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Emerging Trends in AEROSPACE POWER Options for Pakistan

Post Seminar Report

CENTRE for AEROSPACE & SECURITY STUDIES, LAHORE

Emerging Trends in Aerospace Power: Options for Pakistan

POST SEMINAR REPORT

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INTRODUCTION

The term "Aerospace" encompasses both the Earth’s atmosphere and the expanse of outer space. In the realm of strategic considerations, the formulation of airpower has matured over time, yielding a wide array of applications. However, the concept of space power is passing through an evolutionary phase. Nevertheless, space power has the ability to bestow even greater flexibility and strategic reach to military operations than its aerial counterpart. As the boundaries between terrestrial and celestial domains continue to blur, space has emerged as an increasingly pivotal arena for projecting national power, spanning civil and military spheres alike.

The conjunction of air and space constitutes two distinct yet interrelated mediums, each possessing unique physical attributes. Notably, both realms uphold the fundamental tenets of airpower encompassing traits such as speed, range, elevation, and the capacity to engender combative effects in support of terrestrial forces. This extends to functions like enhancing mobility, gathering intelligence, waging cyber warfare, and more. Strategists are vigorously pursuing advancements in hypersonic and trans-atmospheric vehicles, with the aim of harnessing their potential in the broader aerospace landscape.

Though placement of Weapons of Mass Destruction (WMD) in space is banned under the Outer Space Treaty (OST) of 1967, it specifically leaves room for states to assert their dominance in space by placing all other types of weapon systems. The imminent militarisation of space shall be accompanied by establishment of intricate and multifaceted ecosystems. Several ‘Earth to Space’ and ‘Space to Space’ anti-satellite weapon systems already exist. The Strategic Defence Initiative, designed to counteract hostile Intercontinental Ballistic Missiles (ICBMs) after they have been launched, represents another array of Space to Space weapons. Former Soviet Union's deployment of the 'Fractional Orbital Bombardment System,' which enabled the placement of nuclear warheads

in Low Earth Orbit (LEO), shows the rapid progression of space militarisation in ‘Space to Earth’ domain. Evidently, the utilisation of space for combative pursuits is an enduring feature of contemporary strategic dynamics.

Aerospace strategists are endeavouring to seamlessly integrate air and space capabilities. Leading air forces are actively pursuing policies and technological advancements to secure their positions in the domain of space operations as well. While diverse approaches are evident, ranging from the establishment of autonomous space forces to the adoption of integrated aerospace force models, the overarching goal is to harness the potential of these interconnected domains. Notably, India has centralised its space assets under the purview of the Indian Defence Space Agency (DSA), a tri-service entity.

Pakistan's foray into the space domain remains in its nascent stages, characterised by a substantial lag when juxtaposed with its principal adversary. This discrepancy underscores the necessity of revisiting Pakistan's space policy, redefining the national space vision, and recalibrating the space strategy. A cogent imperative emerges to articulate clear objectives aimed at cultivating and capacitating a proficient force entrusted with safeguarding national security interests in the space domain. It is, therefore, vital to establish clear milestones for developing a viable response against likely national security threats emanating from space. Pakistan Air Force (PAF) is entrusted with the responsibility of defending the airspace of Pakistan. Due to proximal affinity of airspace and space mediums’ continuum, the PAF appears as most probable entity to take charge of space warfare as well.

Keeping these considerations in perspective, the seminar titled, “Emerging Trends in Aerospace Power: Options for Pakistan” delved deeply into the complexities of this realm. The overarching objective was to gain strategic insights through interaction with experts in the field, and to chart a set of actionable strategies as well as a tangible roadmap for Pakistan’s space programme.

SPEAKERS OF THE SEMINAR

TOPIC	SPEAKER
Introductory Remarks	Air Commodore Khalid Iqbal (Retd)
Keynote Address	Major General Ahmed Bilal (Retd)
Evolution of Space Power in South Asia: Civil & Military Applications	Dr Ali Sarosh
Gaps in International Space Law and Viable Developmental Strategy for Pakistan's Space Programme	Dr Ahmed Saeed Minhas
Concluding Remarks	Air Marshal Asim Suleiman (Retd), President, CASS, Lahore

EXECUTIVE SUMMARY

A seminar titled, “Emerging Trends in Aerospace Power: Options for Pakistan” was organised by the Centre for Aerospace & Security Studies (CASS), Lahore on 17 August, 2023. Aerospace power is the ability to use air and space capabilities to achieve wide-ranging civil and military objectives in economic, commercial and scientific domains. Pakistan stands at the threshold of numerous opportunities to capitalise on emerging trends like space exploration, satellite technology, unmanned aerial system, and electric propulsion of green aviation. The seminar focused on options for Pakistan regarding aerospace power.

The seminar commenced with a keynote address by Major General Ahmed Bilal (Retd), former Chairman Pakistan Space & Upper Atmosphere Research Commission (SUPARCO), followed by insightful presentations delivered by two eminent scholars in the field of space, Dr Ali Sarosh and Dr Ahmed Saeed Minhas. An extensive Q&A session and concluding remarks by Air Marshal Asim Suleiman (Retd), President, CASS, Lahore, rounded up the seminar.

In his introductory remarks, Air Commodore Khalid Iqbal (Retd), Director National Security, CASS, Lahore, gave a brief overview of the different military and civilian applications of aerospace power. He highlighted that space has already been weaponised and militarisation of space is only a matter of time. There is an ownership dilemma in the aerospace sector with each spacefaring nation racing to claim the top spot. The increasing integration of aerospace power with other domains such as land, air, sea, cyber, etc. has made the battlefield highly integrated and complex. He said that keeping aside the organisational inclinations, the ultimate wish of a typical aerospace strategist is the seamlessly integrated usage of air and space mediums and forces. Pointing out that Pakistan’s space programme was at a nascent stage and in an inordinate lag viz-a-viz its neighbours; the speaker urged for an immediate policy review to make-up for the lost time.

Major General Ahmed Bilal, drawing from his vast experience of having worked with the Strategic Plans Division (SPD) as well as his five year service as Chairman SUPARCO, delivered an enlightening keynote address on space technology's impact on socio-economic development and national security. He highlighted space's role in propelling nations forward and fortifying defence capabilities, emphasising its potential for societal empowerment and economic growth. Acknowledging Pakistan's early entry into space in the 1960s, he noted a pivotal turning point in 2000 when SUPARCO's revival was entrusted to the SPD. The fusion of civilian and military applications in the rapidly evolving global landscape was underlined, with satellites reshaping society, science, strategy, and commerce.

Major General Bilal highlighted Pakistan's unique standing as a nuclear state, where mastering aerospace technology enhances economic viability and national stature. He delved into aerospace trends, from digitisation to additive manufacturing and immersive technologies. Pakistan's strategic focus areas, such as remote sensing satellites and Artificial Intelligence (AI), were outlined to bolster both national development and security. Challenges hindering Pakistan's journey, including lack of resolve, economic fragility, and reliance on borrowed technology, were addressed. He added that key impediments in the way of implementing a credible space programme were insufficient resource allocation (especially finances) and placement of SUPARCO under a military setup. India’s budgetary allocation for its civilian component of space programme, run by Indian Space Research Organisation (ISRO) during fiscal year 2022-23 was Indian Rupees 126 billion while Pakistan’s total allocation was a meagre Rs7.4 billion. He was of the view that pathways of Pakistan’s progress in space programme pass through civilian ownership.

He highlighted a three pronged national strategy as the way forward for Pakistan: Firstly, ensuring full scale applicability of available aerospace capabilities and resources for socioeconomic development and national security; secondly, achieving self-sufficiency / indigenisation as far as possible in the short / medium-term, meeting the basic needs over

complete spectrum of aerospace; and thirdly, synergising the national effort for sustained growth of the aerospace sector.

Major General Bilal urged the creation of a well-defined National Space Policy, reflecting a firm collective commitment that involves all stakeholders. The policy should address the diverse needs of development, defence, education, and international collaboration. This structured approach is essential to align national goals, drive progress, and overcome bureaucratic hurdles.

The second speaker of the day, Dr Ali Sarosh, Associate Professor, Air University, and a leading expert on space related research and development (R&D) focused on the evolution of space power in South Asia, both in civilian and military applications. He highlighted the significant changes in global space power dynamics over the last two decades, where once-prominent space technology leaders are now seeking new advancements, while commercial players are driving innovation and competition in space. South Asian countries have made notable strides in space development due to both necessity and rivalry, with civilian applications of space technology permeating the region's households.

Dr Sarosh emphasised India's substantial progress in the space domain, positioning itself decades ahead of Pakistan. India's approach, marked by a robust commercial space programme preceding military endeavours, has proven effective. He delved into the concept of space power, which encompasses the projection of influence through space in both civilian and military domains, underscoring its significance in the 21st century warfare. Dr Sarosh detailed various aspects of space warfare, including co-orbital anti-satellite operations, directed ascent anti-satellite systems, electronic warfare, directed energy weapons, and space situational awareness.

Comparing the threat matrices of India and Pakistan, he highlighted India's greater perceived threat from China's advanced space capabilities, leading to the need for India’s aggressive counter-Space programmes. Dr Sarosh recommended Pakistan adopt a holistic approach, focusing on sustainability, evolvability, and survivability. He suggested creating an integrated think-tank, fostering a public-private partnership culture, and

developing a strong military space programme. He also urged Pakistan to leverage dual-usage technologies for commercial and military purposes, aiming for a sustainable space economy and indigenous counter-space capabilities over the next few decades.

While concluding his talk, Dr Sarosh emphasised that Pakistan's path to becoming a credible space power lies in cultivating a balanced space programme that addresses both commercial and military needs while contributing to regional growth and security.

The third speaker of the day, Dr Ahmed Saeed Minhas, Pro Vice Chancellor, DHA Suffa University Karachi, emphasised the importance of space laws to regulate global space activities, considering challenges arising from states' self-centered behaviour. He highlighted that Pakistan's space aspirations lag behind India's, necessitating corrective measures.

He analysed key UN General Assembly (UNGA) resolutions and space treaties. These included UNGA Resolutions 1148, 1348, and 1472, which led to the formation of the Committee on the Peaceful Uses of Outer Space (COPUOS). He also discussed the landmark OST of 1967, a cornerstone treaty which bans WMD in space and encourages cooperation. Other treaties which are also important in this regard focus on liability, astronaut rescue, and satellite registration, etc.

He emphasised that despite this plethora of treaties and resolution, there still exist gaps in space-related laws and regulations. The term "peaceful purposes" lacks clarity, and conventional weapons in space are not covered. Existing treaties lack provisions against space debris from anti-satellite (ASAT) tests and long-term sustainability concerns. Informal initiatives like Technical Confidence Building Measures (TCBMs) and codes of conduct contribute to trust but are non-binding.

Dr Minhas proposed a comprehensive strategy for Pakistan to reinvigorate its space programme, focusing on cooperation, innovation, policy development, and international engagement. While comparing India's success, starting in the late 1950s, he said that Pakistan's space programme faced challenges due to economic constraints, military focus, and budget diversion. To revitalise its programme, Dr Minhas suggested

the following strategies: diplomatic efforts to remove SUPARCO from the US Entity List, seeking Missile Technology Control Regime (MTCR) membership, and partnering with China for satellite technology. He also advocated for prioritising self-reliance, allocating more funds, involving the private sector, developing IT skills, and establishing national space policies. Collaboration with other space-faring nations, fostering student interests, and transparent communication about projects are also of vital importance.

During the Q&A / discussion session, various observers raised significant points regarding the challenges and potential of Pakistan's space programme. Concerns were voiced about brain drain, lack of incentives for experts to return to Pakistan, and the need for a standby system. The panelists emphasised the importance of creating an enabling ecosystem, public-private partnerships, and tapping the untapped capabilities. The gap between rhetoric and practical implementation, especially in data utilisation, was highlighted, with bureaucratic bottlenecks and policy shifts being the key obstacles. The discussion also centered on the lack of national resolve beyond financial constraints, with examples of underutilised resources and the need to harness Pakistan's potential for space endeavors.

