CAPABILITIES AND TRENDS IN CONDUCT OF COUNTER-SURFACE FORCE OPERATIONS IN THE FORESEEABLE FUTURE

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As we look to the future of war, we must face one absolute certainty: any projection will prove faulty.

— Col Jeffery R. Barnett[1]

INTRODUCTION

Historically, humans have always developed and used new technologies for military purposes. New technologies have usually created new military options which, in turn, required new procedures and concepts. The latter is the key to assessing whether technological superiority can be translated into winning a war. Technology can, and is likely to, play a significant role in accomplishing war objectives, but only if the application is done in a skilful manner and with a good understanding of what exactly one wants to accomplish. The last conflict fought by India, in the snow-clad peaks of Kargil, showcased the employment of Battlefield Air Strikes

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1. Jeffery R. Barnett, *Future War: An Assessment of Aerospace Campaigns in 2010* (Diane Publishing Co., 1996), p. xvii.

It is definitely expected that weapons will be more versatile and have greater ranges and stand-off capability; mission tasking would be less restricted by aircraft, weapons, weather and ground commanders; aircrew could have access to information from a common network that will electronically model the battlefield.

(BAS) and Battlefield Air Interdiction (BAI) in a high altitude environment. There were initial losses, which resulted in a change of tactics. Similarly, future wars will also bring a paradigm shift in strategy and tactics, greatly influenced by technology.

In the future, advances in technology and the restructuring of organisations and processes are likely to blur the boundaries between the air and space environs. The concept of aerospace power will get expressed in a better pervasive and seamless military use of the third dimension.[2] It is definitely expected that weapons will be more versatile and have greater ranges and stand-off capability; there may even be a possibility of a reconfiguration of damage mechanisms in-flight, as per type of target [based on Artificial Intelligence (AI) target recognition features]. Mission tasking would be less restricted by aircraft, weapons, weather and ground commanders; aircrew could have access to information from a common network that will electronically model the battlefield. One may even see the emergence of space docking stations and a complete transition to unmanned flights and robotics.

The possibilities are endless and while they may presently be nascent, cultured in wild imaginations, these may be a reality of tomorrow. With this background of vast uncertainty on the capabilities of the future and seeming unpredictability, there, however, needs to be a method in the madness. One may not, and should not, aim to predict 50 years hence, but definitely looking at the trends, one may be able to hazard a guess on the possibilities in the next two decades. By applying the trends of recent military conflicts to the evolving social and political world climate, it is possible to make some reasonable predictions. In line with this school of thought, this article would endeavour to examine the possible nature of conflicts in the next two decades

2. *British Air and Space Doctrine, AP 3000,* Fourth Edition (2009), CAPS, Air Command, UK, p. 13.

from where it would seek to derive the future capabilities that could enhance the efficacy of air land battle platforms, technologies and mechanisms.

POSSIBLE NATURE OF AIR LAND CONFLICT

The historic role of maritime forces has been to exercise sea control, while land forces close in and engage the enemy to take and hold ground. Air forces have traditionally supported the other components or acted independently for strategic effect. While the relationship between the maritime and air components has remained largely unchanged, the linkages between the air and land components have evolved rapidly since the end of the Cold War, particularly as the capabilities of air forces have increased markedly in recent years, as demonstrated most convincingly in the 2003 Gulf War. One lesson emerging from the recent wars is that while air power remains an instrument of choice, its effectiveness depends to a large extent upon the adversary, the kind of target systems that can be engaged through the medium of air and the ability of the military and political leadership to use it for maximum effect.[3]

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Conventional Land Conflict

The army increasingly views air power as indispensable to its future war-fighting concepts and seeks mechanisms to ensure that it is available and responsive to the needs of the land forces. For the air force, there is a concern to ensure that air power's unique ability to mass rapidly is not lost in efforts to provide on-call fires

3. *Basic Doctrine of the IAF*, Directorate of Operations (Space) Air Headquarters, New Delhi, 2012, p. 10.

