Inaugural Session

Welcome Address: Brig (Retd) Gurmeet Kanwal, Director, CLAWS

Military modernisation is an integral part of our country's growth. It involves major upgradation of combat facilities to meet new and emerging challenges. This seminar, held at the Manekshaw Centre in New Delhi from 8-9 March, was an endeavour to discuss various facets of modernisation in the Indian context and also to bring together users, manufacturers and developers on a common platform for fruitful exchange of ideas and progress.

Today, there is a wide gap between China's People's Liberation Army (PLA) and the Indian Army. China's defence budget has consistently been increasing by over 10 per cent per annum in real terms, while India's budget has by and large remained stagnant. Defence procurement in India is also plagued by unseemly delays which could have serious consequences on the nation's preparedness for meeting future challenges. This aspect requires urgent attention.

Keynote Address: Lt Gen JP Singh, PVSM, AVSM, DCOAS (P&S)

The armed forces are a vital component both for the nation's security paradigm as also for unhindered socio-economic development. The country is secured through deterrence and if that fails, by decisive victory through the application of the military in a joint services environment. Future wars can be visualised as hybrid and the forces need to be optimally equipped for the same.

Our strategic policy guidelines at the political level and planning at the three services level remains focused and stabilised. The political sanction for modernisation projects is readily forthcoming and is not a source of concern. Over the next 10-15 years, the modernisation drive for the armed forces will be to the order of $130-150 billion. There perforce will be many challenges along the way and these will have to be overcome. The process of military modernisation involves core technology and denial regimes therefore are an inhibiting factor. In order to minimise vulnerabilities, one needs to focus on development of domestic military industry with high technology content. For this, a number of agencies need to come together which includes the DRDO, R&D of DPSUs and R&D of private defence industries and academia. We need to find answers to core technology issues to include technology infusion and technology absorption.

Thrust areas we are looking at are:

- The Capability to See. Ability to look deep into our strategic, operational and tactical space.
- The Capability to Share.
- The Capability to Protect.
- The Capability to Strike.
- The Capability to Move.

In current times, a great deal of stress is being laid on all aspects of Information Warfare. This will remain a defining feature of the modernisation process.

Some observers have commented that we are arming without aiming. It is all right if our enemies retain that illusion but our own people should be rest assured that the entire procurement process for modernising the armed forces has a specific purpose and aim. The equipment will take time to induct, but upgradation will remain a continuous process. We are also focusing on improved munitions for greater effect as also for minimising collateral damage. Other areas of focus are in the fields of mobility, engineering, aviation where we are introducing attack helicopters and tactical lift aircrafts.

Another important area of modernisation is the sustenance of these equipments. One has to maintain and upgrade what comes today, because it will stay with the forces for the next three decades.

In conclusion, I would like to say that the quest for modernisation is important also for the sector of science, technology and manufacturers base which exists and can be of essential help. Joint ventures can change the face of military modernisation. The defence policy needs to be understood with patience. Even if the private industries are currently missing as frontrunners, they will be the main back-end vendors and opportunities will increase as we grow. Rest assured, the volume of modernisation is so large that no one will miss out.

Session I

Conceptual Aspects of Military Modernisation

Chairperson: Gen Deepak Kapoor, PVSM, AVSM, VSM, SM (Retd), former COAS

Speakers

- **Brig Gurmeet Kanwal, Director CLAWS.**
- **Lt Gen CKS Sabu, former GOC-in-C South Western Command.**
- **Maj Gen Sheru Thapliyal, SM (Retd), former GOC 3 Inf Div.**
- **Mr Don Ducey, Global Director, Public Sector & Strategic Initiatives, SAS Institute.**

Gen Deepak Kapoor, PVSM, AVSM, VSM, SM (Retd)

There's no gainsaying the fact that if the country is to continue to grow approximately 9 per cent per annum, it needs a secure, stable environment. And one of the major factors

in ensuring that kind of an environment is to have a military with the capabilities to be able to ward off any security challenge that the country may face. And the country does have a number of challenges to worry about.

For it to be up to the task, the military requires modernisation. Invariably, it is an ongoing process, with the aggregation of the military's resources comprising 30 per cent state-of-the-art, 40 per cent current generation equipment, and 30 per cent equipment heading towards obsolescence. If that be so, it is a continuing process. Therefore, it implies that there is a requirement to continually provide the kind of budgetary support required for the country to have a modernised military. That is where one of the major issues underlie, i.e. whether the levels of budgetary support, if in the region of 2 per cent or 2.3 per cent of GDP, is adequate for military modernisation. The 2011 military budget is 1.83 per cent of the GDP, which is perhaps on the lower side, when one compares the kind of funding for the defence budget provided for India's neighbours by their governments; for instance, China is officially spending $91.5 billion on their military this year, which is an increase of 12 per cent over last year's budget. But this is only the official figure. Unofficially, it could well be in the region of $200 billion. Likewise, in Pakistan, since the military calls the shots there, whatever be the declared official budget, can be only be subject to increase, whether in the form of the West's aid, or support to fight terrorism, or usage of internal resources. When compared with the Indian budget of about $36 billion equivalent, there is a tremendous amount of difference

Another aspect which impinges on modernisation, as has been alluded to previously, is the general targets for the modernisation process not being met. There is a need to look at the systematic factors behind it, wherein certain procedures may have to be changed.

And finally, if India is emerging as a major country on the global arena, it surely has the capabilities to produce and meet the needs for modernising the military, not only on the civil side, but on the military side as well.

Brig Gurmeet Kanwal (Retd) – Emerging Threats and Challenges and the Future Battlefield Milieu

We are living in the second most unstable region in the world after West Asia. Regional instability is caused by the Taliban-Al Qaeda inspired insurgency-terrorism, religious fundamentalism, ethnic tensions, socio-economic disparities and political instability. The unstable regional security environment witnesses the collusive nuclear weapons-cum-missile development programmme of China and Pakistan, strident march of Islamist fundamentalism and majority backlash (e.g. Iraq), Pakistan's Islamisation and gradual slide towards becoming a 'failed state', Afghanistan's endless civil war, Taliban's continued terrorism and Pakistan's interference. There is a diabolical nexus between narcotics trafficking and terrorism and the near civil war in Afghanistan is the single greatest cause of regional instability. The after-effect of Sri Lanka's prolonged involvement in the LTTE insurgency, Bangladesh's emergence as a parallel hub of Islamist extremism and struggle for economic upliftment, the Myanmar people's nascent movement for democracy, Tibetan people's growing disillusionment with Chinese

occupation, the Central Asian republics in transition and proliferation of small arms have only added to India's threat concerns.

