used.

- MWIR (3-5 µm) -Preferred for hot and humid conditions and is better for long ranges. It is better against hot targets with temperatures more than 400K but it is susceptible to solar clutter or glint. The MWIR is used for tracking missiles and rockets.
- LWIR (8-12 µm) - LWIR is preferred for cool and dry scenarios and for smoke and dust filled battlefields. It is better for moderate ranges usually less than 6km and has a better sensitivity for a target at ambient temperature. LWIR is suitable for ground targets and is resistant to solar clutter or glint.
- A new window called the Short Wave Infra Red (SWIR) which works in the 0.9-1.7 µm wavebandimproves performance during haze, dusk and dawn conditions and helps detect laser pulses designated onto the target during a missile firing.They provide better atmospheric transmittance, improved resolution and better camouflage detection.

The third generation systems are much smaller and require lesser power, have better reliability with higher MTBF, increased sensitivity that improve range in poor atmospheric conditions and have better resolution. Advanced third generation systems are either dual band/dual colour cooled imagers or uncooled imagers.The cooled imagers that can operate at elevated temperatures of 120-180K, are applicable to achieve maximum range, large field of view and greater clutter rejection. The uncooled imagers are useful for low cost, low power and moderate performance applications.The cooled

detector technology has a better performance than uncooled technology and a higher resolution but is more expensive and utilises more power. The uncooled detectors are maintenance free and are used for instant operations while the cooled have a cool-down time and are thus not effective for the infantry. However, both these technologies are complementary to each other.Uncooled imagers find applications in surveillance, rifle sights, helmet mounted sights, driver night sights and unattended sensors.Possible future applications could include missile seeking, threat warning systems and mini/micro UAVs.

Some of the thermal imagers that the Indian army currently has are:

- HHTI: For Surveillance, 2ndGen 256X1 MCT (LWIR)
- HHTI: For Surveillance, 2nd Gen 288X4 MCT (LWIR)
- TIIOE (TI & LRF): For Surveillance & Ranging, 2nd Gen 256X1 MCT (LWIR)
- BMP TIM: Gunner sight, $2^{nd}$ Gen 256X1 MCT (LWIR)
- TISAS: Gunner sight fitted in T-72, $2^{nd}$ Gen 256X1 MCT & 288x4 LFPA (LWIR)
- TI ESSA (Catherine Sight): Gunner Sight fitted in T-90 tank, 2nd Gen 288X4 MCT (LWIR)
- GMS: (TI+DAY SIGHT + LRF) For MBT, $2^{nd}$ Gen 288X4 (MCT LFPA LWIR)
- $3^{rd}$ Gen systems
    - LORROS: (TI+ LRF+ CCD), 256X256 (MWIR)
    - GMD: (TI + LRF), 320X256 (MWIR)

Any product that is developed should be inducted as early as possible to avoid it becoming obsolete due to rapid technological advancement. The advances being made in the IR sensors would allow better recognition ability, increased range, system simplification and increased field of view. Multi-spectral/Hyper-spectral would provide collection of spectral information and offer a better field of view. Data processing allows improvement of raw TI images and of images which are distorted due to fog and other adverse atmospheric conditions. Analytics would provide improved automatic target recognition (ATR). The range produced from the imager when deployed during daytime is 15-20% less than that when deployed during night due to the atmospheric turbulence.

Some of the thermal sights that have been developed at IRDE in the last decade are -

- Commander's Thermal Imaging sight cum Day sight for T-72 and MK-I
- Medium range thermal imager for UAV
- Electro-optical fire control system (EOFCS) for India Navy
- Thermal imager for Nag missile carrier

Some of the uncooled thermal imagers developed at IRDE are -

- Helmet Mounted Thermal Imaging Camera (HMTIC): Range = 50m with field of view $50^{o}$x$37^{o}$
- Driver Night Sight: Range = 150m for tanks with field of view $45^{o}$x$34^{o}$
- Dual FOV Weapon sight for MMG: Range = 1.5km with Near FOV $5^{o}$x$4^{o}$ and Weapon FOV $10^{o}$x$8^{o}$
- Weapon night sight: Range = 500m with field of view $8^{o}$x$6^{o}$

There are two types of Electro-Optical payloads for UAV.