to small ground elements spread across a large battle space.[4] While air interdiction and BAI would continue to be important tenets of Counter-Surface Force Operations (CSFOs), with improvements in technology and weaponry, one would also need to relook at BAS, especially as attrition on the battle front would increase the political linkage to war-fighting. BAS produces the most focussed and briefest effects of any force application mission and, therefore, rarely creates campaign level effects. It is the least efficient application of air power, but, as was seen in Operation Anaconda, it may be the most critical for ensuring the success or survival of surface forces. The operational difficulties and the risks involved are greater and that is where the ultimate rationale for modernisation will lie. One of the most tragic lessons from recent combat experiences is that fratricide is still a problem on the modern battlefield.[5] Combat identification and friendly-force tracking techniques will, therefore, enhance dramatically. Precision, information technology, space, intelligence and better command and control enablers will increase effectiveness and can help achieve objectives more efficiently. This would provide commanders a flexible capability to make other applications of military power more effective and drive an early end to conflict.[6]

The conventional land battle in the foreseeable future will be characterised by increased violence, lethality and destruction, with the battle being prosecuted with enhanced firepower, greater mobility, high tempo and manoeuvres by mechanised forces. In this battlefield of high fluidity, with no distinctive fronts, flanks and rear, the focus would be on joint application of air and land combat power. There will be an enhanced role for interdiction, surveillance, reconnaissance and target information, with fire being harmonised to operate within the enemy's decision cycle for neutralisation

4. Bruce R. Pirnie, Alan Vick, Adam Grissom, Karl P. Mueller, David T. Orletsky, *Beyond Close Air Support: Forging a new Air-Ground Partnership* (USA: RAND Corporation, 2005).
5. Leon E. Elsarelli, *From Desert Storm To 2025: Close Air Support in the 21st Century* (USA: Research Report, Air Command and Staff College, 1998).
6. "Counterland Operations: US Air Force Doctrine Document 2-1.3", September 11, 2006. Headquarters Air Force Doctrine Centre, USA.

of his Centres of Gravity (CoGs). Establishment of air superiority conditions over the battle area would, however, remain an inviolable and fundamental prerequisite.[7]

Technology Driven

Following the overwhelming victory of coalition forces in Desert Storm, some air power analysts have begun to declare that technological superiority has finally caught up with air power theory.[8] One line of argument interprets that Operation Desert Storm confirms the decade-old Soviet prediction of an impending "military-technical revolution" driven by advances in microelectronics, automated decision-support systems, telecommunications, satellites, advanced sensors, lasers and other non-nuclear munitions; the effects so accurate and lethal that they could wreak levels of military damage comparable to those attainable with Tactical Nuclear Weapons (TNWs).[9] Soviet theorists have argued that in the near future, the so-called "reconnaissance-strike complexes" would enable commanders to detect targets and attack them effectively at long ranges, and within minutes. These combinations of sensors and weapons would blur traditional distinctions between offensive and defensive fires and allow the conduct of war over far greater distances.

Air power's contribution to future operations will be underpinned by a robust, networked air command and control system that is resilient to cyber attack, counter-Intelligence, Surveillance, Target Acquisition, and Reconnaissance (ISTAR) information and conventional attack. The responsive command and control system provided by air power that combines man-in-the-loop analysis, with machine-to-machine interfacing, automated target recognition and artificial intelligence will enable air and surface component

7 Kapil Kak, "A Century of Air Power: Lessons and Pointers", *Air Power Journal* (IDSA), vol. XXIV no. 12, March 2001.
8. Elsarelli, n. 5.
9. Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey Summary Report* (Washington DC: Government Printing Office, 1993), p. 235.

commanders to operate as one. Operational headquarters would be required to adjust their structures, composition and procedures to exploit the opportunities provided by the network to tackle fleeting targets within an ambiguous battle space. Similarly, networking and the full integration of the joint headquarters will assure access to air power through a flexible, adaptable and more responsive air tasking order mechanism that enables precise synchronisation with the other components.[10]

Unconventional Conflict

Irregular and hybrid warfare have blurred the boundaries among the strategic, operational and tactical levels. Consequently, traditional air power roles have become less sharply delineated. Many operations that would once have been described as tactical, now have impact at the strategic level. For instance, air attacks in Afghanistan in 2008 were confined to limited target sets within a well-controlled battle space, yet their effects resonated strongly among the local population, who were sensitive to the asymmetric application of force and represented a centre of gravity at the operational or strategic level. Consequently, tactical engagements are now often fought amongst non-combatant populations and increasingly in urban areas, where situational awareness is no longer enough to conduct effective military operations; instead, commanders need to develop situational understanding. Understanding the enemy's perceptions, fears and motivations is now as important as building an awareness of his force dispositions and intentions.

