

Adapting an Air Force to Emerging Responsibilities in the Space Domain

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The armed forces' dependence on space-based capabilities will grow further in the coming years. This will make the space domain an economic and military centre of gravity. While being a strength, this will also be a critical vulnerability in times of conflict. When this happens, an air force will be ideally positioned to deal with the threats emerging in the space domain and ensure continued access to space systems for both civilian infrastructure and military operations.

As new space-faring states emerge and space technology proliferates, the potential for threats from and in space will increase. Space defence will become a critical capability for an air force till such time a space force is established for military operations in the space domain. The air force, being closest to the operational medium of space, thus, needs to equip itself to provide the full spectrum of capabilities in the aerospace domain. The attributes of air power, viz., precision, speed, range, flexibility, and the ability towards three-dimensional power projection are

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very much applicable to military space power projection too. The integration of air and space assets will allow seamless operations in air and space with continuity. An air force that can harness the full spectrum of space services and develop limited capabilities in space operations can be termed an 'aerospace force', while a force that is capable of the full spectrum of operations in the air and space domain along with full-fledged capabilities to deploy and utilise space services can be called an 'air and space force'. Strategic and organisational imperatives may require a space force to be independent of the air force.

To operate in the space domain, an air force or an aerospace force will have to develop capabilities that rest on four pillars of strength as mentioned below:

- Space Situational Awareness.
- Space Services and Applications (Space Force Enhancement).
- Space Operations (Small Satellite Launch, Responsive Launch, Flexible Launch, Tracking and Telemetry, Satellite Control, Space Recovery, etc.).
- Counter-space Objectives.

SPACE SITUATIONAL AWARENESS (SSA)

The number of active satellites in orbit has already increased manifold and is set to multiply in the coming years, with the shift towards small satellite constellations or mega constellations as opposed to large single satellites. Lower orbits in particular are becoming increasingly crowded and also littered with debris, posing a risk to satellite operations from accidental collisions. Prevention of such catastrophic situations is going to be a challenge. SSA and Space Traffic Management (STM) are, therefore, the most challenging activities today in outer space and will remain relevant in the coming years. Besides space debris and mega constellations, the other major reason for this is orbital crowding and uncertainty about how the space environment will emerge. This is particularly

so for nations that are dependent on the space surveillance networks of other states agencies. These space surveillance networks give a selective visibility for open source users as well as for those organisations having an SSA sharing agreement, albeit, with a higher accuracy. Orbital crowding will, therefore, have to be managed by a globally governed SSA network.

Space Situational Awareness, a pillar of aerospace power, contributes to the safety and security of a state's space capabilities. It has three components, viz., surveillance, data collation and conjunction or predictive analysis. It needs to be backed up by a robust information analysis and distribution system. Gap-free surveillance would require sensors on the ground as well as in space. SSA can be considered as a foundational requirement for any kind of operational capability in space. SSA for the air force should meet five distinct needs, as given below:

- Position information of own satellites and spacecraft as well as objects in their vicinity.
- Assessment of the threats that adversary space systems can pose to own satellites and spacecraft, and to own ground infrastructure.
- Provision of accurate inputs for a proximity analysis and collision avoidance measures.
- Sharing of space object information with other organisations and space agencies.
- Provision the necessary information network for Space Traffic Management (STM).

India's SSA is limited to tracking and monitoring its own satellites in terms of positional data. For knowledge of the space environment and other objects in the vicinity of Indian satellites, there is a requirement to have situational data. Dependence on external agencies for situational data has to be minimised. This needs to be done by expanding the sensor network. To have

reliable visibility in space through Low Earth Orbit (LEO) and Geosynchronous Earth Orbit (GEO), sensors are required on the ground as well as in space.

Sensors for SSA have an inherent overlap with air defence radars and the missile defence network. The success of any SSA system is possible only through integration of inputs from all sensors in a common air and space situation picture. This will enable a smooth transition between Air Defence (AD) weapon systems and missile defence systems for a shortened Observe, Orient, Decide, Act (OODA) loop, resulting in a successful engagement.

Visibility in space is essential for the conduct of space operations. SSA can, therefore, be considered as a foundational requirement for executing space operations. Even in a passive space posture, SSA will give an early warning for defensive actions. An air force needs to recognise the operational benefits and challenges of SSA and work towards getting the bigger picture – which is vital to be in a position of advantage.