The unresolved territorial and boundary dispute with China remains a cause of concern and could result in conflict. Also, the China-Pakistan nuclear, missile and military hardware nexus is a threat-in-being. The long term threat coming from China is that it is gradually enlarging its sphere of influence towards South-east Asia and the Bay of Bengal. China is engaged in the strategic encirclement and containment of India—a potential source of competition and conflict.

A nuclear-capable Pakistan remains India's major military threat in the immediate future. The stated aim of the Pakistan Army is

- To wrest Kashmir from India through proxy war and political, diplomatic offensive.
- To contain India in collusion with China.
- To prevent India from emerging as a southern Asian power.
- To destabilise and weaken India internally.

In order to offset conventional asymmetry, the Pakistan army is likely to continue acts of terrorism within India. It is also likely to employ the ISI to spawn the *madrassa* culture and create a communal/sectarian divide. The Pakistan army has a stranglehold over the nation's polity. It dictates the country's Kashmir and nuclear policies and will decide whether the present peace process will be allowed to go forward. Therefore, the real threat to peace and stability between India and Pakistan is the Pakistan army.

The future battlefield environment is likely to witness short and intense conflicts with continuous operations by day and night, an increasingly transparent non-linear battlefield with simultaneity of engagements and operations in depth due to availability of long range weapons. Operations in a nuclear back-drop necessitate the requirement to fight dispersed while retaining the ability to concentrate at point of decision with swift, mobile/mechanised operations in plains, supported by massive attack helicopter strikes and hi-tech weapons and programmemes adding in as force multipliers.

Besides, the internal security environment also remains a serious cause of concern. There is continuing militancy/insurgency in Kashmir and the North-eastern states; rising Maoist/Naxal influence across central India with possible linkages with Nepal; urban terrorism coupled with the ISI/Pakistan's terrorist groups continuing to exploit internal faultlines.

The emerging security challenges for India include proliferation of small arms, increasing demand for energy, depletion in water sources, info/cyber warfare, the grossly neglected maritime security, mass migrations from neighbouring countries, environmental security issues which are gaining prominence, and the security concerns of Indian diaspora.

The future conventional conflict is likely to spin out of unresolved territorial and boundary disputes. In conventional conflict in the plains, large-scale manoeuvre will not be possible in the prevailing nuclear environment; nor will the political leadership permit

deep thrusts into Pakistan. Hence, mechanised operations in the plains will be a synergistic combination of light combat echelons, PGM-based air and ground firepower, C4I2SR and cyber/information warfare. The primary requirement is that of self-contained, small-sized, highly mobile forces to deliver a decisive punch quickly and with devastating results. Overwhelming firepower supremacy shall generate maximum combat asymmetry in the land battle. Also, there is a need to upgrade the strategy of dissuasion against China to deterrence.

Lt Gen CKS Sabu, PVSM, AVSM, VSM (Retd) – Conceptual Aspects of Military Modernisation

The factors affecting force modernisation include strategic direction and vision of a nation's political leadership, the geo-political and geo-strategic environment, threat perceptions, economic standing, defence industrial base and technological constraints.

The Indian army is undergoing its fourth transformation. The new doctrine mandates that the army must transform itself into a central combat force. There is a need to modernise current generation of weapons, invest in next generation technology of weapons and develop totally new and revolutionary technologies. The guidelines for modernising should encompass integration of the three Services, balancing short-term and long-term requirements, efforts towards focusing on war fighting, securing a competitive advantage over potential adversaries, balancing capabilities with efficiency and responding to a strategically changing security environment.

The strategic objectives ahead for the Army include maintaining near and long-term conventional/non-conventional military superiority vis-a-vis Pakistan, deterring near/long-term aggression by China by acquiring credible deterrence and combat effectiveness, catering for more than one front requirement and maintaining a stable internal security environment. However, the critical areas for future modernisation include, battlefield transparency, battlefield management systems, night-fighting capability; enhanced firepower including terminally guided munitions, integrated manoeuvre capability to include SP artillery, quick reaction surface-to-air missiles and AAD guns; latest assault engineer equipment, tactical control system, network centricity; logistics space, improvement of infrastructure in border areas, especially in the Northeast; focus on human development to harness technology at the cutting edge level as also to operate and maintain state of art equipment and platforms; and finally, wherewithal to fight, munitions and other requirements.

Years of neglect has only attributed to this state. India currently is dealing with an ageing force whose primary drawback includes equipment that was designed decades ago for different set of operational doctrines that simply cannot fulfill the requirements of a modern military force in an ever-changing, technologically advancing world faced with multiple threats. Additionally, old equipment costs more to maintain, is less efficient, requires more personnel to operate, is more expensive to transport and breaks down more often and lacks adequate engineering support to sustain exploitation.

The army needs to mandate developing its military capabilities to support its military doctrine implying the following three for future purposes of military strategy:

- Numerical strength and preponderance because greater the numerical strength, wider is the relative capability

- State-of-the-art weapon technology

- Force employment philosophy and capability i.e., operational readiness of force or preparedness

In this reference, three distinct military strategies need to be kept in mind—here and now, the near future and finally, strategy for the distant future. However, current trends of fiscal planning and defence budget do not provide for a clear picture as far as military modernisation is concerned. Transparency and accountability is another looming impediment. There is an urgent need for defence industrialisation and self-reliance in defence systems. Technology would be a force that would steer India through a spectrum of conflict.

Gen Deepak Kapoor, PVSM, AVSM, SM, VSM (Retd)

There's no gainsaying the fact that if the country is to continue to grow approximately 9 per cent per annum, it needs a secure, stable environment. And one of the major factors in ensuring that kind of an environment is to have a military with the capabilities to be able to ward off any challenges that the country may face. And the country does have a large number of challenges to worry about.

