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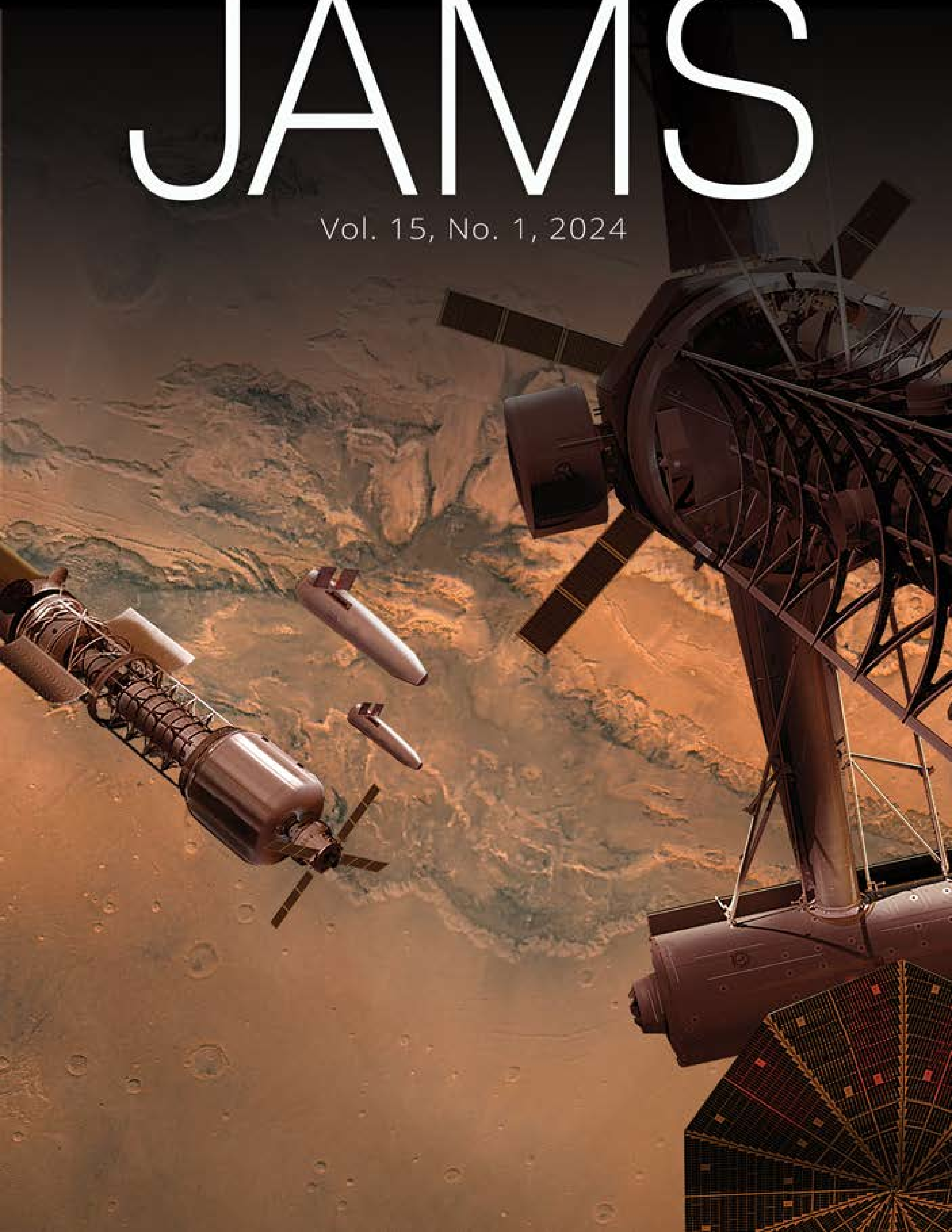

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Space Technology and Its Military Application
Options for Pakistan