Space Traffic Management: Space Traffic Management (STM) is a new concept gaining momentum and is under deliberations with the UN monitored committees. STM is fundamentally different from SSA. While one aims to make objects in space visible and catalogue them, the other aims to prevent collisions by regulations and active control collision avoidance manoeuvres. Both are complementary to each other and essential activities in space.

STM is expected to bring some order to near-Earth space and nearspace which is increasingly becoming important. A space traffic management programme could involve multiple organisations, private agencies and technologies. Sharing information efficiently and securely amongst this group will be vital for managing traffic in a congested space. STM would require a foundation of widespread international SSA data sharing, and building on it an operational structure of space traffic controllers, responsible for coordinating and directing traffic in and between airspace zones

akin to the flight information regions in international civil aviation control regions. It would also require a more comprehensive and internationally integrated system of space surveillance than exists today.¹ It would be virtually impossible to do this from a single operations control centre. It would require geographically dispersed regional control centres where inputs from regional sensors can be fed, and screened for a conjunction analysis.

STM will soon become a reality. There are significant technological, legal, organisational and manpower issues to be resolved. This is an opportunity which India should not miss. The Indian Air Force (IAF) is ideally positioned to take on the responsibility of the operations part of STM based on its vast experience in airspace management. However, this would require regional STM centres to be established under a global STM organisation.²

SPACE SERVICES AND APPLICATIONS

Space services and associated applications form an essential part of any modern air force and complement many of its operations as a major force enabler as well as force enhancer. Armed forces across the world use satellites for communication, Intelligence, Surveillance, Reconnaissance (ISR) functions, early warning, navigation, weather, and allied services. A modern air force needs to adapt to these space services to be able to exploit the full potential of air power, thus, becoming an aerospace power to some extent. The assets required for such an aerospace force are a fleet of satellites in diverse orbits, equipped with payloads to meet specific applications. One needs to have the means to launch the satellites and manage them in orbit, as well as handle the

1. Brian D Green, "Space Situational Awareness Data Sharing: Safety Tool Or Security Threat?", June 2014. Extract of master's thesis of the Institute of Air and Space Law, McGill University, at <https://www.researchgate.net>. Accessed on July 25, 2022.
2. TH Anand Rao, *India's Space Security Dilemma* (New Delhi: KW Publishers, 2019). Accessed on July 22, 2022.

data gathered from these satellites. This would entail dedicated ground infrastructure for receiving and processing satellite signals and ensuring the availability of processed data at the user end. The space services that should be harnessed by an air force and the capabilities that need to be developed are enumerated in subsequent paragraphs.

COMMUNICATIONS

Seamless communication networks and real-time airspace and battlespace awareness are vital in operations. Space capabilities will have to meet the challenge of an aerospace force's need for greater connectivity. An integrated Satellite Communication (SATCOM) system needs to deliver secure communication solutions for mission success. Such a system should be able to accommodate disruptions and still deliver effects. It should be capable of responding to a changing operational environment and possess the ability to rapidly redirect resources to the highest priority missions. Cyber resilience should also be a key to deal with the emerging threats in the operational environment.³

SPACE-BASED SURVEILLANCE (SBS)

SBS has a vital role in military functioning. ISR plays a critical role in how we conduct operations and employ our capabilities against the adversary. Despite the proliferation of airborne ISR systems, they comprise just one element in the network of intelligence collection mechanisms. ISR must provide access to the most difficult targets with operational flexibility, responsiveness, interoperability, and greater precision. This can be achieved by a combination of airborne sensors and satellites.

Electronic Intelligence (ELINT): ELINT through space resources has proven to be of much use in gathering electronic

3. "The Future of DoD SATCOM: Delivering Fighting SATCOM", *Milsat Magazine*, April 2019 edition. Accessed on June 13, 2022.

intelligence of an adversary. This would also complement the Signals Intelligence (SIGINT) collected through aerial resources with the advantage of having a vast ground coverage. Space-based ELINT capability is critical for real-time alert warnings, detection in mountainous terrain and the vast Indian Ocean Region (IOR). China has demonstrated a near continuous electronic surveillance capability over its perceived hotspots with the Yaogan constellation of satellites. An aerospace force needs to have near real-time ELINIT that is essential in maintaining the tempo of modern warfare and to counter hybrid threats.