For it to be up to the task, the military requires modernisation. Invaraibly, it is an ongoing process, with the aggregation of the military's resources comprising 30 per cent state-of-the-art, 40 per cent current generation equipment, and 30 per cent equipment heading towards obsolescence. If that be so, it is a continuing process. Therefore, it implies that there is a requirement to continually provide the kind of budgetary support required for the country to have a modernised military and that is where one of the major issues underlie, i.e. whether the levels of budgetary support, if in the region of 2 per cent or 2.3 per cent of GDP, is adequate for military modernisation. The 2011 military budget is 1.83 per cent of the GDP, which is perhaps on the lower side, when one compares the kind of funding for the defence budget provided for India's neighbours by their governments; for instance, China is officially spending $91.5 billion on their military this year, which is an increase of 12 per cent over last year's budget. But this is only the official figure. Unofficially, it could well be in the region of $200 billion. Likewise, in Pakistan, since the military calls the shots there, whatever be the declared official budget, can only be subject to increase, whether in the form of the West's aid, or support to fight terrorism, or usage of internal resources. When compared with the Indian budget of about $36 billion equivalent, there is a tremendous amount of difference

Another aspect which impinges on modernisation, as has been alluded to previously, is that the general time targets for the modernisation process are not being met. There is a need to look at the systematic factors behind it, wherein certain procedures may have to be changed.

And finally, if India is emerging as a major country on the global arena, it surely has the capabilities to produce and meet the needs for modernising the military, not only on the civil side, but on the military side as well.

Discussion

Owing primarily to terrain constraints, the classical mechanised warfare pattern does not seem feasible in the future battlefield. Future wars are likely to be limited to the mountains without further escalation. Even though state-of-the-art technology is the need of the hour, induction and budgetary constraints are key impediments. There is a need for continuity in modernisation plans including acquisitions. Modernisation of India's artillery is lagging behind by nearly a decade. Army should not be brought into the task of usage of non-lethal weapons, which ideally should remain with the police forces.

Future Force Structures in Indian Context

Maj Gen Sheru Thapliyal, SM (Retd)

In the sub-continental context, terrorism is going to be one of the inescapable evils. Internal fissures are going to be very crucial. A two-front war scenario is very likely, compounded by the Chinese strategic encirclement in Asia, and its 'string of pearls' strategy. In addition, the nuclear overhang is omnipresent in South Asia, a major restraining factor for operations which may need to be conducted in future.

Before one starts evolving a force structure, terrain imperatives have to be considered in the Indian context:

1. The entire border with China is in the mountains, as is the LoC with Pakistan. Therefore, the deduction is that any future conflict is likely to be fought in the mountains.

2. Built-up areas are increasing in the western sector, wherein the erstwhile desert region is almost becoming urbanised.

3. Mechanised operations, in the classical sense, are unlikely to be undertaken at the scale at which they are currently envisaged, because of the stated reasons.

4. In terms of the Revolution in Military Affairs, the two Gulf wars and the operations in Kosovo dazzled many people in South Asia, because coalition forces deployed an array of impressive weapons, leading everyone to talk about the effect of RMA in India. But for it to be effective, it has to be modified to the Indian context. War is going to be on land, it is going to be limited and in the mountains/high altitude areas. Resultantly, it is going to be a low-tech war. Modernisation should not distract people if it doesn't make for a suitable fit. Prudence is a must.

5. The navy will be the key element in any future force structure.

6. There needs to be a well-thought man-machine mix, in terms of military modernisation. One may have state-of-the-art weaponry, but that is only effective if implemented or used by the right person (with the commensurate education, training, and mental capabilities).

7. Technological transfer is a must to move forward in modernisation. Else, one may be stuck with importing 80 per cent of one's requirements.

The nuclear overhang is the biggest concern in India. It is the only country with two nuclear powers as bordering countries, which changes the traditional options of employment of forces. The Chinese may well not employ nuclear weapons against India, but faced with destruction, the Pakistanis may well do so, especially since Pakistan has tactical nuclear weapons in its nuclear doctrine.

Strategic analysis in the nuclear dimension seems to be stuck in theories of assured mutual destruction and massive retaliation, which while acceptable in the theoretical dimension, are inadequate in practice.

We have no idea how to deal with a nuclear-armed Pakistan. All ideas from composite dialogue to economic engagement are bandied about. But the fact remains that a nuclear-armed Pakistan has reduced us to near despair, severely limiting our options, with a direct bearing on our force structure.

In terms of envisaged roles for the armed forces:

Army

- Be prepared for a wide spectrum of conflict, from low intensity operations to conventional operations.
- Be prepared for out of area contingencies, along with navy and air force.
- Control ground-based missiles and be a part of the nuclear triad.

Navy

- Surveillance operations in Western and Eastern seaboards.
- Safeguard Exclusive Economic Zone and sea lanes of communications.
- Assist in out of area operations.
- Choke off adversary shipping and movement to and from his ports.
- Be part of the nuclear triad.

Air Force

- Assist in ground operations.
- Assist army and navy in out of area operations.
- Control operations in space.

- Be part of the nuclear triad.

In terms of future force structures:

- Navy will be the most important service of the future. It must be rapidly modernised. Nuclear submarines will be the key.
- Air force should have the capability to dominate space, especially in the context of Chinese capabilities.
- Army needs to reduce its mechanised component and develop greater capability to fight in the mountains, including undertaking offensive operations in Tibet and PoK.
- Armed forces need to be fully integrated into India's nuclear scheme of things and not be a clueless by-stander as at present.
- Armed forces must be prepared by way of doctrine, organisations, capability, equipment, logistics and training to fight a wide spectrum of conflict from low intensity to a nuclear war.

Analytics in Support of Defence Modernisation: Mr Don Ducey

As a commander, when one looks out across an environment of operations and battles to be faced, the thing one is looking for is actionable intelligence, to help understand what the enemy looked like, how to face it, and courses of actions.

A commander would need to analyse information, patrol reports, intercepts of triangulations of radio signals, information from various sources and units, and bring it together, and try to get as complete a picture as possible – especially to figure out where one's logistics trains are and try to see how they could be brought to bear for the battles one might face. It is the responsibility of decision-makers and leaders to leverage this data and make it useful, to make up for challenges in terms of force structure and budget constraints. In that context, logisticians are very important, and have been so throughout the history of the army.

