Cutting Edge for Future Joint Operations: A Transformed Indian Air Force

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"*Capacity building is important for Indian Air Force. As far as China is concerned, it is not just numbers. The technology is also growing at a rapid pace. Production agencies must invest in advanced manufacturing processes for timely induction of new platforms. Technology delayed is technology denied*"[1]

- Air Chief Marshal AP Singh, PVSM, AVSM

Abstract

In a rapidly evolving global security environment marked by volatility, uncertainty, complexity, and ambiguity, the role of air power in modern warfare has gained strategic importance. This essay examines the critical role of the Indian Air Force (IAF) in safeguarding national interests and adapting to future warfare through joint and integrated multi-domain operations. It highlights the necessity for transformation across infrastructure, logistics, human resources, technology, and indigenisation to ensure operational readiness and strategic superiority. The essay further explores the challenges and opportunities posed by emerging technologies such as artificial intelligence, cyber warfare, and space-based operations, and proposes a phased roadmap for IAF's comprehensive transformation. Emphasis is placed on fostering jointness among armed forces and leveraging innovation to position the IAF as a decisive force in future joint operations.

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Introduction

In the 21st Century, the world is increasingly becoming Volatile, Uncertain, Complex, and Ambiguous (VUCA), and threats to national security are following suit. In these times, no nation can undermine the importance of future-ready joint operations by its modernised armed forces. The Indian Air Force (IAF), one of the world's largest and most formidable air forces, has been at the forefront of national defence, playing a critical role in safeguarding India's vast airspace. As the security environment evolves globally, the IAF faces the challenge of keeping pace with rapid technological advancements, complex geopolitical dynamics, and new modes of warfare. The IAF will have to evolve continuously at the pace of changing character of warfare while enhancing interoperability with the army and the navy in integrated operations. IAF must aim at acquiring advanced capabilities in air, space, Artificial Intelligence (AI), and cyber domains while promoting innovation. To play its critical role in future joint operations, the IAF must undergo a comprehensive transformation encompassing modernisation across various dimensions, including infrastructure, logistics, human resources, technological advancements, and indigenisation.

Air Power in Changing Geopolitical and Security Environment

Air power was initially intended for reconnaissance and bombing enemy populations, with the Italian Army officer Giulio Douhet advocating its use to force an enemy's surrender through extensive bombing of civilian areas to break the morale. During and after World War II, the growth of air forces was pivotal in determining the outcome of conflicts, with superior air forces playing a crucial role in victory by neutralising weaker air forces.

Today, air power has evolved into a key instrument for achieving national interests and its role should not be studied in isolation. In the 21st Century, air power must be viewed as a tool to achieve broader strategic goals, extending beyond military tactics. Success in any war should not only be measured by the tactical effectiveness of air, land, or maritime forces, but by their effective contribution towards national security objectives. In the ultimate analysis, success on the battlefield is not as important as success in meeting the conflict termination criteria, which are invariably set by the political leaders and dictated by larger national security objectives.

The role of air power in the VUCA geopolitical scenario must be seen from this perspective. Air power cannot simply bomb an enemy's population into submission, as history shows questionable results—especially when the enemy is not clearly defined. From the Vietnam War to Gaza, targeting civilians has caused more problems than solutions. In the Cold War, air power was tied to nuclear deterrence but remained unused due to the fear of mutually assured destruction. Though seen as a key solution after the 1991 Gulf War, it has failed to address complex security issues effectively, highlighting the need to consider problems in their full width, depth, and context. Thus, the instrument of air power must be used very judiciously.

Air Power in the Indian Context

In the history of air power, the outcomes of peer or near-peer air wars are yet to be witnessed. There are important lessons for IAF in this conundrum. India would do well to tailor the lessons from the recent conflicts to suit the unique geostrategic environment prevalent in the sub-continent. The wars would be fought to safeguard the territorial integrity and sovereignty, and the adversaries would be peer or near-peer. Therefore, employing air power in a highly unrestricted manner—as has often been the norm with Western air forces in the past—would be difficult to achieve. The option of learning on the job does not exist for India; therefore, the IAF must develop its capabilities based on its own threat perception and the nature of competition, rather than merely imitating the doctrines and capabilities of others.