POSITIONING, NAVIGATION AND TIMING (PNT)

Space-based PNT is another critical requirement for air operations. The Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS) have been providing positioning, navigation and timing services for nearly three decades, and their accuracies have been improving over the years. The European Union's (EU's) Galileo, and China's Beidou are also developing into highly accurate global PNT systems. However, concerns of availability of precise signals during periods of conflict, data ownership, need for autonomy and redundancy, have necessitated the development of the indigenous Global Navigation Satellite System (GNSS). India's own Indian Regional Navigation Satellite System (IRNSS) also known the Navigation Indian Constellation) (NavIC) is a case in point. Having an indigenous satellite navigation system helps in boosting military capabilities across the spectrum of operations, from basic navigation to high precision munition delivery. However, the development of only a navigation system is not enough—it needs to be integrated with the equipment and munitions used by the forces.

EARLY WARNING

Aerospace needs to have an early warning mechanism for missile defence. For this, satellites in GEO equipped, with Infra-Red (IR)

sensors can detect the thermal signature caused by a missile launch. This is an important capability to get an early warning of a missile launch for alerting the missile defence and air defence systems. Multiple satellites will be required to give a global all-round coverage. This alone may not be sufficient to detect the advanced missile technologies like hypersonic missiles. The key to countering more advanced missile threats will be in ensuring that the satellites are integrated with sensors that can detect a launch as well as sensors that can track the missile during the mid-course phase.

SPACE LAYER FOR MISSILE DEFENCE

Space is the operational domain for missile defence, including launch detection, tracking, discrimination, intercept, and kill assessment. Concepts for space-based sensors and weapons have been researched for many years. To intercept a missile in its mid-course phase requires the capability to detect its launch, track its flight, and then discriminate the warhead from any counter-measures and from the debris created from launching it. Satellites in space with sensors for the detection and tracking of missiles will add another layer to the existing missile defence mechanism. This kind of a layered system relies on technologically advanced sensors and Command and Control (C2) systems. An aerospace force will have to upgrade and integrate all the available sensors and intercept systems to achieve a gap-free missile defence system.

GROUND INFRASTRUCTURE

The ground-based infrastructure or the ground segment is responsible for a number of support functions such as control of satellites, monitoring satellite health, tracking satellites to determine their present and future positions, collecting the satellite's mission data, analysing the data and distributing the

data to users. A key component of the infrastructure is the ground station and its networks.

Each component of the ground segment is vital for a satellite's mission success. As new technologies are developed for complex space missions, ground systems must be able to support these developments. An aerospace force needs to have the necessary wherewithal to handle space missions through essential ground systems that can handle future space missions. This will avoid dependence on other agencies to achieve operational tasks.

NETWORK-CENTRICITY

The Network-Centric Operation (NCO) concept of developing and leveraging information superiority by synchronising sensors and shooters provides greater battlespace awareness and greatly enhances the war-fighting capabilities. The NCO has a heavy reliance upon space-based assets and technology. Some of the key enabling technologies of the NCO are the PNT satellites, communications satellites (both military and commercial), and voice and data networks. The essential tenets of an NCO are: improved information sharing through a robustly networked force, enhanced quality of shared information and collaboration, and self-synchronisation through shared situational awareness. An aerospace force needs to harness the potential of satellites, Radio Frequency (RF) spectrum and cyberspace to achieve seamless NCO.⁴

SPACE OPERATIONS

Exploitation of space for military applications requires a joint Services approach due to the commonality of requirements and the limited nature of resources available. Military space operations, on the other

4. Eric E. Silbaugh, "Network-Centric Operations: Challenges and Pitfalls", Air War College, Alabama, November 2005, at <https://apps.dtic.mil/sti/tr/pdf/ADA463336.pdf>. Accessed on July 25, 2024.

hand, would require a professional Service-specific approach due to the nature of the task and core competency available in each of the Services – in this case, an air force. Some of the areas of military space operations that need to be considered are:⁵

- Contribution towards Space Situational Awareness (SSA) through sharing of radar surveillance observations.
- Space Traffic Management (STM) as a part of any regional STM organisation which would be akin to airspace management in the IAF.
- Space weather prediction as an extension of atmospheric weather predictions.
- Anti-Satellite (ASAT) defences and operations of certain ASAT weapons capabilities.
- Responsive launch/launch on demand capability for ISR and ELINT using small satellites.
- Drones and balloons for ISR, ELINT, space observation and airspace observation from near space.
- Ballistic Missile Defence (BMD) which will extend into space for mid-course and boost phase interception.

Technological developments in the space sector have opened up many possibilities for exploitation of space by the armed forces. Certain additional areas which can be adopted by an aerospace force are given in the subsequent paragraphs.