In his concluding remarks, Air Marshal Asim Suleiman highlighted the transformative impact of space technology in contemporary times. He emphasised the significant role it plays in communication, navigation, remote sensing, and military applications. While acknowledging Pakistan's early entry into the space domain, he pointed out the need for accelerated progress. Drawing attention to the growing number of satellites orbiting the Earth, he stressed the importance of leveraging space technology for socioeconomic growth and military readiness.

He highlighted the critical components of a successful space programme, including space economy, military applications, satellite communications, navigation constellations, intelligence, surveillance, reconnaissance, counter-space operations, and miscellaneous space-based activities. He pointed out India's advancements in these areas and the imperative for

Pakistan to bridge existing gaps. Stressing the need for a robust space policy, he urged realistic goal-setting, private sector involvement, and emphasis on R&D.

Furthermore, he emphasised the evolving nature of space law, highlighting the treaties and conventions established by the United Nations. In this context, he stressed the importance of a comprehensive national space policy that aligns with ground realities, national ambitions, and international considerations. In conclusion, he stressed the significance of setting achievable goals, allocating resources, and establishing a robust institutional framework to ensure the success of Pakistan's space endeavours.

KEY TAKEAWAYS

Gaps in International Space Laws

There are gaps in international space law necessitating a major review of all existing treaties and integrating them into a comprehensive international legal framework for effective governance of outer space.

Space Dominance in Modern Warfare

The concept of achieving and maintaining space dominance is vital in contemporary warfare. Lack of this capability can be sternly disadvantageous.

India in the Lead

India has a clear edge in the space domain viz-a-viz Pakistan; enablers for India’s lead are: self-reliance, consistent leadership, strategic partnerships, public private partnerships, diplomatic efforts, and a focus on R&D cantered on self-reliance.

Challenges to Pakistan's Space Programme

Pakistan’s space programme has modest capacity and capability; lag is attributable to: overemphasised military façade of space programme, organisational bottlenecks, economic constraints, international sanctions, and absence of public-private partnerships.

INTRODUCTORY REMARKS

Air Commodore Khalid Iqbal (Retd)
Director National Security, CASS, Lahore

Air Commodore Khalid Iqbal (Retd), Director National Security, CASS, Lahore, opened the seminar with a brief overview. Aerospace is a term used to refer to the atmosphere and outer space collectively. Air power refers to ability to act within the atmosphere and space power denotes the ability to act in the space, whereas aerospace power refers to the ability of acting in air and space as a continuum. He said that space is a 'Global Common', whose ownership would belong to those who made an early entry and had sufficient staying power.

He further stated that while airpower formulation had matured with wide-ranging applications, space power was still evolving. However, he added, space had already become a significant arena for national power projection, both in civil as well as military domains. Space activity is quite diverse, as well as intense. For example, taking count of just one activity, as of 23 May, 2023, tracking website "Orbiting Now" had listed 7,702 active satellites in various Earth orbits. Other typical space applications include satellite communications, guidance and tracking systems, destructive and non-destructive materials testing, propulsion and engine testing, surveillance and electronic warfare, impact studies, engineering, mechanical testing and vibration analysis, etc.

He stated that the UN Office for Outer Space Affairs is of the view that appropriate use of space applications could help in early attainment of over 11 out of 17 Sustainable Development Goals (SDGs) through value addition to sectors like food security, global health, telecommunications, internet access, natural resources' exploration, disaster relief & risk mitigation and environment management, etc.

He explained that air and space are two conjoint mediums with distinct physical properties, and both support the classical characteristics of airpower: speed, range and elevation.

The duo also has similarities with regard to creating combative effects in support of surface forces, mobility support and intelligence gathering. However, air and space environments are quite different with regard to operation of vehicles through them, as each follows a different set of laws of physics. Aerospace vehicles that could move in air and space with equal ease are very few. Today, only a typical space shuttle falls in this category. It launches into space like a rocket, deploys satellites in space, and then returns to Earth like an airplane. Tomorrow, a whole range of aerospace planes may operate at hypersonic speeds in space while taking off and landing on Earth like airplanes. To evolve an aerospace environment, beside multitude of other items, sufficient number of aerospace vehicles need to become a new normal. Extensive experimentation is in progress with a series of hypersonic and trans-atmospheric vehicles, which promises easy and relatively inexpensive access to space in the near future.

Militarisation of Space

Talking about the weaponisation and militarisation of space, he remarked that weaponisation of space was being pursued at a fast speed. A group of ‘Space to Space’ weapons is identified with the Strategic Defence Initiative nicknamed ‘Star Wars’, having the objective of post-launch destruction of hostile Inter-Continental Ballistic Missiles (ICBMs). In ‘Space to Earth’ class, erstwhile Soviet Union had deployed a Fractional Orbital Bombardment System in low orbit that could hit targets on Earth's surface with conventional as well as nuclear warheads. In ‘Earth to Space’ category, there are ASATs to incapacitate or destroy satellites. China, India, Russia, and the United States have successfully tested ASAT capabilities while some other countries are on the threshold of acquiring it as well.

He pointed out that the OST of 1967 and associated laws are quite lax as they only prohibit the placement of WMDs, whereas the rest is free for all. Although Prevention of an Arms Race in Outer Space (PAROS) is one of the agenda items of Conference on Disarmament (CD), the CD has remained at a standstill on PAROS over the past couple of decades.

"The weaponisation of the outer space is here to stay and mushroom, and as a corollary, militarisation of space may just be around the corner."

Air Commodore Khalid was of the view that this window of opportunity is not open-ended and the CD would soon frame the laws for implementation of PAROS. Countries that place their weapons and associated infrastructure in the space before the promulgation of PAROS laws would be regularised as 'Space Weapon States' and the rest would get the nomenclature of 'Space Non-Weapon States'. Following this, various restrictions would be imposed on such Space Non-Weapon States with regard to placing their weapons and associated equipment in the territory.

Air and Space Operations: Ownership Dilemma

The Air Commodore also discussed space operations' ownership dilemma of contemporary air forces.

"Modern air forces are at a crossroads and the options of having an autonomous space force versus having it as an integrated part or as an adjunct of a typical air force will continue to be contemplated for quite some time."

As of now, the world's only independent space forces are of the US and China. Other countries are generally taking the route of combining their space forces under a single military branch, or under tri-services entities. Notwithstanding the organisational trends, the ultimate wish of a typical aerospace strategist is the seamlessly integrated usage of air and space mediums and forces.

Conclusion

He concluded by saying that Pakistan's space programme was at a nascent stage and in an inordinate lag viz-a-viz its neighbours, which warrants a policy review to make up for the lost time.

KEYNOTE ADDRESS

Major General Ahmed Bilal (Retd)

Major General Ahmed Bilal's (Retd) speech focused on space technology and its applications and how they act as a catalyst in the socio-economic development of a country and for its national security endeavours. He thanked Dr Abdul Salam, who was instrumental in ensuring that Pakistan was among the few countries which started the space programme as early as 1961. The first decade saw some quick progress, however, the impetus was slowly lost.

The speaker delved into the subject of emerging trends in aerospace power at the global level, specifically highlighting potential options for Pakistan's engagement in this realm. He emphasised the transformative role of space technology and its applications in both national development and security pursuits. Acknowledging Pakistan's historical foray into space programmes in the 1960s, the keynote speaker noted that subsequent decades saw a reduction in momentum, driven partly by brain drain and the US sanctions beginning in 1999. However, a turning point was marked in 2000, when the SUPARCO came under the domain of the SPD, initiating a new phase of space programme revitalisation.

Global Scenario

Over 60 countries are now involved in spacecraft operations, with a significant contribution from companies worldwide in the space industry. The concept of space systems for socio-economic advancement and national security is increasingly being recognised by emerging spacefaring nations. The extensive network of thousands of satellites orbiting Earth yields far-reaching social, scientific, strategic, and economic benefits to billions.

Aerospace Power

The speaker elaborated on the intricate nature of space technologies,

highlighting their dual-use capabilities. It was emphasised that space-based assets, originally developed for civilian programmes, possess the potential for effective military application.

This assertion was backed by the observation that the military utilisation of space is strategically designed to bolster terrestrial military and intelligence operations. Despite the pervasive utilisation of space for national security purposes, no state has openly criticised the military deployment of outer space assets, and the widely propagated notion of the militarisation of outer space remains contentious and contested by a majority of states.

Citing the 2003 Strategic Master Plan of the US Air Force Space Command, the speaker stressed the critical importance of achieving and maintaining space superiority in modern warfare. This sentiment further underscores the pivotal role of space assets in contemporary military operations. Notably, satellites play a crucial role in various aspects of conventional warfare, including intelligence gathering, remote sensing, navigation, and real-time monitoring duly supplemented by the “Aero” component.

Turning the focus to Pakistan, Major General Bilal highlighted the unique perspective of a nuclear state.

“For Pakistan, excelling in aerospace technology is not just a matter of technological advancement but also essential for economic viability and for projecting its status as a nuclear power.”

He strongly emphasised that in the current landscape, a country lacking the support of space-based assets would be at a substantial disadvantage in any military confrontation. He cited historical events such as 1973 Arab-Israel War and the US War in Afghanistan and elaborated how integrations of space assets turned out to be a tipping point.

He focused on the transformative developments within the space sector, which had extended boundless geographical outreach to space-faring nations. The air component, he explained, had previously enabled a more concentrated sphere of influence within specific areas of interest.

However, when augmented by space-based assets, the operational range and flexibility were exponentially heightened. The integration of technologies like drones, UAVs, LIDAR, AR, VR, etc., the speaker noted, have significantly influenced both civil and military applications of airspace. This intersection of air and space technologies is driving the swift evolution of the aerospace power concept. He illustrated this progression by referencing instances such as the US operations in Afghanistan, underscoring the role of UAVs, and the Tora Bora Bombing.

Major General Bilal further explained that the contemporary landscape encompasses net-centric management and governance, seamlessly spanning across civil and military domains. In this context, he emphasised the pivotal role played by space-based assets in cultivating a net-centric environment.

The speaker outlined aerospace as the discipline encompassing the scientific and engineering principles governing flight within Earth's atmosphere and outer space. Aerospace engineering, he clarified, branches into aeronautics and engineering, both of which engage in reciprocal exchange of knowledge and technology with the aviation and civil sectors. The speaker underscored following key trends which are shaping the aerospace industry:

Digitisation: He mentioned the gradual transition from traditional hydraulic and pneumatic systems to electrical digitised systems, benefiting space operations and aviation alike.

Artificial Intelligence: He detailed how AI-driven automation and error reduction were reshaping the aerospace landscape. He cited instances like Generative Design Technology and Collaborating Robotics as clear examples.

Additive Manufacturing (3D Printing): He explained the current focus on low-stress internal component production and highlighted the potential for future adoption of stronger materials like graphene for revolutionising manufacturing approaches.

Advanced Satellite Technology: The speaker emphasised the rising demand for geospatial data and satellite imagery, coupled with lowered

launch costs. As the retired official highlighted, this has led to the development of miniaturised satellites (Pico and Nanosatellites) and expanded manufacturing possibilities through 3D printing and in-orbit service.

Aerial Mobility: He noted the emergence of concepts such as air taxis, hyper-local drone deliveries, and emergency services, alongside technological developments like eVTOL and supersonic/hypersonic flights.

Immersive Technologies (VR, AR): The speaker detailed how the integration of virtual reality (VR) and augmented reality (AR) was transforming training mechanisms for engineers and pilots. He explained how these technologies were enabling real-scenario simulations and simulator-based training, akin to applications in the gaming industry.

Sustainability: He highlighted the aerospace industry's commitment to sustainability, with ongoing initiatives such as biofuels, electrical propulsion, and enhanced fuel efficiency.