- Medium Range EO Payload (MREO). The range of the thermal imager is 7.5km and it has a Laser Ranger cum Designator.
- Long Range EO Payload (LREO). The range of the thermal imager is 40km. It has also been deployed as Aerostat EO Payloads.

These payloads are also going to be used for border surveillance and there have been negotiations with the army over deploying them in the next three-four years.

## Session I: EMERGING TECHNOLOGIES

**Chairperson -** Air Marshal, Bharat Kumar, PVSM, AVSM, former AOC in C Southern Air Command**.**
**Speakers**

- **Low Light Level Imaging Innovation:**Mr. David Herrison, Business developer, Photonis.
- **Thermal Imaging Technology in use by Military Products and Systems:** Marian Giber, Controp Precision Technologies, Israel
- **Computational Imaging for Improved Situational Awareness**: Arvind Lakshmi Kumar, Tonbo Imaging
- **Industry Presentation -** Mr. Raj Chodankar, CEO, Mechvac Fabricators

The session was devoted to presentation by private corporate sectors on the products fielded and developed by them.

## Session II: COMBAT BY NIGHT

**Chairperson:** Lt Gen RameshwarYadav, AVSM, VSM, Director General Infantry, IHQ of MoD(Army)
**Speakers**

(a) **Mechanised Forces in Night Operations:** Lt Gen SH Kulkarni, AVSM, VSM**, Director General Mechanised Forces, IHQ of MoD(Army)
(b) **Empowering the Infantry for Night Fighting:** Brig UpendraDwivedi, DDG Infantry (B), IHQ of MoD(Army)
(c) **Surveillance and Target Acquisition –** Maj Gen PK Chakravorty, VSM (Retd), Adviser BrahMos Aerospace

Wars that involve 24X7 operations require equipment with sound ergonomics that prevents fatigue among the crew.Transparency of battlefield necessitates countermeasures against the collective array of night vision devices available with the enemy.While the focus on individual platforms is important, there is a need to give more importance to developing collective tactical level capability.The Indian tank fleet is partially night enabled with all new acquisitions like the T-90s and the Arjuns being night capable but the older T-72s and BMPs are not. The industry should give attention to retrofitting these systems on to the older platforms in an appropriate way.

While conventional wars can still be sustained with partial night blindness, when it comes to CI ops in order to minimize collateral damage precision firing in bad weather and at night is very important.Conventional and sub-conventional operations require operations by agile, responsive and networked infantry units in small teams that are night enabled. The device needs to be seamlessly integrated with the weapon and provide increased accuracy, lethality and standoff capability of weapon delivery system. Night devices for Surveillance and target acquisition should match the effective ranges of the weapons.The basic character of infantry has to be retained while incorporating technology.
Diverse sensors should provide all weather capability and gap-free surveillance of areas of interest. UAVs should be used extensively and integrated with Unmanned Ground Sensors. Military robots needed for enhanced and effective surveillance tasks.The soldier should have capability to access the enhanced ISR inputs by night.

The desired attributes for induction of new equipment are:

- High sensitivity & resolution and low power consumption
- Equipment should be versatile while at the same time maintaining standardisation across types.
- Ruggedness and survivability in the battlefield environment and should not degrade over prolonged use.
- Power pack should have multi utility capability and longer durability
- Real time transfer of imagery in the desired resolution
- User friendly display at both ends – at the weapon sight and terminal view point end in the form of computer, handheld or smart phones.
- Mission Reliability to ensure high availability and reliable back end support
- Should have associated field testing and minor repair equipment
- Modular Design to enable easy replacement and quick repair
- Fitment &upgrade possible '*in situ*' by the user.
- Reduction in size, weight and cost with improved DRI ranges.
- Tech threshold of AFV crew needs to be raised for optimised handling of high-tech equipment.
- Realistic Training in line with technology incorporations.Simulators and other tools/equipment for practice given the high technological sophistication. Training for fitment and maintenance too.
- Sustenance – extended 'in service' life in the army.
- Smooth transition to superior technology. It should merge with existing technology
- Competitive price for procurement in large quantities, while not compromising on the operational requirements.