Irregular Warfare

Pertaining to irregular warfare, air power can provide critical capabilities including persistent over-watch, security and force protection for land forces over large areas, where friendly or indigenous force ratios are low. The benefits include its capability as a force multiplier where its mobility and firepower reduces the requirement of surface forces and political

10. "Future Air and Space Operational Concept in Practice—The Next Iteration of Modern Air Power", undated article in *RAF Journal*. Accessed at http://adastra.rafweb.raf.r.mil.uk/ live/ general/fasoc.htm.

sensitivity, ability to bring precise and proportionate firepower to bear, speed of response, kinetic and non-kinetic effects and unique ability to exert psychological pressure through a show of force. Pitfalls include the misperception that its employment is disproportionate because of its destructive potential; a temptation to substitute air power for ground forces, beyond rational limits; and inadequate joint planning, when air operations are added as an afterthought to a two-dimensional plan that has already been conceived, rather than being integrated from the outset.[11]

Hybrid Warfare

The concept of hybrid warfare has been used to describe conflicts where high-technology and conventional capabilities are mixed with irregular tactics. The Lebanon conflict of 2006 was the most recent example of application of this type of warfare. The Israeli Air Force's experience in fighting Hezbollah demonstrated that while air power is decisive in the prosecution of conventional operations, it must be applied with great care in such warfare. In this type of warfare, non-kinetic air power roles may be as important as kinetic effects and a truly integrated joint campaign is likely to be the best guarantor of success.

Warfare in Urban Environment

When an adversary chooses to hide and fight in an urban environment, collateral damage and unintended effects are the inevitable outcomes. Emerging technologies such as small diameter bombs and limited blast radius warheads, in conjunction with increased precision, confine, as well as allow, a better control of the direct effects which would minimise collateral damage and unintended effects.

Other Conflicts

Ethnic conflict in the Balkans, government turmoil in Haiti and famine in Somalia also provide lessons for CSFO employment. They stand in stark contrast to the Gulf War environment and demonstrate the need

11. n. 2, pp. 59-61.

to refrain from assuming that the scenario of Desert Storm is applicable to all future air power requirements. As competition for limited world resources intensifies, it can be assumed that these environmental stresses will bring states into conflict. Examples of these possibilities include oil reserves in the Persian Gulf, water supplies in the Arab-Israeli region and commercial access to the South China Sea.[12] Military confrontations in Yugoslavia, Angola, Burundi, Afghanistan and Georgia are but a few of the better-publicised conflicts that illustrate that ethnic conflict will remain high on the list of future trouble spots.[13] Supporting such scenarios places unique constraints on the application of air power and CSFO in particular. These problems include close proximities of adversaries, target acquisition difficulties and very short response requirements. Air assets of the future must be just as capable of a graduated response in these situations as ground units.

The Indian Context

India currently faces, and will continue to face, the full 'spectrum of threats' ranging from nuclear confrontation, conventional war, conflicts (limited in area, scope or objectives), to lower end friction such as insurgencies, terrorism, etc. Moreover, India also needs to be prepared for an escalation of conflict from limited wars to nuclear wars. The spectrum will acquire complexity and technological sophistication, making it prudent and necessary to move away from a "threat-based" preparation, to a more accommodative and flexible "capability-based approach".[14] Our own national security strategy recognises these potential threats and describes the need to be able to engage in not one but two major theatre wars with overlapping timeframes.

12. Patrick M. Cronin, *2015: Power and Progress* (Washington, D.C.: National Defense University Press), p. 80.
13. John L. Petersen, *The Road to 2015 (*Emeryville, CA,USA: Corte Madera: Waite Group Press), p. 274.
14. Fali H. Major, "Indian Air Force in the 21st Century: Challenges and Opportunities", *Journal of Defence Studies,* (IDSA), vol 2, Summer, 2008.

FUTURE CAPABILITIES

Collation of Requirements

Capability development is essentially based on requirements. The nature and types of battles in the 20th century instigated certain requirements which, in turn, led to the development of evolutionary technologies. The 21st century is also being shaped in a similar manner. Collation of the trends of the previous century and a changing viewpoint, as brought out in a study by RAND Corporation is tabulated below.