The importance of analytics lies in its application of technologies, for effective utilisation across the spectrum of affairs. For instance, Honda was able to reduce 50 per cent of its inventory supplies at its service stations and yet maintain 99 per cent of effectiveness through analytics. In the same way, army units can reduce the amount of spares they carry and continue to maintain effectiveness, thereby rendering budget leeway for strategic decision-making.

In defence modernisation, in the process of getting better equipment and weapons to perform a mission, systemic reforms are also required in terms of procurement, tactics, strategy, resupply and intelligence – all of these factors need to be modernised for India to be an effective force in a tough neighbourhood.

SAS has been able to work with the US DoD, in certain modernisation matters, which may have implications for India as well:

- The US Marine Corps wanted to figure out how to give the commander better battlefield control of logistics. SAS modernised their battlefield logistics doctrine, to increase the ability of the commander to understand and support his logistics posture, to support his tactical intent.

- Command forecasting and optimisation for US Coast Guard: Improved shipward maintenance management system, spares optimisation, improved inventory optimisation, assumptions of and planning for demands. This same optimisation strategy was also applied on 123 ft cutters, removing 70 tons of excess equipment, leading to increased steaming speed, reduced stress on engines, and space that could be dedicated to more important materials.
- Condition-based maintenance: Based on experience and assumptions, test out the reliability of materials, contrasting with recommended replacement times and actual requirements.
- Out of the first Gulf War, the US Army learned that not all equipment damaged or rendered redundant can be left behind. They learned about how one has to bring equipment back, put into a recapitalisation programmme, to save money and resources.

Shaping the battlefield, allowing for across the board exposure to data, and greater insight into data available as a result of surveillance, reconnaissance, UAVs, is something that analytics has a role in, which can make a difference in the way commanders lead, and operators implement their roles.

Discussion

Despite progress, more improvement in procurement and licensing process needs to be worked on, especially in light of the demand that the country's requirement should be met with 70 per cent indigenous equipment.

In terms of modernising the current inventory, investing in next generation weaponry and developing new revolutionary technology, the ratio needs to be re-thought, for currently, DRDO is spending only 10 per cent on developing new revolutionary technology.

- There should be a bottom-up approach to modernisation – the demands and requests must come from the soldiers.
- There is a need to encourage continuity, both in terms of the DRDO maintaining the employment/assignment of individuals to the procurement process, but also Army HQs assignment of personnel to the procurement and acquisition cycles
- The Army should be catering for a mix of response towards the mountains and plains Traditional mechanised ops won't be possible, so shouldn't be stressed on. The mix should be 1/3 plains, 2/3 mountains.
- The modernisation of the Indian artillery has been lagging behind for more than a decade. The last gun acquired was in 1986. Current plans to acquire the ultra-light howitzer should see some progress.
- While greater weightage can be given to mountains, the army must continue to pay attention to the entire spectrum of conflict. All the strike corps will still be required for deterrence purposes.

- While India is concerned about China encircling it, China is worried about the opposite effect, in terms of India's growing relationships with Russia, US, UK, and Europe.
- Naval modernisation is not only important, it should be carried out on priority, because it is the most cost-effective.
- Modernisation of the Ministry of Defence is paramount, which should be exemplified with the creation of the CDS.
- It is the irrationality of a rational player (i.e. Pakistan) which leads India to be paranoid about the actions it can take in the regional neighbourhood. However, it must not allow its neighbour to overwhelm its planning procedures.
- One must also focus on modernisation of military infrastructure. The air force and navy are more aware of this aspect than the army. It is capital intensive and has a long gestation period, close to two decades. If one has to fight in areas perceived to be under threat, massive amounts of resources must be brought to bear in terms of infrastructure.

Session II

Modernisation for Conventional Conflict

Chairperson: Lt Gen VK Kapoor, PVSM (Retd), Editor, SPs Land Forces.

Speakers

- **Lt Cdr Piyush Baranwal, Faculty of ECE, Indian Naval Academy**
- **Mr David John Jarret, Director, Business Development, General Dynamics, UK**
- **Dr Hans-Peter Hoffman, Chief Systems methodologist, IBM**

Chairperson – Lt Gen V K Kapoor, PVSM (Retd)

India faces a variety of security challenges. It has its traditional adversaries along its western and northern border. Apart from these, there are a number of internal challenges. Thus, in the future, the military will be deployed in a discriminate manner. Also, it will be employed selectively. If that be the case, we can focus on certain areas which require modernisation. The army being a human intensive organisation, we can find places where to induct more technology and where to induct more manpower. Modernisation is required because without it we will not be able to compel or coerce our adversaries to do what you want it to do. The modernisation focus of the Army in the 11th Plan was outlined by the Vice Chief of the Army Staff at a seminar in 2010. It focussed on the areas of precision firepower, air defence, aviation, F-INSAS, infrastructure development, battlefield awareness, ISR and night vision.

WiFi-WiMAX Technologies from 'Invention to Innovation' for Enhancing Operational Effectiveness of Field Units – Lt Cdr Piyush Baranwal

A battalion of the Army today needs a Tactical Field Wireless System (TFWS). This will take wireless connectivity down to the foot soldier at the platoon level. The TFWS will have hundreds of moving clients. The qualitative requirements of such a system are:

- To provide robust and reliable communication with Bandwidth and Quality of Service (QoS) guarantees to support Voice, Video and data service.

- To have low LPI and good ECCM features.

- Usage of COTS/MOTS technology.

- Good broadband characteristics and access/ transport performance.

- Have additional features like full user mobility, rapid deployment and Fault Tolerant System.

The first technological logic related to soldiers at field level is the WiFi network or the IEEE 802.11.

Some basic definitions:

BSS: (Basic Service Set). The basic building block of a network. It consists of a group of two or more stations.

BSA: Communication takes place within a fuzzy area called Basic Service Area, defined by the propagation characteristics of the wireless medium. It is just the area (or volume) within which communication can take place between the stations.

The two types of 802.11 networks are:

- Infrastructure. These are structured networks having multiple layers.