**Capacity Building**

- Proactive procurement policies – to ensure utilisation of state of art technology
- Concept of L1T1 - a healthy mix
- Retain technology currency despite lengthy procurement procedures
- Incorporating upgrades on the same form fit periodically
- Seamless integration of technology for optimised benefits
- JV with foreign partners for current technology and future upgrades
- Offsets optimised to obtain critical technology. Complete transfer of technology (software, protocols, codes)
- Level of Technology Absorption by Indigenous Industry.Strong R&D to achieve indigenous technological base and cost competitiveness of indigenous efforts.
- Collaborative impetus to R&D for design and development; greater participation by private sector - promote joint ventures with leading technological giants
- Effective inventory management by concepts like JIT.
- Assured long term OEM involvement with repairs, product improvement and resupply to minimize repair time and ensure high availability of the equipment
- Established echelon for maintenance/repairs.Replication of OEM mandated production and repair procedures and best practices
- Development of Adequate Infrastructure and wide vendor base in India.
- Optimum QA/QC by regular DA/OEM, DGQA and Independent Agency Audits.

**Discussion:**

- Network centricity with recce, surveillance and acquisition architecture and the desired communication requirement is essential for effective command and control.Devices need to be integrated at all levels to get the complete picture.

- We need a combination of doctrine and technology to overcome challenges.
- We need protocols and procedures in place for amalgamation of network centricity and night vision surveillance.

## Session III: AIR OPERATIONS BY NIGHT

**Chairperson and speaker**: AVM M Bahadur VM (Retd), Distinguished Fellow, Centre for Air Power Studies

**Speakers**

(a) **Army Air Operations by Night:** Brig Jaswinder Singh SM, DDG Avn, IHQ of MoD(Army)

(b) **Naval Air Operations By Night:**Rear Admiral DM Sudan, ACNS (Air) , IHQ of MoD(Navy)

Night gives us greater protection while executing a raid or being at the receiving end of a raid. Night vision brings in great asymmetry.Our night vision enhancement is based on Image Intensifier tube technology and Infra red imaging. Modern helmets have projection capability on their visors which is selectable by the pilot donning them. NVGs have made their appearance on certain aircraft, notably the A-10s.

NVGs cannot see thru smoke while IR sensors can; on the other hand IR sensors cannot see through glass while image intensifiers can – and obviously, image intensifiers cannot see in the absence of light while IR sensors can. So, technology has been used to mix the two to form the ENVG or the Enhanced NVG. Overlays of the two for piloting have been experimented with; however, there are yet no operational systems for aircrew. High resolution night vision systems with better FOV, processing and visualisations are being developed the world over.

**Synthetic Vision.** 'Synthetic Vision' would combine world wide data bases of terrain and airport facilities, precise navigation information, traffic information and tactical hazards and produce real time synthetic vision tactical display with guidance. It can also be employed by the UAVs. This passive system would be immune to being blinded, spoofed, or detected jam proof and allow stealthier yet safer operation globally. It would allow realistic pre-mission simulation of flight to and from target and a potential windowless-cockpit flight capability to afford crew laser protection.

Modern developments aim to utilise a greater part of the EM spectrum. New materials that could release near infra red light over prolonged periods would help in navigation and target designation functions. Fusing of the three optical sensors — the visible range, long-wave infrared and short-wave infrared (SWIR) would radically alter the employment of night vision goggles.

Helicopter is the basic unit for army operations by night that can operate from unprepared surfaces and can perform multiple roles including delivery of firepower from the air. It can also be employed as an electronic warfare platform or as a surveillance platform or as an airborne command post.