Table 1:Table of Identified Requirements[15]

Old View (20th Century)	**New View (21st Century)**
Peace-time tempo	War-time sense of urgency
Reasonable predictability	Era of surprise and uncertainty
Single-focussed threats	Multiple, complex challenges
War against nation	Conducting war in countries we are not at war with (safe havens)
One-size-fits-all deterrence	Tailored deterrence for rogue powers, terrorist networks, and peer competitors
Responding after a crisis starts (reactive)	Preventive actions, so problems do not become crises (proactive)
Crisis response	Shaping the future
Threat-based planning	Capabilities-based planning
Focus on kinetics	Focus on effects
20th-century processes	21st century integrated approaches
Static defence and garrison forces	Mobile, expeditionary operations
Under-resourced, standby forces	Fully equipped and fully manned combat-ready units
Battle-ready forces (peace)	Battle-hardened forces (war)
Large institutional forces (tail)	More powerful operational capabilities (teeth)
Major conventional combat operations	Multiple, irregular, asymmetric operations
Separate military service concepts	Joint and combined operations

15. Paul K. Davis, "Military Transformation? Which Transformation, and What Lies Ahead?" Accessed from http://www.rand.org/pubs/reprints/RP1413.html.

Old View (20th Century)	**New View (21st Century)**
Forces that need to deconflict	Integrated, interdependent forces
Exposed forward forces	Reaching back to the continental United States for support
Emphasis on ships, guns, tanks and planes	Focus on information, knowledge, and timely, actionable intelligence
Massing forces	Massing effects
Set-piece manoeuvre and mass	Agility and precision
Single-service acquisition systems	Joint portfolio management
Broad-based industrial mobilisation	Targeted commercial solutions
Service and agency intelligence	Joint information operation centres
Vertical structures and processes	More transparent, horizontal integration (matrix)
Moving user to data	Moving data to user
Fragmented homeland assistance	Integrated homeland security
Static alliances	Dynamic partnerships
Predetermined force packages	Tailored, flexible forces
United States performing tasks	Building partner capacities
Static post-operation analysis	Dynamic diagnostics and real-time lessons learned
Focussing on inputs (effort)	Tracking outputs (results)
Department of Defence solutions	Inter-agency approaches

Technologies and Capabilities for Future

We shall seek to examine the technologies and capabilities that may unfold in the future starting from what is currently under development and known in the media; to certain technologies which are nascent and being applied in different fields but which could shape the manner of conduct or efficacy of CSFO operations.

Future Offensive Air System: Future Offensive Air System (FOAS) is the name given to a number of concept options which are being examined for the UK Ministry of Defence's requirements. The Future Combat Air Capability Programme will be looking at the force mix of aircraft and missiles

already under procurement, including the Strategic Unmanned Aerial Vehicle Experiment (SUAVE). The manned aircraft would operate in long range, low level missions, using stealth technologies and terrain screening. Electronic warfare research areas being examined include multi-sensor data fused networks, more powerful radar and counter-measures processors and the frequency dependence of stealth technologies, sensors and decoys. A possibility of using the Airbus Military A400M as a platform for Air Launched Cruise Missiles (ALCMs) is being examined. A range of Unmanned Aerial Vehicles (UAVs) would be deployed for surveillance, weapon targeting, command and control as well as for the electronic warfare and combat role. Studies of fire-and-forget missile technologies are underway on propulsion, guidance (using millimetre-wave and imaging infrared with focal plane arrays) and on robustness against counter-measures. Other concepts include a combination of advanced cruise missiles, modular carriage and release concepts, data linking to satellites, Joint Surveillance and Target Attack Radar System (JSTARS) or other Command, Control, Communications, Computers and Intelligence (C4I) assets and real-time battle damage assessment.[16]

Advances in Unmanned Systems: Unmanned systems are highly attractive in the air and naval sectors due to their favourable costs, covert nature and lack of associated casualties. They also reduce energy costs and logistical footprints through their lighter structure and heightened fuel efficiency. Developments are underway to improve autonomy and weaponisation for broader offensive and defensive deployment. Requirements for enhanced surveillance capabilities have also led to work on nano-unmanned aerial systems [nano-Unmanned Aerial Systems (UAS)], individually and as potential components of 'nano-swarms' or 'swarm drones'. It is estimated that the switch to all unmanned flights will take place two to three decades hence.