LAUNCH CAPABILITY

Launch capabilities are infrastructure intensive and need to be maintained and operated by the designated space agency. However, the critical requirement for an aerospace force would be the capability for '*launch on demand*' or '*responsive launch*'. This is an essential requirement for reconstitution of the space resources and redundancy of the space segment. It also gives a tactical leverage

5. Anand Rao, n.2.

for '*on -demand*' imagery requirements. An aerospace force will have to maintain and operate mobile small satellite launch systems, which could place mini/micro satellites in Very Low Earth Orbit (VLEO) with less reaction time. These could be vehicle mounted for mobility or could be co-located at air force bases.

SPACE CARGO AND LOGISTICS

Space transportation is being envisioned in a novel concept which would entail passengers and logistics being space-lifted from one place to another on the Earth. This will be made possible with fully reusable rockets becoming a reality. Spacelift is akin to airlift, the difference being in the mode of transport. A rocket with load and passenger carrying capacity could be launched, orbited, and made to land at a destination across the globe in a matter of a few minutes. Spacelift could be particularly useful for strategic transportation of military equipment and personnel.

NEAR SPACE OPERATIONS

The expanding space domain has diminished the demarcation between airspace and outer space. At the closer orbital ranges, satellites are being positioned for VLEO, and pseudo satellites, balloons and high altitude drones are being used for exploiting the near space region. The ambiguity between airspace and near space is even more predominant with the proliferation of aerial platforms in the near space region which could be in an adversary's airspace, yet would not be violating the sovereignty of the adversary's airspace. It could be operating in the region of ambiguity – near space – where detection targeting capabilities are still to mature. This domain is well within the operating jurisdiction of an aerospace force, and an air force must develop capabilities to operate in the near space region for ISR, communication, real-time data links and radar tracking of aircraft.

COUNTER-SPACE OBJECTIVES

Space control strategies, which form the basis of counter-space techniques to be adopted, essentially involve protecting space infrastructure and space-based assets from disruption or damage by an enemy or any other agency, knowingly or otherwise. It comprises three major components; *space protection*, *space denial* and *space situational awareness*. While *space protection* involves securing own space assets from disruption /damage, *space denial* means denying an enemy access to its space resources during a conflict. The strategy for *space control* can either be defensive (protecting its space assets) or offensive (degrading/destroying the enemy's space assets). *Space situational awareness* would be a prerequisite for any space mission. While space dominance comprises an overwhelming superiority in space and offers unrestricted freedom of operation of space assets, space control through space protection and limited space denial measures would be a more practical approach for an emerging aerospace power.

Space protection, space denial and space situational awareness are, hence, the primary requirements towards space security through military means which can be adopted by an aerospace force and need a doctrinal approach for planning, training and execution. An aerospace force will have to define its scope of space operations and adopt the required mix of counter-space techniques based on the threat perception, space security strategy for the armed forces and organisational requirements, including inter-organisational dependencies.

Aerospace power is an extension of air power in the fourth dimension – space – and, hence, parallels can be drawn with air power doctrines for executing space missions. A well-orchestrated space doctrine, coupled with organisational and infrastructural support and demonstrated capabilities will have effective deterrence value.

CONCLUSION

The essential mission of an air force is to secure the sovereign airspace in peace as well as war-time. Space is the natural extension of the air domain, at least up to the orbital region. Operations in this zone overlap with those of the air force. Inevitably, air superiority and space superiority will eventually merge making 'aerospace' an integrated whole. This will make the air force an aerospace power that can respond within hours with great accuracy. It is to that standard and purpose that an air force must be organised, trained, and equipped.

The dimensions of aerospace power are still expanding. Vast improvements still lie ahead in sensors, weapons, and the capabilities of air and space vehicles. The dividing lines between air power and space power will continue to be blurred. In the integrated arena of aerospace, air power and space power share common operational characteristics and freedom from the geographic constraints of the Earth's surface. The inherent features of aerospace allow an air force to act with effectiveness and flexibility. But for that to happen, the air force must adapt to the emerging challenges in space to take on its responsibilities as a military force closest to the space domain.

The military developments in space are a threat to national security objectives. This demands a graduated approach towards repurposing an air force for securing freedom of action in space and providing unrestricted access to space services for our nation as well as the armed forces. Till such time a space force is created to handle the task, an air force, with its projected space capabilities, is well poised to protect a nation's space interests. To make this a reality, the air force needs to undergo essential changes to embed space services and space operations into its operations, training, maintenance, and administrative activities.