Need for Jointness

> "*There are experts of land, sea, and air warfare. But as yet, there are no experts of warfare. And warfare is a single entity, having a common purpose*"[2]
>
> - Giulio Douhet

The rapid advancement of technology demands seamless coordination among land, sea, and air forces to enhance their capabilities. Victory in warfare now relies on mastering information flow and conducting joint military operations. Believing the three military branches can operate independently in future wars ignores global changes. Success will depend on the ability to integrate

and synchronise efforts across all armed forces, highlighting the critical importance of a unified approach to modern combat.[3] The Defence Minister of India recently stressed upon the significance of evolving a joint military vision and preparing for the challenges that the country may face in future wars, while emphasising synergised, swift, and proportionate response to provocations.[4]

In the Indian context, the theatre command concept is expected to bring about much-needed degree of integration and jointmanship among the three services. With the real-time threat of a two-front scenario and less than the required number of squadrons with the IAF[5], seamless and cohesive jointness is the 'Urgent need of the hour'. Appropriate use of air power has been and will remain a critical factor for the success of future operations. However, the strategic impact of air power in complex operations will be significant only through well-planned and well-executed roles by all services in well-defined domains. According to stakeholders in national security, special attention needs to be given to the strategic importance of cyber and space-based capabilities in modern warfare, underlining the necessity of preparing for future conflicts that will increasingly span multiple domains.[6]

Beyond Joint Operations: Multi-Domain Operations

The modern battle-space is heavily influenced by technology and it has forced modern militaries to ponder over the question, 'What is after joint'.[7] The character of warfare has undergone a profound transformation; the modern battle-space has become an intricate, multifaceted environment where success is contingent upon the harmonious orchestration of capabilities spanning diverse operational domains.[8] The term 'Joint' usually signifies the operational level, whereas multi-domain seeks to integrate at every level, from the strategic down to the tactical level.[9] Multi-Domain Operations (MDOs) have evolved as a method to integrate and synchronise activities across land, sea, air, space, cyber, and information domains to achieve strategic objectives. The ability to seamlessly operate across these domains is crucial for military success in any contemporary and future conflict. Looking at various recent conflicts spread across all kinds of domains, the author opines that it is time to ponder upon planning and execution of joint MDOs.

Role of the Indian Air Force in Multi-domain Operations

> "*Our increasing space assets will have to be protected from hostile actions, and since air and space belong to the single aerospace continuum, the IAF would remain the logical primary military component to undertake air and space defence*"[10]
>
> - Late Air Commodore Jasjit Singh, AVSM, VrC, VM (Retd)

Traditionally, air forces have exercised and executed cross-domain deterrence and coercion, as evidenced by numerous historical examples, where they have softened army targets or conducted anti-shipping strikes to support naval operations—often while simultaneously engaging enemy air power across different theatres. Air forces are inherently equipped, organised, and trained to operate in a multi-domain construct. They have personnel with skills and expertise within their organisation who can leverage the specialised capabilities required to move from the joint operations construct into MDO.

The IAF has all the driving elements required to play the most crucial role in MDO. Leveraging high-end technology, the innovative mindset of personnel, strategic reach and flexibility, integrated Command and Control (C2) infrastructure, Intelligence, Surveillance, and Reconnaissance (ISR) capabilities, and technological prowess in the space and cyber domains are all key strengths of the IAF. When applied in any MDO scenario through well-orchestrated joint planning and integrated operations, these capabilities can effectively contribute to achieving both military and political objectives.

Challenges for Indian Air Force to be Joint Multi-domain Operations Ready

The rapid pace of technological advancements and their infusion in the battlespace are already leading to increased complexities[11] in the operating environments and will surge in future wars. The use of AI, hypersonic weapons, weaponisation of space, and cognitive warfare present new challenges and opportunities for military operations. AI and Machine Learning[12] (ML) have the potential to revolutionise military operations. Data is already being termed the new munition—and could well be called the new gunpowder. Powered by vast amounts of data, AI and ML are

transforming battlefield decision-making by enabling faster and more accurate responses to dynamic threats. Hypersonic weapons have blurred the distinction between air and space, posing significant challenges for detection and interception, and necessitating new approaches to effectively counter their threat. Contested space environments[13], where adversaries can degrade or deny access to space-based assets, coupled with weaponisation of space, necessitate the development of new capabilities and strategies to ensure continued effectiveness of space operations. Successful conduct of MDO by IAF mandates that these challenges are addressed. IAF, with its focus on technological innovation, capability, and human capital enhancement, also needs to undergo transformation concentrating on developing joint doctrines and niche technology-based frameworks across all domains to achieve seamless integration with other services to ensure successful joint MDOs.

Other undeniable factors that pose challenges in this process include a limited budget with the Ministry of Defence (MoD), reliance on foreign military technology in certain critical areas, the perception of modernisation as a threat by regional neighbours—potentially leading to conflicts—and, finally, internal resistance within the system towards the adoption of new doctrinal concepts.