- Ad hoc. Known as Independent BSS (IBSS). STAs communicate directly with each other across a single hop. 802.11s broadcast/multicast over multi-hop networks (Mesh networks)

Application of WiFi networks:

- Lower tier i.e. intra platoon communication will use Wi-Fi/802.11e for communication.

- 802.11e/Hybrid Coordination Function (HCF) is a queue based service differentiation scheme proposed by IEEE 802.11e working group.

- QoS support is provided by introduction of Access Categories (AC) and multiple independent back off entities.

- 802.11e enabled products are available in market.

QoS in 802.11

- QoS is the ability of a network element to provide some level of assurance for consistent network data delivery.

- Parameterised QoS is a strict QoS requirement that is expressed in terms of quantitative values such as data rate, delay bound and jitter bound.

- Prioritised QoS is expressed in terms of relative delivery.

IEEE 802.16 - WiMAX

- Published April 1st 2003.

- Called Wireless MAN.

- Original IEEE 802.16 specifies only point to multipoint functionality – great for gateway links.

- The extensions specifies user-user links using:

    - Either centralised schedules, or

    - Distributed schedules.

- Supports bandwidth of up to 100 Mbps.

Proposed Architectures

The proposed architectures for networking a battalion are

- Mobile Ad hoc network.

It has following characteristics:

- Flat Network Topology.

- Wireless technology used are IEEE 802.11 family.

- Routing protocols used are OLSR, AODV and DSR.

- Nodes if not in communication distance use multiple hops to reach destination.

- Nodes alternate roles as source/ destinations and routers.

- Problems encountered are low throughput and no QoS guarantees.

- Two tier WiFi Mesh.

It has the following characteristics:-

- A hierarchial Network Topology using Wi-Fi at both Upper and Lower tiers.

- Each platoon has one or two clusterhead/ gateway.

- The clusterhead has dual radio with 802.11g interface for intra-platoon communication and 802.11a interface for inter-platoon communication.

- Intra-platoon communication uses single hop while inter-platoon communication is achieved by multihops.

- Two Tier Wi-Fi WiMAX Network.

It has the following characteristics:

- Hierarchal Network Topology.

- Wireless Technology used is IEEE 802.16, 802.11, 802.11e and 802.11n.

- Upper Tier uses WiMAX as backhaul.

- Lower Tier uses 802.11e for communication.

- Uses a specifically designed hybrid QoS enabled AP

Hybrid QoS Enabled Access Point

- A Hybrid Access Point functions as a Subscriber Station (SS) to WiMAX Network and as a QoS enabled WiFi Access Point to WiFi nodes.

- It uses QoS mapping table for converting packets from WiFi to WiMAX and vice versa.

- Improved performance observed with QoS mapping.

Conclusion

- For intra-platoon communication performance of 802.11e has been found to be optimum.

- For a large battalion deployment a two-tier network becomes imperative because of scalability issues.

- A two tier hierarchial network with QoS mapping between HCF and WiMAX provides better performance then without QoS mapping.

- In case of failure of two tier Wi-Fi WiMAX network, roll back to two tier Wi-Fi or *ad hoc* network depending on the deployment configuration.

Discussion

On being asked how this system can be guarded against jamming and e-surveillance, the speaker said that WiFi WiMax has modes which can counter jamming. Next, at battalion level, transmission can be done only in one direction, that of the receiver, rather than an omni-directional one thus making it very difficult to intercept. In answer to the question that traditionally the Army has been ahead of civilians as regards to induction of new technologies, but why it has been lagging behind in the field of communication, the speaker said that this was because today this technology is available off the shelf which was not the case earlier. Two more points were brought out; Army has already floated an RFP for tactical communication system at the field/ battalion level and that where net centricity is involved it calls for a flatter organisation. The capability that we get from net centricity should be used to cut costs, to make the organisation flatter and make communication faster and more effective.

Mr David John Jarret: Network Centric Transformation – UK Experience

The goal of network enabled capability is to link sensors, decision-makers and weapon systems so that information can be translated into synchronised and overwhelming military effect at optimum tempo. After a tedious process of ten years, networks are in place in UK and they effectively interact with each other. Owing to network centric transformation in UK, the interconnectivity has drastically improved and it has facilitated speedy decision. The effect of the same was felt during operations of UK forces in Iraq and Afghanistan. The lessons learned from the UK experience are as under:

- Network centric transformation has thrown a message that a cohesive and multi pronged support from major players in the process is required to achieve the desired results. The network centric transformation has brought about radical changes in the communication for the Army. Number of institutions has also been raised in UK to make network centric transformation more successful.Army conducted extensive training to regularly update their knowledge which contributed to effective and timely implementation of the programmeme. In the process, command and control software has also been developed. Also, the adoption of network centric transformation was 'command led' in UK Army wherein top brass of the Army adopted the change willingly hence laying a path for early adoption of system down the channel. For field support, it is equally important for a system to be successfully implemented. We have to keep in mind various systems and procedures in vogue in a particular country before adopting network centric structure. For instance, procurement procedures in UK are more open due to which it generates more competition, which may not be the case with India.
- Technology is an enabler but also creates problems since it is vulnerable to rapid obsolescence. We have to be very quick in adopting a technology since it advances at a faster rate than we can adopt. Emerging new visions of the technology adopted by us are possible hence; our adoption process has to be real quick and dynamic. The above fact assumes greater importance in defence procurement since their procedures are tedious and time consuming.
- Network Enabled Capability (NEC) is not a traditional 'capital asset' which is actually kept for long time. Unlike tanks and other weapons which have a long

life, NEC has a short life since it has to be regularly updated. New needs are identified from technology, changing nature of operations. New needs are also identified from new adjacent systems and recent experiences of the country in adopting a system like NEC.

- Another important lesson is the need for pragmatism in technology adoption. Good planning is good but is not sufficient. We are required to make a cautious decision while deciding the amount of information which can be shared without compromising on security. We also have to pragmatically strike a balance between ergonomics and functionality. Another decision necessitating pragmatic approach is the choice between time vs elegance and cost as both of them are interrelated. We have to take a calculative risk so that the project does not get unduly delayed or exceeds its financial limits. It is imperative that any country which wants to emulate UK model of network centric transformation has to carefully analyse the prevailing atmosphere in that country and apply necessary correction to make it more practical.