Blockchain: He elucidated how blockchain technology's high-level encryption is enhancing data security and network resiliency within the aerospace industry. The speaker emphasised its role in eliminating single points of failure and enhancing access and visibility in supply chain data. He also reinforced the critical role of space technologies in modern warfare scenarios.

Regulatory Mechanism

Focusing on the regulatory mechanisms governing outer space, the keynote speaker emphasised that space is a global common, regulated by the UN through a series of international treaties and protocols. He highlighted that the subsequent speakers would delve into the subjects of civil and military applications, international obligations concerning the space sector, and the development strategy.

Key Assets & Technologies in Space Sector

Major General Bilal emphasised that with Pakistan having a fairly stable base to develop a space sector and to cater to maximum benefit, the

immediate focus should be on acknowledging the challenges and establishing a relatively stable foundation. He emphasised the need for immediate attention in domains where varying levels of capabilities have already been harnessed, while also emphasising ongoing enhancements in weaker areas. The specific areas of focus include: Remote Sensing Satellites (Optical, Hyperspectral, LIDAR, Radar, IR, N IR, etc.); Communication Satellites; SLV and Launch Stations; Computing Systems (OBCs); Radar Technologies; Data Interpretation and Application Technologies; Navigational Satellites constellation (Local Area); Sensor Technologies; Space Observatories; Propulsion Technologies; Robotics and AI; Ground Based Control, Receiving / Transmitting systems and Special Mission Satellites.

The intent behind this strategic approach is to optimise existing capabilities while progressing in areas requiring further development, thereby advancing the broader goals of the space sector.

Remote Sensing Satellites

The speaker elaborated on Pakistan's existing capabilities in the realm of remote sensing satellites, highlighting the current deployment of two satellites in Low Earth Orbit (LEO), PRSS and PakTES 1, were active since 2018. A substantial archive of data spanning decades, from 1976 onwards, has been amassed for R&D endeavours. While acknowledging the current utilisation of this data across diverse sectors, he emphasised the potential to optimise its use in various areas, including agriculture, disaster monitoring, hydrology, forestry, environmental surveillance, etc.

He noted the optical nature of existing remote sensing satellites and proposed the integration of diverse sensors such as IR, N IR, Radar, Hyperspectral, and SAR in future satellites, augmenting data value and facilitating comprehensive analysis of various regions, both commercial and militarily. The development of a comprehensive National Spatial Data Infrastructure (NSDI), underscored by initiatives like the Integrated Flood Assessment System (IFAS), Disaster Management (SACRED), and more, was emphasised to expedite data accessibility for informed decision-making and effective governance.

Furthermore, he raised several thought-provoking questions. Is Pakistan maximising the use of its satellites and available data? If not, what are the underlying reasons?

"There is a need to harness both aviation and space-based assets for obtaining pertinent data, thereby establishing operational synergies between the two domains."

He highlighted that a noteworthy aspect is the limitations of Remote Sensing satellites which has prompted the utilisation of aviation resources to gather more relevant data for specific analyses and applications. This underscores the necessity for operational connections between aviation and space-based capabilities. Instances include geomagnetic surveys and LIDAR technology, highlighting the synergy between these domains to enhance data acquisition and further refine analytical insights.

Communication Satellites

Shifting the focus to communication satellites, the speaker highlighted the presence of PakSat 1R, currently serving various domains within its footprint, from tele-education and telemedicine to direct-to-home TV and broadband internet. With the upcoming retirement of PakSat 1R in April 2026, Pakistan's second communication satellite, MM1, is set to launch in September 2024, offering C, Ku, and Ka Bands. The speaker urged a consideration of how to optimally utilise MM1's capacity, especially during its two-year overlap with PakSat 1R as the latter has completed 80 percent of its useful life and is currently utilising only 50 percent of its available capacity.

Flexibility in planning and decision-making processes, he stressed, would be pivotal in achieving optimum satellite utilisation.

Navigational Satellite Constellation

The speaker addressed several crucial aspects of aerospace development, shedding light on the significance of navigational satellite

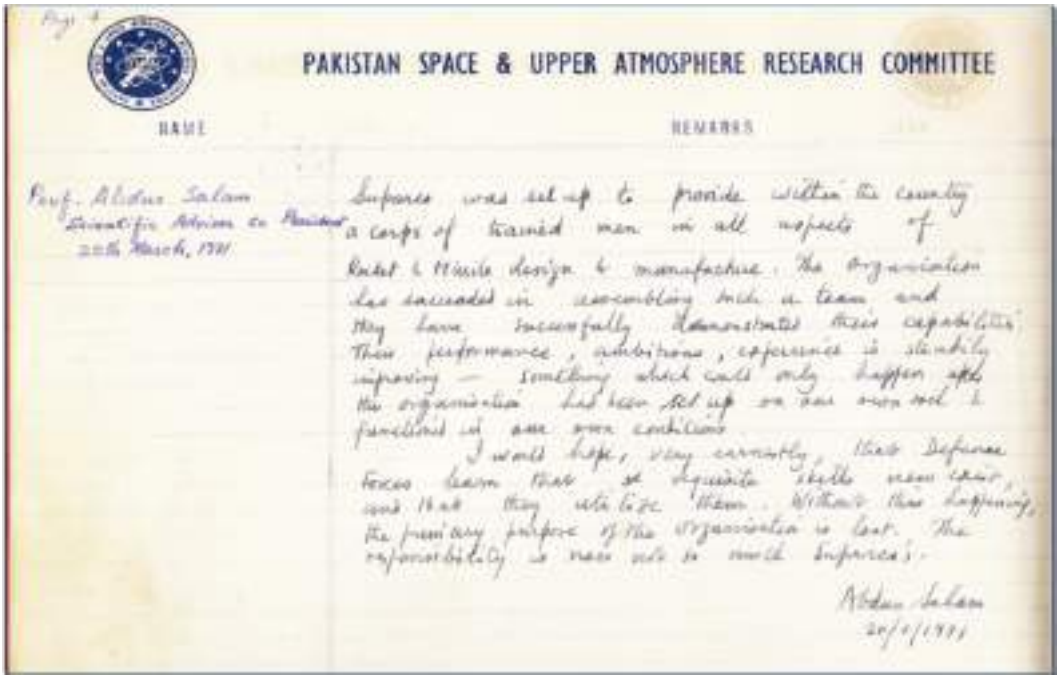
constellations. It was highlighted that Pakistan's acquisition of a regional constellation for navigational satellites should be complemented by a ground-based CORS system. He referenced the establishment of an experimental five-node cell in the Karachi area, a testament to the viability of this concept.

A key point emphasised was the potential of combined satellite technologies to elevate governance standards and drive revenue generation. The speaker highlighted how pilot projects by SUPARCO have effectively demonstrated these possibilities.

Rocket Motors and LPRE: Satellite Launch Vehicle (SLV) Development

Moving forward, the speaker delved into Pakistan's proficiency in rocket motor development. It was noted that SUPARCO had been launching indigenous sounding rockets since as early as 1966-67. The organisation's technological prowess was evidenced by its role in developing rocket motors for the Pakistan Air Force. SUPARCO helped develop the first few Shaheen missiles in the late 90s. It also demonstrated technological prowess by indigenously manufacturing special rocket motors for PAF.

The speaker presented an archival document (dated 20 March 1971) by the founding Chairman of SUPARCO, Dr Abdus Salam (appended on next page), expressing grave concerns about the organisation’s performance with regard to not accruing the latest technical skills. He lamented: “I would hope, very earnestly, that Defence Forces learn that requisite skills now exist and that they utilize them. Without this happening, the primary purpose of the organisation is lost.”



PAKISTAN SPACE & UPPER ATMOSPHERE RESEARCH COMMITTEE

NAME

REMARKS

Prof. Abdus Salam
Scientific Adviser to President
20th March, 1961

Supparco was set up to provide within the country a corps of trained men in all aspects of Rocket & Missile design & manufacture. The organization has succeeded in assembling such a team and they have successfully demonstrated their capabilities. Their performance, ambitions, experience is steadily improving — something which could only happen after the organization had been set up on its own soil & functioned in some even conditions.

I would hope, very earnestly, that Defence forces learn that to acquire skills never exist, and that they utilize them. Without this happening, the primary purpose of the organization is lost. The responsibility is more with the Defence's.

Abdus Salam
20/3/1961

A Note by Dr Abdus Salam

To excel in propulsion technologies, the speaker recommended a strategy optimisation, focusing on:

- Indigenous development of a Small LPRE engine for the last stage of SLV, enhancing satellite acceleration.
- Short-term development of solid-fuel SLVs for launching satellites in LEO.
- Continuation of LPRE development for SLVs, allowing the launch of satellites into the Geostationary Orbit. Till then, continuing the purchase of a launch every six to seven years for the communication satellite programme.

Radar and Sensor

The speaker highlighted that radar and sensor technologies are both integral to aerospace management and applications. While sensor development required fresh incubation, radar development could progress rapidly due to existing knowledge and engineering capabilities.

Reasons for Slow Development of the Space Sector

According to Major General Bilal, since the establishment of SPD, the pace of development in the space sector has picked up, but much needs to be done at the national level. The main reasons for slow development are:

- Lack of national resolve and will to progress in the space sector.
- Weak economy.
- No clear and announced space policy.
- Lack of awareness of the importance of the space sector.
- Weak education sector (schools, colleges and universities).
- Hardly any curriculums of space sciences and engineering in universities. Poor standards in disciplines such as applied mathematics, applied physics and no faculties of astrophysics, astrobiology, space mechanics, astronomy, etc. in universities.
- Virtually no high-end technical institutes.
- Reluctance of using space technology applications for socio-economic development.
- Banking on borrowed technology instead of evolving technology. The concept of Transfer of Technology (TOT) needs review.
- Lack of R&D and innovation.
- No system of utilising spin-off technologies.
- No system to evaluate a new idea or concept on merit.
- Lack of continuity of programmes.
- Partial lack of transparency in sharing of knowledge and information.
- Duplication of efforts and resources in the wake of a weak economy.
- Difficulty in acquiring data for research (space sector).
- Intellectual corruption (detrimental to knowledge generation).

Technology Life Cycle

A critical observation was the reliance on borrowed technology rather than technology evolution. The speaker called for a review of the concept of TOT. The lack of R&D, innovation, spin-off technology utilisation, and evaluation systems for new ideas was underscored.

Highlighting the technology life cycle, the speaker explained its four stages

- The innovative stage
- The growth stage
- The maturity Stage
- The decline stage

He stressed that nations typically share technology during the first two stages. According to Major General Bilal, in countries like Pakistan, the products also are sold in advance maturity stage, while key support technologies are held back.

"If Pakistan wants to be an important player in the aerospace sector, it must get involved in the first two stages of the technology cycle, and the other two will automatically come through."

The speaker directed the focus toward a prospective path forward, underpinned by a resolute national commitment. Over the coming decade, a dedicated, concentrated national effort, as outlined, holds the potential to deliver remarkable achievements.

The Way Forward

In considering the path ahead, assuming the presence of national determination, a concentrated and dedicated national effort over the upcoming decade can yield the following achievements:

- Maintain two to three communication satellites in the Geostationary Orbit (GEO).
- Maintain 6-8 RS satellites in LEO to meet the data requirements.
- Be capable of indigenously designing and developing communication and RS satellites to meet national requirements.
- Be capable of developing different sensors for mission-oriented, earth observation satellites.