Shamaila Amir, PhD; and Nazia Abdul Rehman, PhD

Abstract: Space technology has aided military operations and has established its place in national defense. There is a dire need for Pakistan to exploit this military tool for the balance of power in the region. Space technology is changing the face of military warfare and the contest for dominance in space has increased its pace. The same has been a neglected part of the national policy of Pakistan and has not received its prioritization yet despite having an early start on this front. This article focuses mainly on the current performance comparison of Pakistani-leased satellites with Indian indigenous developed satellites. If Pakistan does not plan to keep pace with India's fast-growing space technology, it may result in disastrous results in the future, keeping in mind the history of wars between the two countries. The authors suggest that an inclusive, steady, and strong national space policy on the part of Pakistan should be articulated and executed.
Keywords: militarization, space technology, space program of Pakistan

Introduction

With the launch of the first artificial satellite, *Sputnik 1*, in 1957, the Soviets set the stage for the space race. Cold War rival America followed suit by launching *Explorer 1* four months later.[1] This started

Dr. Shamaila Amir is a retired naval officer with 23 years of service experience. She has experience teaching to the officers and sailors of the Pakistan Navy and foreign trainees. Her fields of interest are linguistics, military studies, and geopolitics. https://orcid.org/0000-0002-6385-8325. Dr. Nazia Abdul Rehman is an assistant professor of economics and management in the Federal Urdu University of Arts, Sciences, and Technology. Her fields of interest are leadership and management along with teaching research in financial and socioeconomic analysis of projects and policies. https://orcid.org/0000-0002-4660-2045. The views and opinions expressed or implied in this article are those of the authors and should not be construed as carrying the official stance of Pakistan Army, Air Force, Navy, or other agencies or departments of the government of Pakistan or their international equivalents.

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the never-ending queue of satellites. In the initial stages, national prestige was the predominating factor that motivated nations to explore the new front of warfare and later critical military applications of satellites and missile developments led nations to pursue the development of satellites and satellite launch vehicles. The Sino-Pakistani nexus in the space domain covers intelligence, surveillance, and reconnaissance (ISR) and satellite navigation services. While Beijing has extended cooperation to Pakistan in the areas of space exploration, science, and astronaut training for many years, the Chinese plugged Pakistan into their indigenously built BeiDou Satellite Navigation (BDS) system since 2013, which is China's equivalent of the American-built Global Positioning System (GPS) network.[2] Conversely, Russia and India have undertaken joint ventures in missile development. Russia and India have a relationship that has endured for decades, benefiting India in its space exploration and its attempts to widen its portfolio of defense and strategic partnerships. There is a legacy of Russian military equipment in the Indian inventory, across all the services including nuclear systems. In the following years, many civilian and commercial applications of satellites were identified and extensively developed.[3]

On one hand, civilian satellites are used to generate awareness and uplift the socioeconomic conditions of people living in far-flung areas.[4] On the other hand, military satellites are used for providing real-time reconnaissance about important enemy installations, intelligence about enemy deployment, battle damage assessment, missile launches, or even hunting down terrorists.[5] Satellites have enabled military commanders to get firsthand information about the likely target.

Recognizing the growing potential of satellites and satellite launch vehicles, many nations of the world initiated their national space program, and Pakistan was no exception. It is vital to understand the role of space technology and its military applications with particular reference to Pakistan.[6] Considering its Indian-centric approach toward national security, Pakistan needs to reevaluate what it considers to be a national security concern. If Pakistan is unable to introduce a cohesive and comprehensive national space policy, it will be difficult for the country to match Indian space efforts in South Asia, especially when India, with its hegemonic designs, aims to use space as another pawn in the regional gamble for dominance. As space technology is a vast field, however, efforts are being made to understand the importance of satellite technology for Pakistan to counter a potential threat from India's fast-growing space technology.