Dr Hans-Peter Hoffmann: Best Practices for Model Based Systems Engineering.

Delivering complex system requires the development of optimal design on time, within budget and with the right level of quality. But even the best detailed design cannot compensate for poor system architecture. System engineering is not just a technical activity in the life cycle – it determines the commercial viability of the entire project. The state of the art answer to these challenges is Model–based System Engineering. Using the UML/SysML as modelling language, these practices support the elaboration and verification/validation of system requirements as well as the design synthesis through model execution.

The Harmony process consists of two closely coupled sub-processes:-

- Harmony for System Engineering
- Harmony for Embedded Real Time Development

System engineering should always be seen in the context of the overall system development lifecycle. The system engineering workflow is iterative with incremental cycles through the phases requirements analysis, system functional analysis and design synthesis. The increments are use case based.

Key objectives of the model based system engineering process are:

- Identification and derivation of required system functionality
- Identification of associated system states and operational modes
- Allocation of required system functionality to a system architecture, taking into account non-functional aspects of the requirement.

Using the formal notation of the UML/Sys ML, Harmony for System engineering enables systems engineers to verify the completeness and correctness of both system requirements and the chosen architecture through model execution. In addition, by using the UML/Sys ML as paradigm independent modeling language, Harmony for

Systems Engineering enables a seamless transition from function driven system engineering to objective – oriented software development.

It is imperative that as manufacturer we have to understand the customer's requirement in the early stage of system development process to avoid re-working on the project which would be counterproductive. The system engineering should be applied in a holistic manner to derive the maximum benefits from this technique.

Session 3

Modernisation for Sub-conventional Conflict

Chairperson: Dr K Sekhar, CC, R&D (MS&LIC), DRDO

Speakers

- **Maj Gen Dhruv C Katoch, SM, VSM (Retd), Additional Director CLAWS.**

- **Mr Bradley S Barnard, Raytheon International Business and Strategy Land Combat Product Line and Missile Systems.**

- **Cdr Arun Kumar Nijhawan (Retd), Business Development Manager, Tyco Electronics Corp India (P) Ltd.**

- **Dr Vinay G Vaidya, Chief Technology Officer and Vice President, KPIT Cummins Info systems Ltd.**

Chairpersons Remarks: Dr K Sekhar

Slowly and decisively, the theatre of war is drifting towards sub-conventional conflict the world over. There are no rules of engagement for the terrorists who have their own style of operations. They use technology in an innovative manner. At times, the technology used though simple may be very difficult to detect. That challenge is required to be met at all costs. There is no technology today to detect explosives buried six feet deep or to detect a pair of cables protruding from an IED in a dense jungle terrain; a common technique being adopted by Naxals. The DRDO has takenup the challenge to focus on such aspect so as to assist security forces in their efforts.

Maj Gen Dhruv C Katoch, SM, VSM (Retd): Infantry Weapon Systems

A look at the emerging character of conflict around the world indicates that conventional conflict is increasingly giving way to sub-conventional conflict. In the Indian context, the probability of conventional conflict occurring as of now is low. On the other hand, the security forces have been engaged in sub conventional conflict since the sixties and continue to be so engaged in Jammu & Kashmir, parts of North-east India and in parts of the country afflicted with Naxal violence. India's security mechanism however remains a function of conventional threat matrix primarily due to unsettled borders which India has with China and Pakistan. This could lead to conflict for which India has to be prepared. Consequently, the sub-conventional security dynamics is yet to attain the

political, strategic, economic and technological impetus, to the extent that it deserves. A view of the borders over which conflict could erupt is instructive.

The weapon systems which we procure must primarily be focused on conventional conflict and be used for sub-conventional conflict when required – and not the other way around. India is currently engaged in sub-conventional conflict in various parts of the country. We have terrorism in J&K, low intensity conflict in parts of North-east India, Left Wing Extremism in parts of the country and isolated cases of terrorist actions in the hinterland.

Terrorists and insurgents are generally armed with automatic weapons and have good communication systems. As part of tactics, they operate in dispersed groups and rely largely on IEDs to inflict damage. They also resort to stand off attacks, raids and ambushes of security forces but prefer to avoid direct contact. Non-traditional battlefields now also includes space, cyber space, media and information warfare. We can say that asymmetric and dispersed warfare therefore is becoming the modern terrorists answer to the conventional might of the state. The need to modernise our forces to take on this threat therefore cannot be overstated. Some essentials for modernisation are:

- While preparing for conventional conflict, have the ability to undertake sub-conventional operations.
- Battlefield transparency assumes criticality for operations across the spectrum of conflict.
- Consistency in performance in all weather, all terrain, all visibility conditions.
- Cost Effectiveness.
- Need to be light – foot mobility.

While modernising the force, a look at present capabilities would indicate areas requiring additional emphasis. The relative combat power of the Armed Forces, as compared to the insurgents / adversaries, purely in weapon terms, is satisfactory. The 'capability inadequacy' is accordingly relatively low. With respect to communications, the army again has good capability. However, when compared to contemporary advances in communication technologies in the civil sector, there appears to be enhanced scope for improvement in the communication field. The essential inadequacy appears to lie in the domain of situational awareness encompassing the entire range of battlefield transparency devices, the sensors and reconnaissance means, the intelligence gathering apparatus, the means to transmit, store, process and make available information and data to combatants, in real timeframe. The ongoing revolution in information technology offers immense scope for enhancing situational awareness in the Army. Scope for improvement also exists in the adequacy of protection provided by individual protective gear and the existing counter IED capability.

Some of the capabilities which we would require enhanced are:

- Currently we are using the 5.56 mm INSAS rifle which is adequate for conventional operations. The essential requirement in CI operations is of a lightweight, user-friendly weapon with a very high level of assured operation in all

visualised battle contingencies in the Indian context such as the Russian Kalashnikov rifles, the German Heckler & Koch Rifles, the US M-16 Series of weapons and the SAR 21. A rifle on the above lines could be developed indigenously with state of the art sighting system and having an integral under barrel grenade launcher.

- We need to consider inducting Uzi type Machine pistol and Heckler & Koch MP5 type carbine as replacement of 9 mm pistol Browning and 9 mm Carbine.