- Be capable of launching its LEO satellite through an indigenous SLV programme, besides undertaking commercial LEO launches for other customers.
- Operate a constellation of Regional Navigation Satellite System (RNSS).
- Establish a fully mature CORS system for benefiting from RNSS/GNSS application in Pakistan and transferring its benefit for the uplift of society and national security.
- Develop space technology applications and permeate these into the national system to support the socio-economic development effort.
- NSDI Programme must be put in place as soon as possible.
- Scientists and engineers in the space discipline (HR) in our universities and provide enough exposure of space related issues to students in schools/ colleges.
- Have at least two National Space Observatories, one in the north and the other in the south of the country, with links to international observatories to enable universities and other researchers to study the cosmos.
- Have a space weather counter to provide information on changes having an impact on Pakistan.
- Benefit from the Chinese Space Station programme for microgravity experiments and sending a Pakistani astronaut into space.
- Synergise the development in the space and aviation sectors while getting ready to harness the potential of aerospace power.
- Organise forthwith a tri-service cell at SPD to streamline military uses of the space sector and combined aerospace applications for national security.

Space Policy

According to the speaker, as of today's status, national space policy may be described as rather indistinct and lacking formalisation. However, the achievement of a harmonious national synergy within the realm of space demands the creation of a well-defined space policy, the responsibility of

which falls upon the government.

"A cohesive effort from all stakeholders, including developers, users, facilitators, and others, is essential to work seamlessly towards the common objectives of effectively developing and utilising the space sector and its supporting industries over the long term."

This underscores the undeniable significance of the aerospace sector. Additionally, the retired official highlighted the need to eliminate any bottlenecks and bureaucratic hurdles that may impede progress. The space policy must be meticulously formulated, drawing inputs from all relevant stakeholders, and subsequently announced to bind all sectors together in the collective endeavour to propel the growth of the National Space Programme.

Noteworthy contributors in this endeavour may encompass entities such as the defence forces, intelligence organisations, Ministries of Defence, Foreign Affairs, Science and Technology, Commerce, Industry, Education, Communications, Law, and Finance, among others.

Major General Bilal proposed the following objectives of the space policy:

- To build a space infrastructure and industry for the socio-economic benefit and national security.
- To empower civil society in enriching their quality of life through the innovative application of space technology.
- Acknowledging space as the frontier for new knowledge generation, and to capitalise on it for contributing to scientific and technological development.
- To build a space infrastructure and industry for the socio-economic benefit and national security.
- To empower civil society in enriching their quality of life through the innovative application of space technology.

- Acknowledging space as the frontier for new knowledge generation, and to capitalise on it for contributing to scientific and technological development.

In the context of having established and made public the space policy, the speaker emphasised the pivotal role of the aerospace sector. He proposed a three-pronged strategy, as follows:

- Firstly, it is important to ensure the comprehensive utilisation of existing aerospace capabilities and resources to drive socioeconomic development and enhance national security. This strategy also involves the ongoing upgradation of capabilities in response to evolving technology and user demands.
- Secondly, Pakistan must strive to achieve self-sufficiency and indigenisation to the greatest extent possible within the short to medium terms. This involves addressing the fundamental requirements across the entire spectrum of aerospace while avoiding duplicative efforts and resource wastage. The proposal also involves active engagement in emerging science and technology disciplines to maintain relevance in the ever-growing aerospace sector. Additionally, the speaker pointed out the intention to leverage the benefits arising from R&D efforts, as well as harnessed technologies, for industrial and economic gains.
- Thirdly, the speaker proposed the imperative to synergise the collective national endeavour to ensure sustained growth within the aerospace sector. This would entail harmonising diverse national policies and collaboratively coordinating their execution, all aimed at fostering continual growth in the aerospace sector. This strategy requires ensuring a consistent supply of human resources, along with technological, industrial, economic, and international support.

Key participants in this effort would encompass universities, schools, colleges, R&D organisations, technology companies, precision

engineering establishments, relevant ministries, and elements of the national security apparatus.

Conclusion

In the end, it was emphasised, that, technology is changing at a fast pace. A sustained uninterrupted effort is needed to benefit (economic and operational) from it in the time window it offers. This holds true for the main technologies or their spin-offs. Incubating technologies at home and putting them to use is the only way forward for sustained progress, economic viability and operational independence.

Evolution of Space Power in South Asia: Civil & Military Applications

Dr Ali Sarosh

Dr Ali Sarosh initiated his discussion by stating that the last 20 years or so have witnessed a major shift in global space power. Countries that were once the powerhouses of space technology are now seen wanting for newer space tech. In addition, a growing number of commercial actors have also gotten involved in space, resulting in more commercialisation, innovation and benefits on Earth, but also more congestion and competition in space.

He stated that South Asian countries are neither benign nor hermetic to global changes; they have been making considerable progress in development and utilisation of space power; sometimes driven by a need for change but often out of rivalry and status. Nevertheless, the civil applications of space tech have already penetrated nearly every household in South Asia. Pakistan's Paksat-1R, PRSS constellation, and India's Cartosat constellation continue to provide services. India's Mangalyaan and Chandrayaan missions have placed South Asia on the map of space exploring nations. He predicted that it will just be a matter of time before the spin-off effect, technology competition and the perpetual regional rivalry will draw in other competitors in this race too. He stated that the military aspect of space tech has been equally significant in South Asia. Although the outreach has been limited primarily to India and Pakistan only, space-based systems are becoming increasingly significant for weapons and vessels both. As space assets of countries around the world and in South Asia grow, so does the need to protect them.

Space Power & Space Warfare

The speaker explained the term space power, which is broad and wholesome. It encompasses an entity's ability to project its reach in both civilian and military domains through the space medium.

He further said that in essence, space power, be it in military or commercial forms, is a manifestation of a single larger phenomenon called “space dominance”, the most overwhelming tool of the 21st century warfare.

The ability to provide commercial space services to subscribers at market competitive rates and hence become an active member of the global space economy’s ecosystem such as SpaceX, Aotian Technologies is as much and sometimes bigger part of space power. Fundamentally, space warfare is a concept of military operations. In reality, it is just half of the definition of space power; an act of launching attacks from earth-to-space, space-to-space, or space-to-earth on the adversary while operating from beyond the Karman line.

“The pinnacle of military space power is the counter space technology; the ability to deceive, disrupt, deny, degrade, or destroy adversary’s space systems so as to gain military advantage.”

He remarked that countries that invested in building civilian space programmes using legacy technologies then proceeded to develop indigenous tools for commercial space application. This was followed by military space programmes.

The speaker further said that with global powers treading fast on the path of creating, implementing and expanding their space force structure implies that militarisation of space is about to become the new normal in global strategies. The OST & START treaties of the 1960s and 80s are feeble, unwholesome and lack technological depth, thus, for now, the only mechanism keeping the world from descending into a space weapons chaos is a delicate equilibrium between the relative abilities of the global powers.

Evolution of Space Power in South Asia

The speaker said that the evolution of space power in South Asia has been an asymmetrical process, with India coming from behind to take the

lead which is now several decades ahead of the closest rival, Pakistan.

He said that the history of space power in South Asia has had varying overtones, whilst India's space programme from its inception has been predominantly civilian with recent military spin-offs, that of Pakistan has had a profound military overtone, which, unfortunately, has turned out to be less beneficial than expected from both, space technology and space economy perspectives.

He further highlighted that today, while Pakistan is toiling hard to become a regional space player, India has already cut into the global space league with more than 75 orbital spacecraft, indigenous launch capability to LEO and geostationary transfer orbit (GTO), planetary explorations, ballistic missile defence capability, and a rapidly evolving counter-space operations (CSO) programme. He stated that India's strategy has been simple: it is following the best practices in the space industry for building a commercially viable and sustainable space programme before venturing into space warfare. This strategy appears to have worked well for all major space powers.

The evolution of space power on Pakistan's side has, however, been less organic. An inevitable need for reactionary spontaneity to adversary's stimuli, a reduced degree of acceptance of technology failure in evolutionary tests and trials, and a retrograded priority for space commercialisation have all contributed to Pakistan falling behind its foremost rival, especially in space power. For Pakistan to get out of this economic-security conundrum-like situation, it is not too late to make some fundamental corrections such as a one-step back and two-step forward approach, which is the need of the hour.

Global Trends and Indian Space Warfare Ambitions

The speaker said that although India has acquired over five decades of experience in commercial space applications and technologies, its military space tech is just about two decades old. Even today, India's bedrock of space power is its commercial space programme. Ever since commencing its international space operations in 2014, India has launched 353 foreign

commercial satellites and generated revenue in excess of $30 million from US and over Euros 180 million from European Union customers alone. The availability of commercial space revenue, home-grown legacy space technologies and a burgeoning economy offer a perfect recipe for India's space warfare ambitions.

He said that since 2009 India has used China's ASAT test of 2007 as a pretext for building the counter space programme. He quoted Air Chief Marshal P V Naik's 2010 statement, "Our satellites are vulnerable to ASAT weapon systems because our neighbourhood possesses one." The Indian IDC considered that India must have its own ASAT capability too, for which it has developed a military space programme based on cutting-edge space technologies.

The speaker described and enlisted Offensive CSO technologies which are making global headlines. The Co-orbital Anti-satellite (CO-ASAT) Operations, he said, is a highly complicated and clandestine Rendezvous & Proximity Operations (RPO) manoeuvre that is performed using robotic arms to grab adversary's satellite for tugging and deorbiting. He elaborated that this is a dual-use technology which can be used for space debris remediation and offensive CSO.

"Based on the current technology assessments, India is about five years from performing their first orbital docking and hence they will be in a position to implement CO-ASAT by the end of this decade."

The speaker then explained that possibly the most commonly known offensive CSO is the Direct Ascent Anti- Satellite Systems (DA-ASAT). He mentioned that it holds a cult status for all aspiring space forces. To date, US have performed 33 tests (since 1959), Russian has performed 37 tests since 1963, and China has performed 12 tests while two tests were performed by India in 2019. Importantly, the mission complexity of DA-ASAT and space debris problem increase manifold with orbit altitude. Therefore, most tests have been performed at orbit altitudes less than 500 km. Nevertheless, he stated that India's enduring desire is to reach the

800km orbit altitude for which the viable option will be to replace the existing Prithvi with Agni-V launcher. Additionally, to perform DA-ASAT on adversary's assets at such high orbit altitudes, India will also need a very high-fidelity space situational awareness solution for which the Basic Exchange Cooperation Agreement (BECA) 2020 agreement with the US is of high importance.

Strategic Significance of DA-ASAT to India

He then went on to explain that mission Shakti holds vital significance for India's strategic vision as a regional or continental military power. On the one hand, it proves India's technological prowess as a military space power; a legitimate edge of getting into the direct ascent ASAT club. He said that this in the backdrop of what India considers a missed opportunity in 1968 when they were left out of the nuclear non-proliferation treaty due to a delayed nuclear testing of 1974. Now any future space weapons treaty will not be made without India.

In terms of Electronic Warfare (EW) operations, India is actively pursuing the most potent of EW i.e. Counter Communication Systems (CCS) – for wide-to-full spectrum communication jamming of L, C, Ku, Ka and X-bands, link jamming of GNSS, satellite communication.

Directed Energy Weapons (DEWs) is another dual-use technology with space debris remediation and dazzling adversary's satellites. As per early information, India's government has unofficially acknowledged that DEWs of 10kW and 20kW power were underdevelopment and may take another three to four years before being test-ready technologies for laser dazzling against adversary satellites. He further described that advanced laser cooling tech, further supplemented by Neutral Particle Beaming (NPB) that will be essential for overcoming the deteriorating effects of Earth's magnetic field on energy beams, can be added in later stages.

About Space Situational Awareness (SSA), the speaker mentioned that India's ISRO spearheads NETRA for multi sensor integration of SSA systems to identify and track objects in LEO and GEO both. Up till 2021, India had acquired the ability to track and identify cooperative objects,

however, India still lacked the ability to identify, and track non-cooperative objects. To remedy that, Prime Minister Narendra Modi's government successfully concluded the BECA 2020 agreement with the US. He described that this agreement is a technology game changer as India will receive direct assistance in the form of classified data-sharing and data processing from US Space Force and non-governmental entities. A good SSA will thus provide the most precise knowledge of what-is-where to the Indian space warfare machinery.