While the modes of operating any flying machine remains unchanged by day or night, the standard of preparation both in air and on ground and standard of equipping them is different.To meet basic operations by night, helicopters must meet these requirements:

- Night goggles with image intensifier technology which allows maximum image clarity under all flight conditions even in low light and overcast conditions. It is very difficult to perceive depth through NVGs. Cabin and instrument lighting, helipad lighting and landing light should be compatible to NVG system.

- Visual acquisition of target by night would be almost impossible. Arrays of sensors to be able to navigate, identify, acquire and engage enemy targets and be able to meet flight safety requirements.These would include Forward Looking IR radar, digitised moving map display coupled with GPS locations, threat zones and obstructions. The system architecture should include an automatic flying control system, digitised terrain avoidance warning system, ground proximity warning system and obstacle avoidance system and wire cutters. Tactical systems such as Identifying Friends or Foe (IFF) would reduce risks of engagement by friendly fire and protective suites including Infra Red Suppressors and IR Jammers and flare and chaff dispensers would protect against missile attacks.In case landing has to be carried in a battle field, it must carry the IR landing light and even troops on ground should have such lights. For operating at low altitudes in dusty conditions, it is desirable for the helicopter to have particle separators.
- System architecture for display of. Systems such as Head Up Displays (HUDs) of flight data and data captured by the sensors could contribute towards reducing pilot work load allowing him to concentrate on the situation outside the helicopter without compromising on the flight safety.
- Suitable man machine interface should be capable of converting degraded visual environment by day and night into clear images in day light or night.
- Use of night vision equipment requires intensive training.

Night flying over sea can cause disorientation due to the lack of reference points. The medical aspects also get aggravated in case of night flying over sea.Weather vagaries add on to the difficulty. Landings and take offs on the unstable platform with limited recovery and landing aids is difficult. Chances of having an accident by night are definitely higher than during the day and an accident at night is twice as likely to be fatal, as compared to a daytime accident.The way to overcome these is through instrumentation and equipment and training of which instrument flying is particularly important.

Night missions for naval fighter and helicopters involve Air Defence or Strikes, Anti Submarine Warfare (ASW) Dunking and Night SAR. Additional equipment and capabilities are assisting in take offs and landings and undertaking of mission by night. These include Electro Optic and Infrared Sighting systems, NVGs, HUD, automatic flight control, stability augmentation systems,inertial navigation systems and radars in the aircraft. The naval Seaking and ALH helicopters have GEN $2^{++}$ NVGs while trials are being conducted for Gen3 Goggles. Microwave landing system and NVG compatible landing aids on the ship improve safety of night deck operations. All ships are going to be modified with it.

All new acquisitions are equipped with night flying capability catering to NVG Ops. All pilots are being trained in NVG Ops. Some Cheetahs and MI-17s have been modified for NVG operations.Some other older helicopters are not NVG compatible.

## Session IV: COUNTERING THE THREAT

**Chairperson**: Maj Gen KB Kapoor, VSM (Retd), Director, Centre for Joint Warfare Studies.

**Speakers**

(a) **Camouflage and Concealment against Night Vision Capable Platforms** - Brig TPS Rawat VSM**, Army HQ

(b) **The Importance of Catching up with our Adversaries in Night Fighting Capability:** Maj Gen GD Bakshi SM VSM (Retd), Editor, Indian Military Review

(c) **The case for Inexpensive Thermal Analytics - Intrusion Detection:** Mr. InderjeetSehrawat, DVTEL India

Concealment and deception would play an important role in ensuring success of own plans and operations. The aim is to gain the capability to completely hide from the enemy or at least deceive him. There are shortcomings in some aspects of camouflage and concealment measures.The ISCDC (Inter Services Camouflage and Detection Committee) under the ENC that meets once a year has taken a decision to make a camouflage policy.