Key Factors for Transformation

There are many factors to be considered for overall transformation, however, six major drivers of transformation are mentioned below:

Modernisation of Infrastructure. The foundation of any successful military force lies in its infrastructure. As the IAF prepares to undertake more complex and integrated operations with other armed forces, the modernisation of its infrastructure becomes critical. The following infrastructure must be enhanced to accommodate newer, more advanced systems, ensure efficient operations, and maintain readiness[14]:

- **Airbases and Runways**. With the increase in the size and capabilities of aircraft, existing airbases need extensive upgrades. Runways must be extended and reinforced to handle modern supersonic jets, heavy cargo aircraft, and future unmanned systems. Remote and forward bases in strategically important areas should be developed to support rapid deployment and quick reaction. While the Modernisation

of Airfield Infrastructure project is a step forward, its application should be expanded nationwide to enable all-weather operations.

- **C2 Centres**. Integrating C2 systems across different military branches is vital for joint operations. Modernised operations centres, equipped with advanced communication and tracking systems, are essential for ensuring seamless coordination with the army, navy, and paramilitary forces during joint exercises and combat operations.[15] The proliferation of the Integrated Air Command and Control System highlights progress, but further combined efforts are required.

- **Maintenance Facilities**. To ensure operational readiness, the IAF must establish cutting-edge maintenance, repair, and overhaul facilities focusing on advanced systems such as the Rafale, Tejas, and Unmanned Aerial Vehicles (UAVs). Additionally, the emphasis should be on dual-use technologies to cater for both defence and civil aviation needs, thus, maximising resource utilisation.[16]

Logistics and Supply Chain Optimisation. An efficient logistics system is fundamental for sustained operations, especially during joint deployments. The transformation of IAF logistics must focus on modernisation and optimisation.

- **Automated Systems**. Integrating AI and ML into logistics can streamline inventory management, predict maintenance needs, and optimise supply chains. Smart warehouses and autonomous systems for material transportation will ensure reliable and timely supply chains. The Integrated Material Management Online Logistics System of IAF already exemplifies this approach but requires broader inter-service sharing.[17]

- **Joint Logistics Operations**. Integrated logistics systems are necessary for multi-service deployments. The IAF must collaborate with the army and navy to establish shared logistics hubs, ensuring synchronisation during crises.

- **Rapid Mobility and Deployment**. Enhancing rapid deployment capabilities, including airlift capacity and positioning strategic reserves of supplies and fuel in key locations will ensure readiness.

Human Resource and Doctrinal Development. The Chief of Defence Staff General Anil Chauhan in one of his recent podcasts said that biggest challenge to transformation is changing the mindset and to go through the process of learning, unlearning, and relearning.[18] The quality and adaptability of personnel are critical for modern warfare. Developing a skilled workforce is the top priority for the Indian Army, which requires the following:

- **Training Programs**. Comprehensive training regimes focusing on joint operational tactics and proficiency in new technologies. Training modules must be changed to focus on developing mindset for jointness in MDO. Virtual training and simulations will prepare personnel for multi-domain battlespaces.[19] The initiative of Future Warfare Course by Headquarters Integrated Defence Staff is a step taken to develop an understanding on the manner in which future wars will manifest in terms of being contact, non-contact, kinetic, non-kinetic, psychological, or informational, as also the domains where they will be fought, be it cyber, space, or electromagnetic spectrum.[20]

- **Innovation and Adaptability**. Fostering a culture of innovation through collaboration with research organisations, universities, and private tech companies will enhance problem-solving and technology integration. More focus must be on cyber, space, and AI-related technologies.

- **Doctrinal Evolution to Foster Joint Culture**. For ensuring operational transformation across services and developing culture of jointness, the IAF needs to collaborate to create unified joint operations doctrine. Focus of this doctrine must be seamless integration of services at all stages of training, learning, planning, and execution.

Technological Advancements and Cyber Capabilities. The IAF must leverage the following cutting-edge technologies to maintain an edge over adversaries:

- **AI and Autonomous Systems**. Investing in AI-driven systems for surveillance, reconnaissance, and combat operations will enhance battlefield awareness and, consequently, operational efficiency.[21]

- **Cyber Warfare**. Strengthening cyber offence and defence and electronic warfare capabilities is crucial. Specialised units focused on these domains will ensure air superiority while countering adversaries.[22]

- **Interoperability with Other Services**. This will prove to be the backbone of integrated operation in MDO. Adopting standardised communication protocols and ensuring compatibility of IAF systems with systems across army and navy will play crucial role in joint operations at any and every level.