- Replacement of WW II No 36 Grenade with modern and reliable grenades (where the fuse well is hermetically sealed and does not deteriorate.)

- Stun Grenades would be required to cater for escalation of urban terrorism and especially for hostage rescue situations.

- Thermobaric weapons need to be exploited for their psychological impact. A fail-safe, reusable Flame Thrower with a range in excess of 25 m is needed.

- Improvement in capability of night vision devices, especially in terms of the power source.

- The need for an effective and user-friendly counter IED technology is paramount in the conduct of successful counter insurgency operations. Robotics could play a major role in the same.

- Exoskeletons can improve the weight carrying capability and agility/endurance of the individual soldier.

- Unmanned Aerial Vehicles (UAVs) have the potential to transform the battle space, both in the conventional and the sub – conventional domain. The vast potential mandates further exploitation and indigenous development of the technology. We need to have Predator class Armed UAVs at the Corps level and above, Heron/Searcher/Nishant class UAVs with updated sensor package at Divisional/Brigade level, Hand-launched UAVs with updated sensor package at Battalion level and Micro Aerial Vehicles (MAVs) with updated sensor package (200-300gm, 1 hour endurance class) at the Company level.

- There is a need to graduate to *cellular technology*, which is small, fail proof and user friendly. 3G Cellular Technology has numerous advantages and is likely to *contribute significantly to situational awareness in the sub-conventional domain* in addition to the communication requirements in the entire span of conflict situations. CellularTowers could be based on wheels (Cells-On-Wheels – COW) or on light trucks (Cells-On-Light-Trucks – COLT)

- GIS has emerged as a powerful tool having potential to organise complex spatial environment with tabular relationships. Integration of GPS and GIS technologies has vast potential in the realms of '*situational awareness'*. By suitably juxtapositioning the GIS, GPS, communication means, sensors and other related devices, a holistic picture of own and adversary can be created thereby enhancing situational awareness significantly.

- Lightweight body armour (with protection in the upper chest and neck regions) not exceeding 5 kgs and capable to defeat penetration of AK-47 bullet from a range of 10-15 m. This could be in a modular format to suit every mission profile.

Mr Brad Barnard: Excalibur Overview

Excalibur Description: It is basically a Swedish and US international cooperation programmeme under taken by Raytheon Missile Systems. It is a GPS Guided, Extended-Range 155mm Artillery Projectile to be used in conventional as well non conventional operations to complement the existing conventional projectiles. It has a precision & accuracy rate of within 10 metres. It minimises the collateral damage and risk to civilian causalities. It offers employment flexibility in Close Support Missions and achieves target effects with fewer rounds when compared to conventional ammunition. Its Steep Terminal Approach Angle optimises the unitary effects and is ideal for Urban, Complex & Mountainous Terrain. It offers integral Multi-Option Fuze to include Point Detonation, Delay and HOB to meet the varying requirements for better effect in operations.

System Configurations

Increment Ia-1. It was fielded in May 2007 to meet urgent needs and to provide precision capability to theatre/ battlefield.

Increment Ia-2. It is their baseline programme with Improved Countermeasure Capability to meet full Operational Requirements. Though the IOT&E was completed in Feb 2010, the full rate production is pending, said Mr Barnard.

Increment Ib. Is the Next Sprial Iteration of Excalibur. It has gone through final design and qualification phase. It will offer better reliability and precision than the earlier versions besides cutting the cost. The initial production is likely to commence by 2012.

Excalibur Operational Benefits: Mr. Barnard claimed that Excalibur can quickly engage targets previously unreachable with cannon artillery. The benefits as claimed by Mr. Barnard are as follows:-

- Extended Range.(Fires 35-40km in 39-cal, 50km in 52-cal)
- Accurate Within 10m CEP across operational envelope.
- Designed for Employment in the Close Support Role.
    - Near-Vertical Terminal Attack Angle.
    - Optimizes HE Fragmentation Effects.
    - Minimizes Collateral Damage in Urban and Complex Terrain..
- Multi-function Fuze Modes.
    - Provides Scalable Effects.
    - Expands the Cannon Artillery Target Set.
- Fewer Rounds to Achieve Target Effects.

- Cannon Crew and Technical Fire Direction Procedures Generally Unchanged.

- Autonomous, All-Weather, Day & Night capability.

- Meets most insensitive munitions threat requirements.

Feedback From the Field

Mr Barnard stated that Excalibur is being used in operations in Iraq and Afghanistan with success close to 90 per cent. In the end he projected the war fighter perspective on Excalibur by sighting few reviews as below:-

- "Incredibly accurate…at its minimum or maximum range, you get that same level of accuracy"
- Easy to Use – "Firing Excalibur was similar, if not easier, than firing conventional artillery."
- Used to attack IED emplacement team that retreated to a house in dense urban neighborhood – effects successful and contained within the targeted house
- Saving lives today – "The unit was able to fire an artillery round at a target within 50 metres of infantrymen on the ground. If we did not have Excalibur, we would not have been able to engage the target."
- More responsive than air delivered assets – "Every soldier/marine has access because the artillery directly supports every battalion and company in contact."
- "Excalibur gives the commander another means to rapidly respond with precision and lethality."

Cdr Arun Kumar Nijhawan (Retd): Using COTS Technologies in Design and Engineering of C4ISR Systems for Enhancing NCW Capability – Balancing the Advantages and Challenges.

Possibility of frequent engagement in low intensity conventional hostilities have increased the need for smaller, more manoeuvreable, precise and highly agile forces. It is important to have ICT-enabled C4ISR systems for improving net-centric warfare capability that give near real-time battlefield situational awareness, information and communication dominance over adversary, positive, timely and reliable ID of friends, foes, neutrals and unknowns, mission responsive resource control, collaborative situation assessment and cooperative engagement capability, information consistency, integrity, protection and authentication, network management and control with seamless connectivity and responsive, flexible and precise logistics system wherein logistics velocity is substituted for logistics mass.

Net-centric warfare vision calls for near real time sharing of voice, video and data. Technology areas mainly include rugged computer systems, high capacity radio including SDR, optical cum satellite-based communications and link hardened IP-based networking. Related paradigm includes cost effectiveness with improved computing

capability, high reliability, managing obsolescence, faster access to modern technologies, enhanced interoperability and long-term support.