Weapon Advances: Weapons advances are in the form of integrating technological and electronic advances to increase range, lethality, speed, accuracy and stealth. There is a push for weapons technologies to counter

16. "Future Offensive Air System, UK", 2015, RAF Article. Accessed at www.airforce-technology.com on October 3, 2015.

Future systems are evolving towards making the soldier 'an individual C4ISR node on the modern battlefield', equipped with lightweight command, control and communications elements that can be worn on helmets, attached to wrists or used as tablets or smartphones.

'difficult air targets', such as UAVs and surface-to-air weaponry. Developments are ongoing in such areas as **kinetic, directed-energy** and **precision-guided weaponry**.

Advances in Intelligence and Surveillance Systems: Improvements in electronics and computing are being integrated to improve the quality, quantity and accessibility of actionable intelligence. Digital **electronic surveillance** is a highly sensitive area of technological development, with current research addressing jammers, geolocation techniques, radar and future challenges from engaging in urban theatres. Advances in **Geospatial Intelligence** (GEOINT) are occurring in the sea and land sectors. GEOINT is benefitting from graphics and computing advances in the commercial electronics industry to enhance 3-D imaging and speed intelligence dissemination. General interest in **electro-optical systems** reflects the increasing importance of improved visual sensing capabilities and lighter, more sophisticated unmanned vehicles.

Advances in Radars: Radars have improved through integration of related technologies, with 3-D volume search radars capitalising on advances in transmitting and processing, waveform generation, digital beamforming and electronic scanning and stabilisation. These domains are also expected to expand as new detector materials reach maturity, as has been achieved with currently used compounds and micro-bolometers.

Advances of Man-Machine Interface Systems: To benefit from the heightened volume of intelligence and communications, the man-machine interface is becoming increasingly individualised and mobile in order to improve rapid and easy access to information. Future systems are evolving towards making the soldier 'an individual C4ISR node on the modern battlefield', equipped with lightweight command, control and

communications elements that can be worn on helmets, attached to wrists or used as tablets or smartphones. This is also true at the macro equipment level, an example being the use of commercially inspired touchscreen capabilities in new cockpits.

Additive Manufacturing or 3-D Printing: Additive manufacturing or '3-D printing' may have a transformative impact in a range of areas, enabling customisation of goods, localised production, added functionality and intricacy of design. This is more in the maintenance realm but could easily find resonance in most defence related equipment, including weapons in the future. It offers a revolutionary manufacturing technology that significantly reduces time scales for every stage of the design and production process. This technique enables quick innovation as well as rapid equipment replacement in an operational context.

New immersive and virtual reality technologies are improving the realism of the simulated experience, like 3-D capabilities, Augmented Reality (AR), network interoperability to involve multiple machines, multi-player and motion-sensor technologies.

Synthetic Environment:[17] The Synthetic Environment (SE) is a multi-disciplinary technology area that may represent either natural or artificial environments, virtual reality technologies and is capable of modelling complex relationships and interactions between various actors and components of a given system. Closely linked to Information Technology (IT) developments, SE advances are occurring in the areas of visualisation, interaction and processing technology. New immersive and virtual reality technologies are improving the realism of the simulated experience, like 3-D capabilities, Augmented Reality (AR), network interoperability to involve multiple machines, multi-player and motion-sensor technologies and Graphics Processing Units (GPUs). SE is a valuable enabler of military training, particularly due to the reduced tempo of modern military operations and the lack of space for live training at a realistic scale. Live, Virtual and Constructive (LVC) training can

17. Maryse Penney, Tess Hellgren and Matt Bassford, "Future Technology Landscapes: Insights, Analysis and Implications for Defence". Accessed at www.randeurope.org/dstl.