Technology has reduced the size of sensors while improving their capability in terms ofdetectionranges& image resolution across the entire spectrum of the atmospheric window. Next generation sensors have multi/hyper-spectral data acquisitioncapability. Both active and passive sensors would be employed in future conflicts and effective camouflage would require counter measures across the full electromagnetic spectrum. The available equipment is now gradually shifting towards thermal range and a complete threat analysis would be required for its effective use. Equipment today is 70 percent in the thermal range and only about 20 percent is in the VIS-NIR range and 10% in the Microwave range.

**Infra Red** signature of a target is the quantitative measurement of its apparent IR brightness as function of wavelength. IR signature besides having spatial and spectral details is dynamic and dependent on operating condition of the object and environment parameters.Camouflage and concealment against any infrared sensor depends on the signaturemanagement of the target.

**Countermeasures**

Counter measures against night vision devices in the visible spectrum involves the following:

- Synthetic Camouflage Nets. Different patterns for different terrains.
- Multi Spectral Camouflage Nets. For critical equipment & 'A' vehicles. They help avoid detection from ground based visual, ultraviolet & IR sensors, TI devices and radars. All terrain variants.
- Infrared reflective and multi spectral camouflage paints: These paints match reflectance with the background. It provides protection against photo & active infra red. DRDO has also developed software called Sigma 2 that generates patterns based on the place and environment.
- Low emissive coating. It is thicker than the reflective paints and enables IR/ thermal signature reduction and background matching. They can be applied on mobile, fixed, aerial and naval assets.
- Multi Spectral Personal Camouflage Equipment**.** Sniper suits, ponchos and personal screens provide reasonable protection to soldiers against the naked eye, high resolution binoculars and PNVDs. They are reversible and can be used in two different terrains. They should be fire resistant and water proof and of light weight.
- Mobile Camouflage System. They are tight fitted suits for equipment including tanks and guns and other strategic equipment that is on the move. They protect against visual, NIR, thermal and radar. They are generally fabricated after mapping the radar, thermal and visual signatures of the area where it is to operate.
- Smoke screen is used to camouflage and conceal in the visible and the infra red wave spectrum. They protect against laser guided, TV guided and advanced picture forming IR target seekers.

**Futuristic Trends in Camouflage**

- **Thermal blanket** to screen heat radiation as well as reflect heat away from the tank.
- **Liquid Nitrogen**. Cold liquid nitrogen used to cool payload bay, cockpit, windshields and nose.
- **Nano Technology**. This allows development of polymers that can change colours at the flick of a switch through differing levels of electric current being applied to it.
- **Metamaterials**. Convert a positive reflection into a negative reflection changing the perceived location of the object from the actual location.
- **Light weight Camouflage Systems**. They provide multispectral camouflage equipment that can be easily dismantled.
- **Stealth**. This works by absorbing or reflecting the incoming radiation.
- **Plasma stealth technology**. Protects against radar and thermal detection techniques by generating a plasma cloud around the object consisting of highly charged particles which thereafter deflects UV and thermal radiations coming out of the sensors.
- **Invisible tanks**. A concept that will use adaptive ink sensors to capture image of surrounding areas and thereafter display it on the tanks to make them merge with the background.

The hype that surrounded air power during the First Gulf War based RMA managed to obfuscate a parallel revolution in Night Fighting Capabilities.The T-72 tanks of the Iraqi Republican Guards Divisions that put up a fairly good fight by day, suffered badly by night due to the differential in night fighting capabilities.Most combat in South Asia will take place at night and there is a need to improve the night fighting capabilities of our MBTs.

Programmes are underway to equip 700 Indian tanks with Thermal Imaging Stand Alone Systems (TISAS) and 418 with Thermal Fire Control System(TFCS) at cost of around 230 million dollars. Approximately around 300 Israeli TISAS have so far been installed. On 02 Apr 13, Thermal Imaging Night Sights worth 300 million dollars were cleared by MoD. Under this plan BEL will supply 5000 NVDs, 2000 for T-72 tanks and 1200 for T-90 tanks and 1780 for BMP-1s. 100% Indian Tanks are expected to have NVD devices by 2017.