Fractional Orbit Bombardment System (FOBS), he described, is an offensive space operations technique which is not new and has been affected by the OST and SALT-II treaties. Nevertheless, he said, China successfully combined the concept of FOBS and hypersonic glide vehicle (HGV) in one package. He mentioned that in July 2021, the PLA's FOBS mounted HGV orbited the Earth several times before gliding back and hitting the target on ground. The concept was successful in proving the evasive abilities of FOBS mounted hypersonic space vehicles which are another dual-use space technology. The growing frenzy with hypersonic system is visible on this list of fielded weapons and those currently under development in different parts of the world. This implies that the coming decade will possibly witness an array of novel highly unpredictable hypersonic space system making way into conflicts around the globe. For India, Brahmos-II will be their platform of choice.

The speaker said that the intermediate-range ballistic systems (IRBM) based exo-atmospheric interception capability of Prithvi Air Defence (PAD) system plus the AD-1 missile-based endo-atmospheric interceptor, supplemented by the recently inducted S400 TRIUMF offer an effective if not wholesome Defensive CSO package. He stated that for the South Asian region, this plethora of military space technologies confirms that India's space ambitions are now unambiguously offensive. Regarding the question about why does India need to put up an elaborate counter space programme and to what extent should Pakistan or rest of South Asia worry about Indian military space tech, he said that the answer lies in understanding the Indian and Pakistani threat matrices.

Indian Threat Matrix Vs Pakistan's Threat Matrix

He quoted Sun Tzu from his classical works, The Art of War, that "if you know the enemy and know yourself, you need not fear the result of a hundred battles". He said that it is absolutely essential to understand as to what has made Indian space ambitions so effective and aggressive. The answer to this lies in understanding the threat paradigms of India and Pakistan.

He compared the threat matrix of India and Pakistan and concluded that India's perceived threat to space assets does not emanate from Pakistan as much as it comes from China's near-full spectrum capability. Moreover, he said that the ever-increasing array of Indian assets in orbit and on the ground implies that India finds itself under far greater pressure to develop and deploy an offensive and defensive counter-space programme for safeguarding its own assets against the perceived threat from Beijing. He further said that the overall level of perceived threat to Indian space assets is far greater than that posed to Pakistan. Pakistani assets are few versus an evolving and still nascent Indian counter-space programme, there is rarely an Indian space asset that does not have a direct and imminent threat from China's counter space capabilities.

"For Pakistan, any augmentation in Indian offensive counter-space capabilities will pose a disproportionate threat to its limited space assets."

Options for Pakistan to Neutralise India's Space Advantage

The speaker expressed that nascent powers such as Pakistan have limited space assets and resources; thus, they cannot afford to allocate unlimited resources towards space militarisation. Therefore, he advised that to safeguard Pakistan's interests in the space domain, three key factors of vital importance are: sustainability, evolvability and survivability.

A nascent space power's first and foremost concern should be to build a space programme that generates adequate revenues and becomes sustainable in the future. The space programme should be supported by

active research so that space assets go through an evolutionary process starting from legacy systems evolving into newer generations of contemporary space-qualified products. He said that evolvability also implies segment-by-segment growth.

Survivability is the factor, whereby military space operations play their due part. The first and foremost would be to put in place an effective defensive CSO programme. Next, he stated, should be the evolution of offensive CSO mechanisms. He then expressed his views on how Pakistan can proceed through the next decades.

He said that firstly, Pakistan needs to take a fundamental one-step back and create a highly integrated “technology-strategy” think-tank, consisting of strategists, technology developers, military planners, and prospective financiers into a wholesome body possibly an Integrated National Space Centre, to oversee the implementation and continuing evolution of the space programme and space policy.

Secondly, he said that space power must be rethought as predominantly a $1 trillion upcoming space economy with tangible commercial gains for Pakistan, leading to high-end military spin-offs, achievable through the collaborative development of space assets using the public as well as curated private space entities.

Thirdly, Pakistan must endeavour to create a public-private ownership enterprise culture in space domain. There is a need to remove all possible bureaucratic hurdles for private sector to enter and work with SUPARCO on commercial space ventures. An excellent opportunity could be a commercial spaceport in the coastal region for posigrade and retrograde launches from a single location.

Fourthly, on the military side, Pakistan must start from the doable and reach for the undoable i.e. high fidelity space situational awareness (SSA) solutions integrated with sensory network and the acquisition of BMD are inevitable in the next five years or so.

Lastly, he said that the readiness for an offensive CSO must still be pursued. The conversion of exiting intermediate range ballistic systems offers a suitable candidate platform for kinetic CSO option. The extent of

offensive CSO must be commensurate with the degree of external threat, the extent of dependence for space technologies acquisition and most importantly the budgetary constraints and economic priorities of the country.

The recent resurgence of dual-use space technologies must be tapped-in for integrating space commercialisation and space warfare in one package. Space robotics could potentially offer on-orbit servicing and CSO in one package; hypersonic technologies could be used for space transportation as well as in fractional orbit systems (FOBS), etc.

The speaker summed up his discussion by stating that in essence what Pakistan needs is a sustainable, rapidly evolving space programme and space policy to turn into a credible space power, one capable of supporting its own commercial and military needs and those of the region.

"Pakistan must aim for a sustainable space economy based on orbital operations, light-lift capability, spaceport services, etc., together with indigenous counter-space capabilities over the next two to three decades."

He concluded his discussion with a quote by Viktor Frankl: "Between the stimulus and response, there is a space. And in that space lays our freedom and power to choose our responses. In our response lie our growth and our freedom."

Gaps in International Space Law and Viable Developmental Strategy for Pakistan's Space Programme

Dr Ahmed Saeed Minhas (Retd)

Dr Ahmed Saeed Minhas started his discussion by stating that in order to effectively manage and regulate the actions of this particular entity, it is essential to establish laws and regulations, including the governance of outer space. He said that the exploration of space is accessible to all nations based on the principle of equality. In accordance with the realist paradigm, he said, global space governance faces challenges due to the states' self-centred behaviour, which overlooks negative consequences and seeks to maximise benefits. The security implications of space-based technologies drive interstate competition, with great powers exploiting space for their military advantages. Dr Minhas opined that the blurred distinction between peaceful and military use of space-based capabilities further multiplies the urge to misinterpret others' actions and respond accordingly. He said that Pakistan is a space aspiring state, however, it lags behind India, while the latter started its space programme in same time frame, rather a little late. There is a need to take corrective measures to return to track.

International Space Law and the Gaps With Regard to Militarisation of Space

The speaker presented an analysis of International Space Law. He started by mentioning the 14 November, 1957 UNGA Resolution 1148 (XII) which resolved to organise a 'joint study' by the US and Soviet experts to suggest a verifiable inspection system to ensure that the outer space assets sent to space shall be exclusively for peaceful and scientific purposes. He said that it the most initial initiative by the UN to ensure that outer space is used for peaceful purposes only. The subject UNGA resolution was adopted after the failure of the US-Soviet bilateral talks on

keeping the outer space exclusively for peaceful purposes after the Soviets' launching of the Sputnik on 4 October, 1957.

He then mentioned the 13 December, 1958 UNGA Resolution 1348 (XIII) which suggested establishing an Ad Hoc Committee on the Peaceful Uses of Outer Space. The Ad Hoc Committee was an initiative to institutionalise the cooperation for peaceful uses. He further mentioned the 12 December, 1959 UNGA Resolution 1472 (XIV) which lead to the establishment of UNCOPUOS. It was established to regulate space activities and avoid the extension of rivalries into outer space, which could appropriately be undertaken under UN auspices. He said that UNCOPUOS later became the most influential UN body for addressing space law issues and the committee has five outer space related treaties to its credit since its inception. Then on December 20, 1961, the UNGA/ UNGA Resolution 1721 (XVI) was passed which set two principles for use of outer space: international law, including the Chapter 51 of the UN, applies to outer space and celestial bodies; and outer space and celestial bodies are free for exploration and use by all states in conformity with international law and are not subject to national appropriation. UNGA Resolution 1721 recognised that the international law and UN Charter applies to the states' outer space activities inter-alia use of force for self-defence, etc.

The speaker also highlighted the 13 December 1963 UNGA Resolution 1962 (XVIII) titled "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space". This resolution was the identification and declaration of legal principles for governing outer space activities. The legal principles comprise nine aspects which include space exploration for mankind, outer space and celestial bodies free for exploration on equality by states as per the international law and the UN Statute, no national appropriation of space, promotion of international cooperation, states are liable for action, states shall have jurisdiction on its space launched object, and astronauts' personal safety and security assurance. He stated that the subject resolution was a sequel to UNGA Resolution 1721 (XVI).

"The principles identified by the UNCOPUOS are regarded as the most influential legal base for the currently enforced outer space treaties as well as for the future negotiated treaties related to outer space activities' regulations."

He mentioned another treaty UNGA/ UNGA Resolution 1884 (XVIII) "Question of General and Complete Disarmament" which called upon all states to refrain from placing nuclear weapons or WMDs in Earth orbits, or on celestial bodies. He said that the subject resolution was the most initial step towards negotiating the OST. Similarly, in 1963, there was an Eighteen Nation Disarmament Committee (UN Body)/ The Limited Test Ban Treaty (LTBT) which aimed to ban the nuclear weapon testing or explosion in outer space environment for the obvious environmental damage. This was first ever multilateral treaty which specifically mentioned outer space in its text. Still in force, however, it has been stalemated with regard to including 'underground' testing since 1991 due to the US' resistance. It banned nuclear weapons testing in the atmosphere, in outer space, and under water.

The speaker mentioned the 1967 OST which aimed to achieve outer space cooperation in exploration and banning nuclear and WMDs in the territory. He said that this treaty is regarded a Mother Outer Space Treaty, Outer Space Statute and foundation stone for all future international space laws and treaties / conventions. OST was a sequel to the principles identified in UNGA Resolutions 1884, 1721 and 1962. The OST set the path straight for other four outer space legal treaties i.e. Astronaut Rescue, Moon Treaty, Liability Convention and Registration Convention. It was also an extension of LTBT scope which banned the placement of WMDs in outer space besides nuclear weapons. He then talked about the 1968 Astronaut Rescue Agreement which aimed to ensure safe rescue of astronauts and space-crafts which have an unintended landing due to emergency, accident or distress. He said that this agreement was an endeavour of granting immunity to an astronaut in case of an emergency unintended landing anywhere, including seas and geographic jurisdictions

of other states. He further mentioned the 1972 Liability Convention which was a political commitment for undertaking liability to pay compensation for damage caused by a space launch on Earth to an aircraft and assets in outer space. He said that the negotiations on subject convention were spread over 10 years (1963-1972) and were led by the UNCOPUOS legal subcommittee and an extension of the Article VII of the OST which touched upon the liability issue. An indirect warning / deterrence were initiated through this convention against a deliberate attempt of causing damage to an outer space object.

Moreover, he said that the 1974 Registration Convention objective was to identify the outer space assets, including satellites so as to facilitate the liability compensation by assured attribution. He stated that the convention contributes towards peace in outer space by deterring states from initiating hostile acts from a registered outer space objects besides attribution. Moreover, the registration convention refrains spacefaring nations from launching those outer space assets which have the potential to be used in offensive mode or carry weapons as well as outer space mines.

The 1979 Moon Agreement was another important space related treaty with the objectives to prohibit placement of nuclear or WMD on Moon surface or the Moon orbit. It also prohibited use or threat of use of force on Moon or from Moon. However, it only has 11 signatories and 17 parties and was not accepted by many states for various reasons. Out of P-5 states, only France has signed it but it has not ratified it. On the other hand, US, Russia, UK and China have neither signed nor ratified it. Pakistan had ratified it in 1986, whereas India is just a signatory. It was considered to be an elaboration of the OST with specific focus on Moon. As Moon was accepted to be used only for peaceful purposes, the US and Russia have been and still are tangent to the understanding of term ‘peaceful’.