Net-centricity and ability to collate fused information in real time from various platforms is the way forward. As seen from the recent wars, airborne and space-based sensors provided a constant flow of information about enemy force dispositions and activity.

be used at all stages of the training process: providing initial learning, preventing skills from fading and delivering post-mission recuperation. In defence acquisition, SE is useful across the full range of testing and development, from exploring initial concepts through to assessment, demonstration/ manufacture and upgrading of equipment. SE enables equipment testing in controlled environments, decreasing the expense and risk of real demonstrations. SE is also useful in modelling disposal scenarios, such as in the UK's recent study on disposal options for a nuclear submarine. SE is valuable for defence testing and training capabilities, both by overcoming challenges of real-life scenarios (such as cost) and by enabling hypothetical situations to be modelled.

Nanotechnology: This is another priority area marked for rapid expansion as a key enabling technology. It has future potential to revolutionise material properties such as strength, weight, cost and conductivity.

Cyber Warfare: While cyber warfare has not yet matured, its future offensive and defensive deployment could transform the nature of battle. Reflecting this possibility, cyber security concerns continue to influence defence capability needs in C4ISTAR areas of information sharing, intelligence, espionage and 'cyber-situational awareness'.

Other Developments: A number of emerging technologies in the early stages of development and integration are characterised by both high uncertainty and high potential for cross-sector application. Identifying and applying **new materials with self-healing capabilities** to lighten and strengthen military equipment is a commercial-led area with wide-ranging possibilities. The technology's potential applications include reducing radar visibility, providing vehicular armour, offering coating for jet engine performance, and creating 'smart' materials that react to environmental conditions.

The possible technologies and future impact potential are tabulated below.[18]

Table 2: Future Technologies and Impact Potential

Technology	**Impact Potential**
Nanotechnology	Potential unknown, but possibly a game changer
Radar	Step by step advances from integration of new technologies which are rapidly maturing
Cyber warfare	Game-changing possibilities for evolving offensive and defensive techniques
New materials	Wide potential in many applications in both marginal and non-linear changes
Unmanned systems	Marginal improvements in functionality with some major steps possible in autonomous combat systems; swarms and nano will be game-changers in increasing surveillance and combat capacities without casualties
Hybrid/alternative energy sources	Potential game-changer but tangible application has been marginal so far
Electro-optical systems	Step by step improvements as new detector materials reach maturity
Simulation techniques	Step by step improvements for training programmes
3-D printing	Game-changer if incorporated across defence industrial base
Man-machine interface	Game-changing advances in usability and accessibility of informational inputs
Engines technology	Step by step improvements in power and fuel efficiency

18. Ibid.

Technology	Impact Potential
Electronic surveillance	Step by step improvements in surveillance and communications techniques in line with increasing civilian usage
Directed-energy weapons	Substantial improvements in accuracy, speed, and disruption
Geospatial Intelligence (GEOINT)	Marginal improvements in current mapping capabilities, data fusion and interpretation
Precision-guided weapons	Substantial improvements in accuracy, range, speed and lethality
Kinetic weapons	Substantial improvements in accuracy, range, speed and lethality

INFERENCES AND RECOMMENDATIONS

Based on a correlation of the factors as listed above, the following aspects emerge:

- India currently faces, and will continue to face, the full 'spectrum of threats' from nuclear confrontation, conventional war, conflicts limited in area, scope or objectives, to lower end friction, such as insurgencies, terrorism, etc. Moreover, India also needs to be prepared for an escalation of conflict from limited to nuclear on two fronts. The full spectrum in the foreseeable future implies both the conventional land conflict and unconventional conflicts. The unconventional conflicts can further take the shape of irregular warfare, hybrid warfare, warfare in the urban environment and other conflicts such as ethnic, counter-terrorism, low intensity, domestic insurgency and skirmishes over national interests. The application of air power in these will be technology and capability driven. Such threats find mention in the Indian Air Force (IAF) doctrines as well.
- There is a need to invest more resolutely in unmanned platforms such as Global Hawk high-altitude UAV and Predator type of UAVs armed with Hellfire missiles.
- Net-centricity and ability to collate fused information in real time from various platforms is the way forward. As seen from the recent wars,

airborne and space-based sensors provided a constant flow of information about enemy force dispositions and activity. This would also solve the persistent problem of attaining timely and correct intelligence. The security of networks from cyber attacks/electronic interference would be vital.

The IAF needs to develop capabilities to be able to tackle the full spectrum of threats as envisaged in the future towards which there is a need to set up mechanisms to seek commensurate technologies, alongwith a plan and roadmap to absorb such technologies.