Hardware-linked advantages of COTS include reduced total cost of ownership for user, technical superiority by faster leveraging of modern technologies, interoperability, upgradeability, maintainability and user-oriented, flexible and quasi standard-based open solutions. Software-linked advantages include leveraging economies of scale by use of customised commercial packages, reduced non-recurring costs for system development, higher reliability requirements in e-business deployments and mission-critical transactions over internet are ensuring convergence towards military use, secrecy and security being met by specific tweaking and customisation and faster development of complex system algorithms.

They are not without challenges, however, which exist in the form of inadequate information on realistic system operating environment, insufficient data on COTS product(s) performance, lack of proven reliability assessment tools, parametric problems in ICs due ambient temperature extremes, compensation in design and layout techniques for very hot, very cold and/or highly moist conditions, managing technology obsolescence, extending life support, and increasing reliability.

In short, modern COTS technologies offer a cost effective alternative for C4ISR based NCW capable systems. However, challenge lies in adapting these to suit stringent military requirements. Associated Reliability and Maintainability engineering must change to suit existing paradigm. Indian Army, DRDO and related defence industry should plan and institute adequate R&D in related domain. Technology is only one aspect of military modernisation. Associated logistics, manpower training, organisational and operations doctrine must also be accordingly changed for enhancing net-centric warfare capabilities.

Dr Vinay G Vaidya: Space Frequency Representation (GSFR) Techniques for Enhancement under Low Light Conditions

We need better information for those in the battlefield. The problem with traditional methods is getting the real-time information without any disturbance. The focus of GSFR technologies is to enhance audio and video quality. The method involves three steps:

- Removal of noise using GSFR based on Variance to Mean Ratio. Divide the image on overlapping blocks of size 5x5 or 10x10 pixels and calculate Variance to Mean Ratio (VMR) for each block. The VMR threshold can be tuned based on the quality of input image. If the value is less than a VMR threshold, apply GSFR to the block. A low value of VMR indicates the presence of noise which can be removed by using the GSFR based filter.
- Sharpness improvement using second-order derivative-based conditional unsharp masking technique. Calculate the 2nd derivative for the centre pixel in four directions using the kernel. Threshold can be tuned based on the quality of input image. If the value is higher than a threshold, apply unsharp masking on that block. Wigner

Distribution is a special case of GSFR used extensively by researchers in speech processing. If it is used with exponential kernel, it is more effective.

- Brightness enhancement using non-linear curve. Mapping of input pixel values to output pixel gray values using nonlinear curve: pear shaped or tear drop. In this regard, there is a lot to learn from nature for technology enhancement.

Discussion

- Army has come out with RFP. Pluggable inscription – decryption model has been made mandatory to the service providers. Information has to be kept secured till the time of its relevance. They are any way under indigenous control. There are, however, concerns of some of the hardware used.

- We have foolproof communication system. Presently, it is outstanding at the higher level. But there are problems at the lower level. They are still operating at VFH. We need to move on to 3G. It requires towers, which may be difficult to install in conflict areas. For this, we can go for vehicle based towers and also consider extensive use of satellites. DRDO has also developed technology for secured and effective communication.

- There has to be accurate technology roadmap. There is a lifecycle for every technology. Every vendor has to constantly monitor technological developments and maintain products accordingly.

- There are different ways and means of achieving interoperability. Although challenging, it is not a impossible. COTS based products are interoperable.

- INSAS has problem of reliability. 5.56 was brought not to kill but to hurt. So this weapon has not been effective against terrorists. Each weapon as a life. We have to graduate to new weapons faster rather than waiting for present weapon to go obsolete. We also need to improve metallurgy for better weapons in our country.

- There is a 'trust deficit' in military modernisation. There are many fly by night operators in this sector. Defence should not be money making business and fail the users. Modernisation is also required in the mind of concerned men. If that happens, actual modernisation will be easier.

- Indian mil requirements are unique. It is imp to have a control on the situation, but without losing much lives. Excalibur in Indian context cannot be used for CT ops. In remote areas we may make an attempt that too after gaining pin-point accuracy.

- It is not Army's job to fight Left Wing Extremism. It can involve only when other forces cannot handle and when the situation goes out of control. If they are short duration employment it is OK, but they are seldom short. Army can be involved only if there is external abetment or if there is a threat to territorial integrity or sovereignty.

VALEDICTORY ADDRESS:

Lt Gen DS Chauhan, AVSM, DG DIA & DCIDS (INT)

Thrust areas in the Army's modernisation plans

Please go to: http://www.claws.in/index.php?action=master&task=772&u_id=36

Concluding Remarks

Mr Nalin Kohli, Chairman CII Defence Sub Committee on SMEs

The sessions at the seminar have been very fruitful and participants have understood the other's perspective very well. We will continue to provide such platforms because we have had overwhelming response. We need to work towards a societal approach to harness the needs of military modernisation.

Indian military requirements are unique because of the geopolitics and their engagements in various kinds of conflicts. While India moves from a regional power towards a global one and becoming an economic hub, it continues to face certain security challenges because of existential threats and changing nature of conflict. Military modernisation has not only aimed to secure the country but has also provided numerous opportunities for the industries.

Defence Production Policies are complicated, lengthy and needs certain changes. With the release of 2011 DPP, one can gauge the changing attitude of the government. CII has been working towards this change and welcomes it wholeheartedly. It is important to consider private industry players at par with DPSU's and foreign companies. The role of SMEs in this sector is very important and cannot be ignored. Private industry hailing from India hold maximum number of patents and clearly with SME's, military modernisation is incomplete.

Vote of Thanks: Maj Gen Dhruv Katoch, SM, VSM (Retd), Additional Director, CLAWS

Thank you all for your participation. The sessions at the seminar have been most fruitful. I would like to thanks Lt Gen DS Chauhan, Mr Nalin Kohli and all our chairpersons and speakers for their much admired talks and speeches. This seminar was an endeavour to get the users, manufacturer and developers on a common platform for fruitful exchange of ideas. I am sure we all would agree that this platform has served the purpose of directing our efforts towards a societal approach towards military modernisation.