The speaker also mentioned the 2014 Prevention of Placement of Weapons in Outer Space (PPWT) treaty, which is aimed at negotiating a legally binding treaty to pre-empt placement of all kinds of weapons in outer space for ensuring global strategic stability i.e. security for all.

However, it could not make any headway in the CD because the US had certain objections to it. These included the failure to address terrestrial based ASATs, laser weapons or co-orbital-weapons; non-mentioning of threat posed by space debris created by the ASAT tests; and no comment on dual use technologies i.e. if a state captures an active satellite of opponent state in the garb of removing space debris. In addition, the definition of 'outer space objects' does not commensurate with the definition of the same already acknowledged by the Rescue Agreement and the Liability Convention.

Challenges Faced by the International Space Law

The speaker talked about the overall Impression of International Space Law where space powers do not want to have legally binding treaties but Track-II non-binding arrangements. The International Space Law is kept vague and open-ended for keeping the initiative in own hands for maintenance of technology monopoly.

He further explained that there are gaps in OST which includes undefined meaning of peaceful purposes in OST text, and no mentioning of placement of weapons on satellites/ conventional weapons in orbit. He said that the treaty is silent on deploying conventional weapons, use of non-kinetic means against the space assets, non-existent space weapons definition in OST text, and there are issues of the right of self-defence in outer space which are left to the imagination.

Overall General Gaps in Outer Space Related Treaties

The speaker highlighted that outer space treaties have certain gaps in general which includes no legal binding against creation of debris by ASAT weapons' test, no check on testing of space weapons i.e. keeping the ASAT debate open ended, non-existent rules about long term sustainability of the outer space, and no legally binding arrangements to address the space law gaps i.e. hedge behind the informal Track-II initiatives instead of legally binding treaties.

Informal Outer Space Governance Efforts

There are three informal outer space government efforts which are effective currently.

Firstly, there is Technical Confidence Building Measures (TCBMs). The speaker said that China and Russia proposed PPWT at the CD in 2008. The US rejected it due to challenges in execution and verification. Instead, they proposed Space Technical Confidence Building Measures (TCBMs). The UN First Committee proposed a study in 2010, and a Group of Governmental Experts (GGE) which suggested TCBMs in 2013 which has tangibly contributed towards trust, transparency, and peace in outer space activities but all non-binding.

Secondly, he said there is the International Code of Conduct (ICoC) which was proposed as a draft by the EU that aims to enhance safety, security, and sustainability in outer space. The ICoC did work cosmetically, however, the US and other space-faring states took it as an Arms Control initiative. The US got out of the ICoC in 2012 and committed that it would bring in another informal initiative soon. With the exit of the US, ICoC lost its steam.

Thirdly, there is a UK-led UNGA Resolution 75/36 entitled “Reducing Space Threats through Norms, Rules and Principles of Responsible Behaviours”. It has banned the testing of ASAT, however, its development and stockpiling have not been touched. For monopolising, the US announced a self-moratorium in 2022. Pakistan did initially vote in favour of the resolution, however, from 2021 onwards it is abstaining. The US, Russia and India have voted against it.

Indian Space Programme and Its Success Story

The speaker said that India started its space programme in late 1950s i.e. right after launch of Sputnik in 1957 in collaboration with the US Department of Atomic Energy, facilitating the formation of the Indian National Committee for Space Research (INCOSPAR) in 1962. He said that International assistance from NASA and the USSR helped India launch its first sounding rocket in 1963 and its first artificial satellite

Aryabhatain in 1975. India became a ‘spacefaring’ nation when in July 1980, it launched its indigenously built satellite Rohini-I using its own SLV from its own space launching site ‘Sriharikota’ in southern India.He mentioned that it is sixth largest space agency with a considerable inventory of outer space assets.

“As of now, ISRO has over 100 different satellites / space craft (including one micro and three nano satellites), conducted more than 70 launch missions, and launched more than 10 student satellites.”

Last but not the least, it has conducted three state-of-the-art and most difficult re-entry missions, including 3rd lunar probe “Chandrayaan-3”. With the moon mission's landing planned for August 2023, India stands ready to become only the fourth country to achieve the milestone after the US, Russia and China.

(Editor’s Note: The mission was successful six days after the seminar.)

The speaker mentioned that in 2014, Indian indigenously built unmanned satellite Mangalyaan which reached into Mars orbit with a budget of just $74 million.

Reasons behind Success Story of Indian Space Programme

The reason behind Indian success lies in the notion of self-reliance instead of waiting for foreign assistance. India did not join bloc politics which helped it get advantages from both the blocs. India kept the space programme free of any missile-related touch.

He mentioned Dr Sarabhai, the father of the Indian space programme, who emphasised its peaceful nature and even initially opposed any development of a SLV that could taint it.

Indian diplomatic luck also played pivotal role. He then mentioned the unprecedented Indo-US nuclear deal in 2008 and removal of ISRO from

the US Entity List in 2011 as well as the US sponsored grant of Indian membership of MTCR (2016), WA (2017) and AG (2018). With the exception of NSG, Indian side has an access to all the military centred technologies. He said that it may be noted that ISRO took only three years after MTCR membership to overcome the limitations hindering the acquisitioning of the ASAT capability in 2019. In reality, it has tilted the strategic balance in its favour relatively.

Moreover, he said that the SLV capability proved to be instrumental in opening unprecedented foreign outer space collaboration with Indian space programme. He said that the continuity of the chairmen of ISRO was another key factor. Out of 12 chairmen, with the exception of two to three interim chairmen, all had tenures of about four to 12 years. He highlighted the role of Indian Space Agency Association (ISPA), which was created to coordinate the activities of private telecom agencies and the ISRO, thus providing a one window operation for a focused approach. He mentioned the Indian Space Policy-2023 (April 2023) has involved the Industry to take on the production of matured areas while it shall focus on R&D of new space technologies and applications and on expanding the human understanding of outer space. He further mentioned the foresightedness of Indian education system that envisioned for 25 years at least and flooded not only IT personnel but also other skill-based opportunities to the advanced world. He said that because India is the largest democracy in the world, all elements of national power were offering opportunities to the world with the Indian market spanning over $100 billion. He added that economic interests are also involved.

Pakistan's Space Programme

Dr Minhas elucidated on Pakistan's national space programme which was started by the establishment of Space Sciences Research Wing under the purview of Atomic Energy Commission in September 1961 led by Dr Abdul Salam. It was given the status of commission (SUPARCO) in 1981. He said that, in the beginning of the 1960s, the US was in a race to place the first human on the moon with Soviet Union and, therefore, was in a

search to find a suitable location for the research of the atmosphere. The Indian Ocean came to be the most suitable place to investigate the wind dynamics of the upper atmosphere. Pakistan was the best choice for the US and it collaborated with the NASA and did not take long to test its two stage rockets i.e. Rehbar-I and II in June 1962 to become one of the rocket launch capable states. He said that Pakistan was third in Asia and 10th in the world to have met the prestigious milestone.

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"Despite being the first space agency in the subcontinent, SUPARCO could not keep up the pace. Indian nuclear device test in 1974 shifted focus from space R&D to nuclear weapons programme."

Strategy Options for Space Programme Development

The speaker outlined few strategy options for Pakistan and it included focused diplomacy for getting SUPARCO out of the US Entity List and extensive diplomacy to get MTCR membership through US support. He said that China may be asked for ToT of satellites' manufacturing as quid pro quo for China-Pakistan Economic Corridor (CPEC). Moreover, there is a need for policy and strategy making for self-reliance in space R&D. He said that deterrence is intact now, so maximum fund should be spared for the space programme. He also advised to involve private sector in manufacturing and R&D projects spearheaded by the SUPARCO and unveiling of Pakistan's national space laws and National Space Policy for

trust building. He emphasised the need to build capacity in IT and space-oriented skills and collaborate internationally with other spacefaring or space emerging states. He also stressed the need to increase students' interest in studying space technology, announcing only doable projects and keeping organisations away from ASAT development signalling.

CONCLUDING REMARKS

Air Marshal Asim Suleiman (Retd)
President, CASS, Lahore

In his concluding remarks, Air Marshal Asim Suleiman (Retd), President, CASS, Lahore, said that since the launch of the first satellite, space has become a critical resource for the developed nations. During the Cold War, rapid technological advancements took place in this realm. These developments included launch vehicles, spacecrafts, artificial satellites, manned and unmanned flights, robotic exploration mission, telemetry and telecommand systems, etc. Space-based support systems have revolutionised the communication sector. Remote sensing satellites have a vast civilian and military role for climate change understanding, disaster management and the management of earth's resources. Not to forget the navigation satellites, access to space technology is seen as a contemporary and future war potential.

Today, approximately 7,000 satellites orbit the Earth. Most are communication satellites (4,823), then earth observation (1,167), followed by technology development (414), navigation positioning (155) and other purpose (159) satellites.

Pakistan commenced its space programme in 1961. However, despite making an early start, we have not been able gain any respectable progress in this domain. Pakistan has not fully exploited the potential of space-related technologies and services for its socioeconomic growth and military needs. The objective of this seminar was to identify gaps in national space outlook and to suggest policy guidelines and measures to facilitate the realisation of a viable, sustainable, and effective space programme that meets national socioeconomic, scientific, and security requirements.

Space technology has reached a critical mass, causing paradigm shifts in its capabilities. Discoveries are opening new avenues and extending the horizons, and by the next century, an inter-planetary village may exist.

The focus is now on developing dual-use space technologies for human facilitation.

"Pakistan's space footprint compared to India identifies certain gaps that highlight areas for improvement."

Space Economy

The international aerospace industry has experienced unprecedented growth in recent decades due to the loosening of military control over space domains. Space technologies like remote sensing, navigation, and communication have become the main drivers of economic growth worldwide. The global space economy contributed $546 billion with 8 percent growth (Global Space Ecosystem) in 2023 as compared to $464 billion last year. It is expected to grow to $1 trillion by 2040. The telecommunications sector is expected to generate over 60 percent of the total space revenue in the same timeframe. In the developed world, governments are investing heavily in their space sector. They are facilitating private participation through public-private partnerships.

Pakistan's budget allocation is far too less to ensure a successful implementation of the national space programme and to meet the growing demands for space-based services."

Military Applications of Space Technology

National strength is being transformed by emerging technologies, which are influencing warfare and its outcomes. Space-related technologies are crucial for determining nations' military strength. The national security strategy of a country recognises the importance of maintaining access to space, which can be referred to as the fourth medium after land, sea, and air.

Satellite Communications

Satellite communication is very important for civilian usage, and also

crucial for military network-centric warfare, enhancing situational awareness and decision-making. India has 28 communication satellites, including those dedicated for the military, while Pakistan needs improvement in its military asset integration in the Satellite Communication (SATCOM) domain.

Space-Based Navigation Constellations

Satellite navigation systems such as Global Positioning System (GPS) provide precise location and time reference on Earth. US, Russia, China, and India have their own navigation systems. Satellite navigation facility provides potency to command and control systems in providing targeting solutions for guided munitions as well.

"Pakistan's military, however, depends on foreign space networks, which is not a desirable option and can cause a very big setback at a crucial moment during actual operations."

Intelligence, Surveillance, Reconnaissance

Intelligence, Surveillance, Reconnaissance (ISR) is crucial for supporting operations in the land, sea, air, and space domains. It involves planning and operating systems to collect, process, and disseminate data for military operations. India's large fleet of ISR satellites provides high-resolution imagery, while Pakistan's only operational satellite in this domain is insufficient for modern military usage.

Counterspace Operations

A counterspace operation is defined as a mission involving offensive and defensive tasks in various domains of space, requiring situational awareness for timely commands. For counterspace operations, countries with less competence can achieve reasonable abilities as a poor man's solution.