Indigenisation of Key Platforms. Self-reliance in defence production is vital, especially given global supply chain uncertainties. The present government's *Atmanirbharta* (Self-reliance) supports the 'Make in India' policy with sincerity. Time is ripe for mastering new technologies and boosting domestic defence production. AI and information technology will support the following process[23]:

- **Indigenous Aircraft**. The continued development of platforms like the Hindustan Aeronautics Limited Tejas and advanced stealth aircraft should be prioritised. The Light Combat Aircraft (LCA) production must be increased to around 18 a year to begin with. The present Chief of the Air Staff has already expressed his views regarding importance of time-sensitive technology for the armed forces.[24]

- **Drone and UAV Technologies**. Investments in drone development to enhance operational effectiveness in future wars is a must. IAF still has mostly Israeli UAVs and Unmanned Combat Aerial Vehicles (UCAVs). Drone production ecosystem in India is picking up. The lessons from Ukraine conflict indicate the need for large weapon stocking and, therefore, there is need for continuous review. Kamikaze drones have turned game-changers and having those kind of cheap yet effective weapons in bulk is important.[25]

- **Missiles and Air Defence Systems**. Indigenous missile systems such as Akash and BrahMos are bolstering Indian defence capabilities. A multi-layered air defence architecture is essential for joint operations. Development in area of

Ballistic Missile Defence system needs whole-of-the-system approach by the MoD.

Collaborative Defence Approach and Strategic Partnerships

Leading joint operations in MDO scenario requires seamless collaboration with other branches of the armed forces, as well as with international partners.

- **Integrated Defence Teams**. The IAF must work closely with the army and navy to foster joint operational strategies, conducting joint training exercises and sharing intelligence. This approach will create a cohesive fighting force capable of responding to modern threats in real time.

- **Space and Cyber Domain Integration**. There is a need to integrate ground-based sensors with space-based assets for networked warfare proliferating into cyber domain. It will involve bringing public sector undertakings as well as private players onboard. IAF needs to up the ante with putting its best on this front.

- **Partnerships with Foreign Nations**. Strengthening defence ties with global powers such as the United States, Russia, and European nations will allow India to access advanced technologies and share knowledge. Strategic partnerships can also facilitate joint exercises and interoperability, which are key in MDOs.

Roadmap for the Transformation of the Indian Air Force for Leading Future Joint Operations

To transform the IAF into a future-ready force, a strategic and phased approach is essential, considering its critical role in modern warfare and the evolving threats of the future. The journey on the road of transformation can be divided into three distinct phases i.e., short-term, mid-term, and long-term.

Short-Term: Joint Doctrines, Capability Gaps, and New System Induction

Objective. Strengthen the immediate operational readiness by enhancing joint operational doctrines, bridging existing capability gaps, and inducting new technologies and systems to address contemporary needs.

Joint Doctrines and Interoperability.

- **Objective**. Develop and implement joint doctrines for seamless integration across all branches of the Indian Armed Forces. This will ensure smooth collaboration and optimised resource utilisation during joint operations[26], particularly concerning C2 and communication networks.

- **Focus Areas.**

  - Establish protocols for joint planning and execution.

  - Implement robust systems for inter-service communication and data sharing.

  - Standardise joint tactics, techniques, and procedures for a unified response.

  - Develop training programs focused on inter-service operations.

Filling Capability Gaps.

- **Objective**. Address current deficiencies in air power, such as fleet obsolescence, limited precision strike capability, and insufficient surveillance systems.

- **Focus Areas.**

  - Upgrade or replace aging platforms, such as the MiG-21 Bisons, with modern aircraft, e.g., Rafale, Tejas Mk2.[27]

  - Enhance air-to-air combat and air-to-ground strike capabilities. Precision and range are the two critical requirements for both air-to-air and air-to-surface weapons. There is, thus, a need for long-range sensors and weapons that can operate in adverse electronic environment.[28]

  - Improve surveillance and reconnaissance systems, focusing on UAVs and airborne early warning systems.

  - Expand logistics, maintenance, and training systems to maintain operational readiness.

Induction of New Systems.

- **Objective**. Incorporate cutting-edge technologies to bolster defence capabilities and ensure quick adaptation to changing warfare dynamics. IAF needs to have independence in terms of aero-engine, stealth technology, advanced multifunction active electronically scanned array radars, infra-red search and tracking system, directed energy weapons, hypersonic platforms, and smart weapons. This phase demands greater public-private sector cohesion and national will power.

- **Focus Areas**.

  - Upgrade and increase multirole fighter jets like the Su-30MKI and Rafale. Pace of manufacturing indigenous aircraft like LCA and Light Combat Helicopter needs to increase. Timely induction of multi-role fighter aircraft will compensate for the ageing fleets.[29]

  - Integrate more advanced air defence systems, including S-400 systems.[30]

  - Expand the use of UAVs, UCAVs, and drones for surveillance and strike operations.