While the electric LC fence has been able to reduce infiltration substantially, the bulk of the attrition was imposed ahead of the fence by small ambush partiesthat were equipped with Israeli handheld Thermal Imaging devices.

The present capacity of one NVD device per section is insufficient to meet the highly night active conflict of the future.At the current requirement of one NVD per section, the Indian Army will need 30,000 third Gen NVDs for its infantry.MoD is now pushing for 50 percent personnel with NVDs. However, NVDs in service are a generation behind what our adversaries have. They are also power inefficient.Operational staff must prioritize this effort and rework our tactical requirements.On 11 Nov 13, MoD cleared a proposal of Rs 3800 crores for procurement of Image Intensification NVDs for Carbines for Infantry soldiers. The NVDs can generate a tactical revolution in Low Intensity Conflict Operations (CI/CT Operations). We need to invest urgently in Third Gen NVDs - both a mix of passive sights and Thermal Imagers.

**Pakistan** has an Institute of Optronics headed by a Lt Gen that claims to be producing a number of night vision devices that are even being exported. Pakistan has gained from the global war on terror as its Special Forces have been provided American 3$^{rd}$ and 4$^{th}$ generation NVDs.Pakistan Army Aviation has started using helmet mounted night vision goggles. PAF are using NVGs in night flying.

Pakistan has made tremendous strides in using NVGs and is now ahead of us. We have a lot of catching up to do.

**Chinese** night fight capability is their area of strengths as they drill extensively by night.Thermo Goggles are standard gear. They have the advantage of domestic industry contributing to this equipment.

With increased transparency of the battlefield advocacy and training aspects need to be prioritised with more courses being conducted towards awareness.

Command and control systems are prime targets in the modern warfare. They are easy to detect and proliferation of anti radiation missiles (ARMs) make them an easy target. Camouflage and concealment of electronic radiation needs to be taken up as part of the camouflage policy.

Deception measures also need to be developed along with the denial ones. This is especially true for the cyber domain.The ability of using false images and dummies is very critical. Pakistan has invested in a number of UAVs that can masquerade as air strikes.

Perimeter protection is one of the key requirements of any security solution. The 4 D's of perimeter security are: deter, detect, delay and deny. Intelligence Video Systems (IVS) have the capability now, during the day time and at night, to take care of the 4D's. Thermal imaging provides a consistent image 24 hours per day completely independent of lighting conditions. It penetrates smoke and dust and has better performance in adverse weather. They can be seamlessly added to any networked security system. Thermal Cameras with analytics capabilities provide much better detection and response system.

**Valedictory Address: Lt Gen Narendra Singh, AVSM, SM, VSM, Deputy Chief of Army Staff (P&S), IHQ of MoD(Army)**

Keeping in mind the huge requirements of the army and the cost implications, the desire is to focus on indigenisation. The defence forces have put in their maximum effort to ensure that support is provided to the public sector undertakings, the private sector and the DRDO.The earlier scaling of equipment had been low owing to the cost and technological factors. There has been much deliberation on the technological requirements as also the available resources and a roadmap has been prepared for the requirement of the night vision devices. Large inventory of II devices, TI uncooled devices and TI cooled devices are needed by the army. In terms of technology, the army is looking at a FOM of 1700 and that the II tube manufacturing technology should be indigenised. For the TI-based devices, the desired FPA should be 640x512.The target is to ensure that by the next plan, the supplier should be able to guarantee that he will be able to assemble the tubes in India.

We would like to invest in the best of the future technology like foliage penetration etc. and the long term aim is to seek the best technology as well as upgrades for what is being procured today. Orders have already been placed to meet the present scales. The future procurements as per the revised scales are already being processed.

There is a need to expedite the procurement procedure. There has been a focus to make implementable General Staff Qualitative Requirements (GSQRs), rather than ideal GSQRs, so that they don't fail during the trials, which are also being expedited. However, no major procurement is complete without complaints. It is not advised to play around with the established procedures.