Miscellaneous Space-Based Operations

Weather satellites aid civil and military operations in peace and war scenarios. Pakistan needs space technology for effective decision-making and implementation. Space technology's applications offer significant health benefits, including disease epidemiology and telemedicine. Integrating space technology into disaster risk reduction strategies is crucial for early warning and response. Moreover, space capabilities can boost Pakistan's economic development by managing water resources, forecasting extreme weather, and enhancing agricultural yields. It can also help with mineral exploration, urban planning, food security, and land management.

International Law on Space Activities

The UN General Assembly (UNGA) established the Committee on the COPUOS in 1959 to codify International Space Law. Over the years, the committee concluded five treaties and conventions from 1967-1979, including the OST (1967), Rescue Agreement (1968), Liability Convention (1972), Registration Convention (1975), and Moon Agreement (1979). Non-legally binding space principles deal with space safety, environmental protection, scientific investigation, exploration, and dispute resolution.

Pakistan, under the same ambit, should allocate resources to provide administrative, legal, and constitutional support. In order to be internationally compliant, Pakistan should develop a comprehensive legal framework to establish a competent space organisational setup.

Pakistan's Space Programme & Existing Capabilities

Pakistan established the space sciences research wing, SUPARCO, in 1961, which became autonomous in 1981. It established three Technical Wings and the Space Research Council. The programme aimed to establish satellite ground stations, satellite tracking infrastructure, launch communication satellites, and develop indigenous satellites. However, progress was slow, leading to the transfer of SUPARCO to the National Command Authority (NCA) in 2000. Defence Cabinet Committee (DCC)

assigned SUPARCO a realistic task to meet its future goals.

The space programme has experienced its ups and downs in Pakistan, with successes and challenges. Pakistan launched BADR-2 Series in 2009, PAKSAT-1 in 2011, and PRSS-1 in 2018.

The NCA defined Space Programme 2047 in 2011, which gives the country the vision for future space endeavours. SUPARCO should develop satellites, and more importantly, excel in the development of human resources in the space domain. Pakistan's indigenous satellite development and launch programmes are lagging, with only three operational satellites developed and launched from foreign sources. SUPARCO needs strategic revamping and indigenisation of critical sub-systems, ground systems. Progress in human resource development and space professionals for indigenisation is still to see the light of day.

"SUPARCO spearheads Pakistan's space programme, but a realistic analysis of its capabilities and achievements is needed for the fructification of a future roadmap."

Its future programmes should address remote sensing, Geographical Information System (GIS), space sciences, and telemedicine. Pakistan's progress in remote sensing and GIS domains is sluggish, with the country relying on foreign sources for satellite imagery acquisition. Advanced data, for Search and Rescue (SAR), multi-spectral, and hyper-spectral imagery, is needed for effective use. Integration with ministries and departments is crucial for timely dissemination of data and services.

No doubt SUPARCO is pursuing programmes in space and atmospheric sciences, including climate change, natural hazards monitoring, and renewable energy, but these projects need improvement, collaboration, and expansion to meet international standards.

Way Forward for National Space Policy of Pakistan

Space policy is the decision-making process for a state's outer space activities, involving diverse interest groups and organisations. It addresses

various issues, including defence, security, commerce, science, technology, socioeconomic development, and human resources. Pakistan's national space policy should be based on realistic objectives, considering ground realities, national ambitions, and the international environment. It should be a well-thought-out institutional mechanism that creates linkages between state-controlled and commercial activities, ensuring preservation of national priorities and safeguarding state interests.

Its policy should prioritise private sector participation in R&D, encourage commercial sector involvement, and focus on space technologies, infrastructure, industrial and technological potential, and human resources. Pakistan's national space policy must be cautious, balanced, and prioritised while adhering to domestic and international compulsions.

"Internationally, the space sector is growing exponentially, with public-private partnerships in R&D to acquire next-generation capabilities."

To ensure the success of Pakistan's space programme, it is crucial for the national leadership to set goals and develop a credible infrastructure. It should allocate resources to provide administrative, legal, and constitutional support. In order to achieve this, Pakistan should develop a comprehensive legal framework and establish a competent space organisational setup. Pakistan should also focus on commercialising space services and encourage private sector investment, generating more economic activities and creating employment opportunities. Pakistan must integrate space-related services in the mainstream setups for better governance, efficient functioning, sustainable development, and social well-being.

Q&A / DISCUSSION SESSION

Question 1: An attendee wished to know the panellists' stance on brain drain, absence of incentives for the younger generation, ignorance of ground realities, leveraging insights from the nuclear programme and the lack of collaboration among government departments in Pakistan.

Answer: In response, the keynote speaker, Major General Ahmed Bilal (Retd) said that a significant missed opportunity lies in not involving individuals who have left the country. These expatriates find themselves in more conducive environments, enabling their learning curves to flourish. However, the potential stemming from this group has remained untapped, necessitating prompt action to harness it.

Dr Ali Sarosh, drawing on his extensive 10 to 15 years of association with academia, reflected on his role in establishing programmes related to academia and R&D from the ground up. He cited the creation of the inaugural satellite team as an example, with the successful sponsorship of the programme by SUPARCO in 2015, marked by the achievement of PakTES-1A. However, he highlighted the lack of an appropriate ecosystem as a pressing concern. Dr Sarosh stressed the urgency of establishing such an ecosystem to support graduates and provide them with opportunities. He differentiated between students from military and civilian backgrounds, noting the relatively secure environment for the former and the challenges faced by the latter. This led to inquiries from civilian students about job prospects. While the necessary components exist, connecting them remains a challenge. Dr Sarosh, having personally sponsored initiatives, lamented the loss of funding after two years.

Air Commodore Khalid Iqbal (Retd) contributed his insights, underscoring a weak economy as the root cause of various issues. He pointed to a pivotal misstep around two decades ago when the local industry was disregarded in favour of international purchases. This resulted in the erosion of the nurturing ground for technical learning at the grassroots

level, leading to a decrease in opportunities and the closure of profitable industries. He advocated for a return to basics and fundamental principles. He emphasised the necessity of rejuvenating local manufacturing and indigenous developmental processes. While acknowledging the challenging path ahead, he deemed it the correct approach.

Question 2: Has Pakistan forfeited its strategic deterrence, formerly established through nuclear strategies? Moreover, can the nation transition to an innovation-driven economy in the present context?

Answer: Dr Ahmed Saeed Minhas responded that in terms of military deterrence through nuclear weaponry, it remains intact. However, the balance of power remains in flux due to emerging technologies, such as anti-satellite weaponry. India, for instance, has demonstrated lower-orbit anti-satellite capabilities. While the Agni V missile can reach upper GEO where communication satellites are positioned, these satellites could potentially guide strategic weapons, thereby introducing instability if nuclear weapons are involved. In this context, military deterrence remains effective.

Furthermore, the success of project planning requires several factors. Pakistan is on the right trajectory, with willingness and institutional capacity being the first two elements. Thirdly, the availability of resources and technology is constrained due to strategic barriers and the differential US support enjoyed by India. Notably, India is a member of several export control cartels, affording them access to advanced technologies. This membership, particularly in the Nuclear Suppliers Group (NSG) and MTCR, holds significance for Pakistan. The acquisition of certain missing technologies could facilitate the construction of advanced strategic missiles. On the other hand, CPEC assumes importance when viewed from a national and political standpoint.

Dr Sarosh shared an anecdote of an elderly man, Qian Xuesen (aged 97), who was the inventor of ICBM Minuteman 3 and Long March Vehicle 12. At the age of 97, he was still attending college classes lest he missed out

on some important new development. This story emphasises the ongoing quest for knowledge even in old age. The crucial lesson is that a country cannot aspire to achieve monumental feats, such as landing a man on the moon, without first establishing its foundational technologies. The process requires a step-wise approach. Starting with an exospheric interception, the learning curve involves perseverance and repeated attempts.

Major General Bilal responded that consolidation of national power encompasses nuclear deterrence, as it falls within the realm of overall national strength, including social and economic dimensions. Resources like titanium, lithium, and gold, whose quantities remain uncertain, are critical for progress. To strengthen the nation, the collective efforts of all stakeholders are essential. Initial stages involve test runs with dummy satellites to refine the process, progressively advancing towards successful missions. This journey to success is akin to ascending a staircase, where each step counts towards reaching the pinnacle.

Question 3: What is the panellists' approach to establishing a standby team and address the concerns of brain drain and insufficient incentives for experts to return?

Answer: Dr Sarosh responded by emphasising the requirement for an ecosystem. He elaborated on ongoing efforts to establish a public-private setup. He recounted his own experience in attempting to establish an aerospace company and shared an incident where he was contacted by Securities and Exchange Commission of Pakistan (SECP) while setting up the company. The requirement for a NOC from SUPARCO was presented as an obstacle, and despite his persistence, many individuals abandoned similar pursuits due to these complexities. He attributed economic failures to domestic factors and advocated for cultivating a culture of public-private partnership. He acknowledged that a generation has been lost due to these difficulties.

Dr Minhas supplemented Dr Sarosh's response by discussing initiatives aligned with creating a standby team. He mentioned the example of Lieutenant General Khalid Kidwai (Retd), former DG SPD, who established

a school adjacent to train students for future strategic roles. Moreover, he detailed how institutions like the Institute of Space Technology (IST) and the Pakistan Institute of Engineering and Applied Sciences (PIEAS) offered employment opportunities to promising students. He highlighted the reasons behind students seeking opportunities abroad: affluence and international job offers, especially in the IT sector. He noted the evolving global trends, favouring IT and AI disciplines, and the growing need for IT experts in global companies. Dr Minhas pointed out a significant disparity, where the annual student intake is much smaller than the demand, necessitating attention to university admissions and facilities.

Major General Bilal added to the discussion by sharing an example of a company called MIST, which accrued substantial project earnings but faced challenges in sustaining momentum. He critiqued the education system's reliance on results over critical thinking and urged tapping into diverse talents rather than equating positions solely with academic excellence. He noted that selective students often embody remarkable potential. He discussed the imperative of an enabling ecosystem, strategic initiatives like training schools and job offers, adapting to changing global trends and recognising talent beyond conventional metrics.

Question 4: Many initiatives, often under military control, encounter challenges when it comes to data extraction. Despite the rhetoric, practical implementation proves difficult, leading to public apprehension. What is the speakers' perspective on reducing this gap and tapping into the untapped potential?

Answer: Major General Bilal responded, expressing a personal connection to the topic. He referred to the National Spatial Data Infrastructure (NSDI) programme and the National Database and Registration Authority (NADRA), emphasising the government's role in managing data. Despite the availability of raw data, the reluctance to fully utilise these resources remains a challenge. He noted the creation of programmes for educational and disaster management purposes.

He underscored the importance of synergy between the air force's capabilities and space endeavours, highlighting that even within the air force, untapped capabilities exist.

He mentioned SUPARCO's contributions, designing various communication satellite technologies. He highlighted bureaucratic bottlenecks and mindset as impediments. The necessary change should be ingrained in the system and necessitates policy intervention. For instance, the government could leverage SUPARCO to provide data, which, when incorporated into commercial Human Development Index (HDI) systems, could yield substantial benefits. He noted that often the preference is to purchase data from external sources due to hesitancy in local utilisation.

He lamented the absence of a comprehensive policy framework. He illustrated an example of underutilised communication satellites, with approximately 50 percent of capacity remaining unexplored despite passing 80 percent of their lifespan. He argued that redirecting such resources to sectors like education and telehealth could lead to higher economic growth. Ultimately, he stressed the necessity of changing mind-sets and incorporating shifts in policy for tangible change, as mere persuasion might not suffice.

Question 5: What is the lack of national resolve beyond financial constraints?

Answer: Major General Bilal highlighted the essence of national resolve. He compared the example of the national determination displayed during the development of the nuclear bomb with the current state of the space sector, wherein such determination seems to be lacking. He referred to the NSDI programme and his persistent efforts over four years to convince the government to adopt it. He recounted his visit to China as the president of China was scheduled to visit Pakistan. He requested that NSDI be included in the president's speech, leading to inquiries about NSDI's nature once the speech was over. Despite his efforts, NSDI's incorporation into the programme did not materialise.