  - Implement digital technologies and software solutions for command, control, communications, computers, and intelligence.

Mid-Term: Multi-Domain Operational Framework

Objective. Build a multi-domain operational framework integrating air, land, sea, space, and cyber domains to provide comprehensive operational dominance.

Multi-Domain Integration.

- **Objective**. Develop and maintain an operational capability across all domains—air, land, sea, space, and cyber—to conduct integrated warfare.

- **Focus Areas**.

  - Strengthen cyber capabilities and defence to secure IAF's data, communication, and operational infrastructure.

- Leverage space capabilities for ISR, and communications, especially with satellite assets.
- Establish interoperability with the army and navy across various domains for synchronised MDOs.
- Expand joint exercises involving air, ground, naval, and cyber forces to ensure tactical readiness in a multi-domain context.

Data Fusion and Real-Time Decision-Making

- **Objective**. Enhance the ability to fuse information from multiple domains in real time to facilitate rapid and accurate decision-making.
- **Focus Areas**.
  - Develop systems that aggregate data from air, sea, land, and cyber operations to create a unified battle picture.[31]
  - Implement advanced AI and ML systems to analyse real-time data and provide actionable insights for operational commanders.
  - Train personnel in decision-making processes that incorporate multi-domain perspectives, ensuring quicker response times during crises.

Cyber and Space Warfare Dominance.

- **Objective**. Strengthen cyber and space capabilities to ensure operational supremacy in these emerging domains.
- **Focus Areas**.
  - Build offensive and defensive cyber capabilities to protect IAF infrastructure and disrupt adversary operations.
  - Expand satellite reconnaissance capabilities for enhanced situational awareness and target identification.
  - Develop anti-satellite capabilities to counter enemy space assets and deter adversary space-based intelligence gathering.[32]

Long-Term: Dominance in Joint Warfare with Artificial Intelligence and Autonomous Systems

Objective. Achieve strategic superiority in joint warfare by integrating cutting-edge technologies like AI, autonomous systems, and next-generation warfare tools into all operational domains.

AI Integration for Enhanced Decision-Making.

- **Objective**. Leverage AI to automate routine tasks, enhance situational awareness, and improve decision-making efficiency in high-stress, real-time environments.
- **Focus Areas**.
  - Develop AI-powered systems for real-time battlefield management, including predictive analytics for mission planning, threat identification, and resource allocation.[33]
  - Integrate AI in combat platforms for enhanced targeting, flight control, and decision support systems.
  - Use AI to optimise logistics, maintenance, and mission planning in a resource-efficient manner.

Autonomous Systems for Increased Combat Efficiency.

- **Objective**. Employ autonomous systems in combat, surveillance, logistics, and reconnaissance to increase operational effectiveness and reduce the risk to human personnel.[34]
- **Focus Areas**.
  - Develop and deploy autonomous aircraft, drones, and robotic systems capable of performing air-to-ground strikes, surveillance, and reconnaissance.
  - Expand the use of unmanned platforms for hazardous missions where human presence is risky or unnecessary.
  - AI and robotics will allow autonomous operations, drone swarming and support manned unmanned teaming. Much greater investments are required in these. Private sector is investing big in AI and that needs to be harnessed.

- Enable autonomous resupply and maintenance systems to ensure faster turnaround times for operational readiness.

Advanced Joint Warfare through AI, Robotics, and Cognitive Technologies.

- **Objective**. Transform warfare capabilities by combining AI, robotics, and cognitive systems to achieve superiority in joint combat operations.

- **Focus Areas**.

  - Build platforms that leverage AI for autonomous decision-making in complex environments, reducing human intervention.

  - Develop AI systems that can work collaboratively across land, air, sea, and space domains, ensuring joint operational excellence.

  - Integrate advanced cyber capabilities to support AI and autonomous systems, ensuring resilience in the face of sophisticated electronic warfare tactics.

Conclusion

The roadmap for the transformation of the IAF for future ready joint operations is complex but achievable. This path must be trodden not alone but as part of Integrated Capability Development Plan.[35] It is a systematic and phased approach wherein by modernising infrastructure, optimising logistics, developing human resources, embracing technological advancements, and prioritising indigenisation, the IAF can enhance its capabilities to excel in integrated and MDOs. This transformation, guided by a vision of self-reliance, technological supremacy, and joint interoperability, will ensure that the IAF remains a formidable force in the 21st Century, capable of responding to the challenges of a dynamic global security environment.

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