- It is seen that air forces are presently focussed on tackling only the conventional threat. The weapons and platforms are currently optimised for conventional air land battles and not optimised for unconventional warfare. Air forces need to develop capabilities to be able to tackle the full spectrum of threats. A failure to do that would lead to a comprehensive danger of the air force being left out of the other types of conflicts in the future or marginalisation of its role from a principal driver and game-changer to that of subsidiary support. This would not happen if the focus of air forces shifts from CSFO—which is a 'subsidiary support' role—to its primary role of ensuring compulsive deterrence by bringing about a behavioural change in the leadership of the enemy (by systematically neutralising his war-waging potential, economic targets and other centres of gravity—the most important being the leadership).
- The long pending capability enhancements that involve larger gestation periods, are lacking. Future capability build-up, procurement, training and procedures have to be optimised to truly cover the full spectrum of threats in their entirety.
- From the perspective of long-term perspectives and procurement plans towards capability enhancement, the IAF needs to look out for technologies that could enhance its capabilities in the future. This tasking could also be supplemented to extra-government organisations in addition to specialised in-service directorates.
- From the long-term perspective and procurement plans towards capability enhancement, the IAF can look into technologies such as

advances in unmanned systems and nano-unmanned aerial systems for greater autonomy and weaponisation; swarm drones, weapon advances in the fields of kinetic, directed-energy and precision-guided weaponry; advances in intelligence and surveillance systems in terms of digital electronic surveillance, geospatial intelligence, more capable electro-optical systems; advances in radar; new lighter and self-healing materials; advances of man-machine interface systems to provide C4ISR capabilities on the modern battlefield and cockpits; additive manufacturing or 3-D printing, enabling customisation of designs, weapons, maintenance and localised production; synthetic environment systems with virtual reality technologies, network interoperability to involve multiple machines, multi-player and motion-sensor technologies for military training, battlefield replication and the full range of testing and development; nanotechnology, and, finally, cyber warfare.

- The tenets of ensuring seamless functioning of command, control and communication networks and in obstructing the adversary's C4, will remain relevant in the future as well.
- Air space management—especially over the Tactical Battle Area (TBA)—will increasingly need to be well networked and integrated, with control procedures demarcated.
- The IAF needs to practice Out of Area Contingency (OOAC) operations at certain periodic intervals as such capabilities now exist.
- Finally, the changing threat perception and military landscape of the future would require a certain degree of adaptability for the IAF to optimise in the expected threat scenario. In this new century, the IAF is faced with a dilemma in terms of needing to face the future with limited resources, but with an ever increasing need to enhance combat capability. It could, therefore, follow the route of designating units for the different roles as per the spectrum of conflict envisaged and could build up assets and capabilities accordingly. In creating such specialised units, the IAF as an organisation would thereby be able to handle a larger spectrum of threats both in the present and in the foreseeable future.

CONCLUSION

India's security environment is an amalgam of its history, geography, culture, politics, etc. The security challenges facing India are varied, complex and dynamic. The new millennium has witnessed sweeping changes with India emerging as a fast growing economy with a major stake and influence in the global arena. Air power, with its attributes of rapid mobility, reach and flexibility has in the past demonstrated the capability of being able to change the paradigm of warfare by ensuring that troops or marine vessels could be targeted despite the varied theatres of operation.

While perceiving the future, it needs to be appreciated that advancing technology has increasingly shaped the conduct of modern warfare and demands the use of military forces in concert with one another. Military forces on land, sea and in the air now reinforce and complement each other more than ever before. Modern technology has provided us the wherewithal to share capabilities in exactly the manner that we desire. By its nature, aerospace power is futuristic and increasingly utilitarian.[19] However, it is important to discern from a wide canvas, the technologies which would be relevant and which could enhance the capabilities of the IAF in the future. The IAF needs to develop capabilities to be able to tackle the full spectrum of threats as envisaged in the future towards which there is a need to set up mechanisms to seek commensurate technologies, alongwith a plan and roadmap to absorb such technologies. The changing threat perception and military landscape of the future would require a certain degree of adaptability for the IAF to optimise in the expected threat scenario.

19. Major, n. 14.