He introduced the concept of Space Education Awareness Drive (SEAD), stressing that although education and awareness initiatives exist, the space element is not integrated into the academic curriculum. He emphasised the need to embrace and promote space-related initiatives. He cited an instance involving an expert who held a patent for carbon nanotubes. Despite this, the tubes did not transition into industrial applications even after the inventor's demise, representing a lack of national resolve.

Referencing 1902, Major General Bilal (Retd) drew attention to the exportation of chromium, a resource abundant in Pakistan, but underutilised domestically. He underscored that everything used in space and present within Pakistan should be utilised for space endeavours. He criticised the practice of selling one's resources and advocated for self-exploitation rather than relying on foreign entities. Major General Ahmed Bilal provided an example involving titanium, a resource readily available in Pakistan. He expressed concerns over the lack of action to exploit it and highlighted its illegal exportation. He emphasised the need to recognise and capitalise on the value of Pakistan's resources instead of allowing their exploitation by external actors.

SEMINAR RECOMMENDATIONS

Long-Term Space Policy

Create a comprehensive National Space Policy, involving all stakeholders, focused on public-private partnerships, and resource the programme appropriately. Foster enduring international conglomerates to reap the benefits of the upcoming $1.0 trillion space economy.

National Legislation in Line With International Standards

Firstly, make provision in the legislative procedures for enacting national space law by adding “Space” to the federal legislative list, and secondly, develop National Space Legislation in harmony with International Space Law.

Self-Reliance

Establish R&D focused strategic framework that encourages the domestic production of dual-usage space technologies to seamlessly integrate commercial and military applications. Evolve international cooperation for space explorations with like-minded allied countries to bolster capabilities and knowledge sharing.

Encourage Space Education and Awareness

Create public awareness by educating citizenry about the significance of space exploration and its potential benefits by, including appropriate curriculum at the university, collage, and school levels.

Establish Satellites Constellations and Observation Sensors

Indigenously develop and launch 2-3 communication satellites in GEO, and 7-8 remote sensing satellites in LEO. Additionally, develop 2-3 sensors for specialised earth observation satellites to enhance the quality and specificity of collected data. Establish a constellation of satellites for a positioning and Navigation System.

Develop Counter Space Capabilities

Invest in the research, development, and deployment of counter-space techniques by converting existing IRBMs into kinetic CSOs.

PROFILES OF THE SPEAKERS

Air Commodore Khalid Iqbal (Retd)
Director National Security, CASS,
Lahore

Air Commodore Khalid Iqbal (Retd) holds master's degree each in political science, strategic studies, and business administration. He is a graduate of National Defence University's (NDU) National Security Workshop. He has also done a certification level course in International Nuclear and Space Law from Pakistan Nuclear Regulatory Authority (PNRA). During his career in the Pakistan Air Force (PAF), he served as Director Policy at Air Headquarters, Assistant Chief of Air Staff, and Member National Air Defence Committee. He has been a faculty member of PAF Air War College and Combat Commanders' School. His accolades include Tamgha-e-Imtiaz (Military) and Professional Excellence Badge.

Major General Ahmed Bilal (Retd)
Former Chairman SUPARCO

Major General Ahmed Bilal (Retd) is the former Chairman SUPARCO. He holds an engineering degree in tele-communication, besides a bachelors and a master's degree in strategic studies. He did pioneer work in developing the structure of Nuclear Command and Control and raising Strategic Plans Division (SDP). He subsequently held many positions in SPD. He remained associated with National Nuclear and Missile Programme of Pakistan for almost 12 years. He was the first Director of Strategic Weapons Development Directorate, and Commander Signals Army Strategic Force Command. He also organised and established the Nuclear Security Force Headquarters and was its first DG Security & Intelligence. As Chairman SUPARCO he mobilised all the National Resources to boost the National Space Programme. He also spearheaded the space technology application programme to support agriculture, disaster management, urban planning, and other similar sectors. He also spearheaded the drive to develop the National Spatial Database Infrastructure, the need of which has now been acknowledged as a very important tool for better management and governance. In recognition of his services to the nation he was awarded Hilal-e-Imtiaz and Hilal-e-Imtiaz (Military).

Dr Ali Sarosh
Associate Professor
Air University, Islamabad

Dr Sarosh has been a principal investigator of more than 15 high-end industrial research works funded by NESCOM, SUPRACO, and PAF. He is the inventor of two design patents in hypersonic launch systems and rocket-based combined cycle engines. Dr Sarosh has been appointed as member of technical advisory committee on global hypersonic space technologies, by the American Institute of Aeronautics and Astronautics (AIAA.) He has been the founding director of the space education and research programme jointly funded by the PAF and the National University of Sciences and Technology (NUST). He is a tech entrepreneur and founding CEO of Shocks & Stars Pvt Ltd. He is recipient of the Imtiazi Sanad by the Government of Pakistan.

Dr Ahmed Saeed Minhas
Pro Vice Chancellor
DHA Suffa University, Karachi

Dr Ahmed Saeed Minhas is the Pro Vice Chancellor at DHA Suffa University, Karachi. He holds a PhD in Emerging Nexus between Space Weaponisation & Missile Shield. He also holds a master's degree in defence and strategic studies. During his 36 years' service in Pakistan Army, he served at several sensitive positions, including serving as UN Military Observer in Congo. He was also the Director Research at NDU as well as Director Arms Control and Disarmament Affairs Branch of SPD for seven years. He has published extensively on aerospace issues, including Indian space militarisation aspirations and impact of space weaponisation on South Asian strategic stability. He is the recipient of Nuclear Non-Proliferation Fellowship from the Centre for Non-Proliferation Studies (CNS), California, US.

Air Marshal Asim Suleiman (Retd)
President, CASS, Lahore

Air Marshal Asim Suleiman (Retd) graduated from the PAF Academy in 1978 and has flown a wide assortment of fighter aircraft during his career. He has been a part of several operational and training squadrons, including the coveted Combat Commanders' School as an instructor. His command assignments include Command of a Combat Squadron and an Operational Base.

His numerous staff appointments include serving as Staff Officer in different capacities to three Chiefs of the Air Staff, Deputy Chief Project Director of the JF-17 Programme, Director-General Air Intelligence, Deputy Chief of Air Staff (Support) and Deputy Chief of the Air Staff (Administration). He served as an Air Adviser at the Pakistan High Commission in India.

Air Marshal Asim Suleiman (Retd) holds a master's degree in Defence and Strategic Studies from Quaid-e-Azam University, Islamabad. He is a graduate of the National Defence University (NDU), Islamabad, and Defence Services and Staff College, Dhaka. He attended the National Security Workshop at NDU. He was a visiting faculty member at NDU, Air War College, Faisal, Pakistan Naval War College, Lahore, and Command and Staff College, Quetta.

He also served as the Director-General of the Civil Aviation Authority (CAA) for over two years. He was also nominated as the Chairman of the Pakistan International Airlines (PIA) by the Government of Pakistan. He is an alumnus of the Singapore Aviation Academy and has been a regular speaker at international conferences on the development and safety of the aviation industry. He also represented Pakistan as the head delegate at the ICAO General Assembly and as a speaker.

He is a recipient of the Hilal-e-Imtiaz (M) and Sitara-e-Imtiaz (M) for his meritorious services. He was also awarded the Sitara-e-Basalat, and Imtiazi Sanad.

PRESS RELEASE

On 17 August, 2023, a seminar titled “Emerging Trends in Aerospace Power: Options for Pakistan” was conducted by the Centre for Aerospace & Security Studies (CASS), Lahore. Aerospace power is the ability to use air and space capabilities to achieve wide-ranging civil and military objectives in economic, commercial and scientific domains. Pakistan stands at the threshold of numerous opportunities to capitalize on emerging trends like space exploration, satellite technology, unmanned aerial system, and electric propulsion of green aviation. The seminar focused on options for Pakistan regarding aerospace power.

Air Commodore Khalid Iqbal (Retd), Director National Security, CASS, Lahore, delivered the introductory remarks. His speech was followed by a keynote address by Major General Ahmed Bilal (Retd), former Chairman SUPARCO, who highlighted the prevalent global aerospace trends.

Dr Ali Sarosh, Associate Professor, Air University, focused on the evolution of Space power in South Asia, including its military and civil applications while Dr Ahmed Saeed Minhas, Pro Vice Chancellor, DHA Suffa University elucidated on gaps in international space law and viable developmental strategy for Pakistan’s space programme.

Following the guest speakers’ remarks, an extensive question and answer / discussion session was held to delve into the depths of the topic.

Air Marshal Asim Suleiman (Retd), President, CASS, Lahore, in his concluding remarks, said that Pakistan’s national space policy should prioritise private sector participation in R&D, and encourage commercial sector involvement. He added that Pakistan should focus on space technologies, infrastructure, industrial, technological potential, and human resource. He further said that the national security strategy of a country recognises the importance of maintaining access to space, considering that space-related technologies are crucial for determining a nation’s military strategy. The President also said that Pakistan must integrate space-related services in the mainstream setups for better governance, efficient functioning, sustainable development, and social well-being.

The most important takeaways from the seminar were:

A three pronged national strategy be pursued as the way forward: firstly, ensure full scale applicability of available aerospace capability and resources for socio-economic development and national security; secondly, achieve self-sufficiency / indigenisation as far as possible in the short / medium-term, meeting the basic needs over complete spectrum of aerospace; and thirdly, synergise the national effort for sustained growth of the aerospace sector.

The national space policy should be based on realistic objectives, considering ground realities, national ambitions, and the international environment. It should be a well-thought-out institutional mechanism that creates linkages between state-controlled and commercial activities, ensuring preservation of national priorities and safeguarding state interests.

At the international level, the space sector is growing exponentially, with public-private partnerships (PPP) in R&D aimed at acquiring next-generation capabilities. To ensure the success of Pakistan's space programme, it is crucial for the national leadership to set goals, allocate resources, and develop a credible infrastructure.

There is a need to rejuvenate the National Space Policy to generate a new vigor towards development of space capability and capacity for application in civil and military domains.

The success of the aerospace programme hinges not only on recognising the significance and utility of aerospace technologies in socio-economic and national security domains, but also on harmonising national endeavours to attain these goals.

MEDIA COVERAGE

Sindh SOON TIMES

Emerging Trends in Aerospace Power: Options for Pakistan

Daily Asian Sun

Seminar titled "Emerging Trends in Aerospace Power: Options for Pakistan" was conducted by CASS

NEWS

CASS SEMINAR-Emerging Trends in Aerospace Power: Options for Pakistan'

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CASS arranges Seminar on 'Emerging Trends in Aerospace Power


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GALLERY


Emerging Trends in Aerospace Power
Options for Pakistan


Emerging Trends in Aerospace Power
Options for Pakistan

EMERGING TRENDS IN AEROSPACE POWER
OPTIONS FOR PAKISTAN

"With over 60 countries involved in spacecraft operations, the importance of space systems for socio-economic advancement and national security is being widely acknowledged."
– Major General Ahmed Bilal (Retd)

"The International Space Law is kept vague and open-ended for keeping the initiative in own hands for maintenance of technology monopoly."
– Dr Ahmed Saeed Minhas (Retd)

"For Pakistan to get out of this economic-security conundrum-like situation, it is not too late to make some fundamental corrections such as a one-step back and two-step forward approach, which is the need of the hour."
– Dr Ali Sarosh

"While airspace boundaries of a nation coincide with its international borders, space is a global common; its ownership goes to those who are the first to reach and have sufficient staying power."
– Air Commodore Khaliq Iqbal (Retd), Director at CASS, Lahore

"Pakistan's space policy should be a well-thought-out institutional mechanism that creates linkages between state-controlled and commercial activities, ensuring preservation of national priorities and safeguarding state interests."
– Air Marshal Asim Suleiman (Retd), President, CASS, Lahore

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