Pakistan's Space Program: History and Steps Forward

Pakistan's space program was initiated with the establishment of the Space Sciences Research Wing under the Pakistan Atomic Energy Commission (PAEC) in 1961. The wing was set up on the advice of the scientific advisor to the president, Professor Abdus Salam, the only Nobel laureate from Pakistan.[7] However, in July 1964, the wing was detached from the Pakistan Atomic Energy Commission and placed under the direct control of the president of Pakistan. Later, in March 1966, it was reconstituted as a separate organization and functioned under the administrative control of the Scientific and Technological Research Division.[8] Space organization was granted autonomous status and the Pakistan Space and Upper Atmosphere Research Commission, commonly also known as SUPARCO, finally came into being in 1981. The same year, the Space Research Council was set up and headed by the president of Pakistan, who was later replaced by the prime minister as head of the council, while SUPARCO remained under the administrative control of the cabinet division for almost 20 years from May 1981 to September 2000.[9] It is interesting to note that during this period, only one meeting of the Space Research Council was held in 1984. Afterward, no meeting was conducted until the dissolution of the council. Finally, in December 2000, the Space Research Council was replaced with the Development Control Committee (DCC) and SUPARCO was transferred from the cabinet division to the National Command Authority.[10]

Pakistan's launch capability started when a batch of Pakistani scientists trained by the National Aeronautics and Space Administration (NASA) became involved in building sounding rockets.[11] Pakistan was able to launch the meteorological rocket Rahbar-I within one year of its inception and became the 10th country in the world and 3d in Asia to attain such a capability.[12] The two-stage rocket, Rahbar-I, was sent 130 kilometers in the atmosphere carrying 80 pounds of payload.[13] After a month, Rahbar-II was also successfully launched. The data received from these rockets enabled scientists to gather information on wind shear, cloud formation, cyclones, and weather formations over the Arabian Sea and, by 1972, Pakistan had carried out 45 rocket launches.[14]

As compared to launch capability, Pakistan's journey in the field of satellite technology started quite late. SUPARCO first built a small radio satellite, named Badr-1, in the late 1980s with the help of the Pakistan Amateur Radio Society.[15] Since the satellite was planned to be launched from the *Challenger* (OV-099) space shuttle, the launch was delayed due to the explosion.[16] Badr-1 was finally launched into low Earth orbit by a Chinese launcher in July 1990. It weighed 52 kilograms and was inserted into a 205 kilometer orbit.[17] Although Badr-1 could not complete its designed lifespan of six months due to technical malfunction, the voice and data communications from the satellite were successful. SUPARCO could not maintain pace with further developments of the second satellite due to the economic sanctions of the 1990s.[18]

Badr-II was launched in December 2001, from Kazakhstan, on a Russian launcher. It weighed 68 kilograms and was inserted 1,050 kilometers above the Earth into orbit.[19] The progressive improvement in Badr-I and II enabled scientists to develop basic expertise in the field of satellite making. Then in 2003, Paksat-I was relocated to an orbit over Pakistan.[20] Paksat-I was a third-hand communication satellite originally bought by Indonesia. Later, it was sold to Turkey and, in 2002, it was hurriedly purchased by Pakistan to occupy its only slot in space.[21]

Out of 360 space slots allocated by the International Telecommunication

Union (ITU), 320 slots are already in use by various countries. ITU allotted five slots to Pakistan in 1984, but Pakistan failed to launch any satellites until 1995.[22] That year, Pakistan was granted an extension; however, Pakistan again failed to meet the deadline and lost four of its space slots.[23] However, Pakistan managed to protect its last slot by relocating the Turkish satellite and renaming it Paksat-I, with fairly successful progress.[24] Since becoming operational in January 2006, it has grown its customer base in the fields of broadcasting, communication, and internet use throughout the Middle East, Africa, South Asia, and Europe.[25]

A review of the developmental period reveals that during the initial years, Pakistan remained committed to developing launch capability. However, after a lull period of almost 10 years, the focus shifted toward developing satellite capability during the 1980s and 1990s. This disorganized development strategy delayed satellite development by 20 years. Moreover, the rocket capability did not result in any progress in the flight of satellite launch vehicles.

Pakistan's Present in-Space Technology

The present capability of Pakistan mainly consists of Paksat-1 and several application programs based on data from foreign satellites.[26] Paksat-1 is a communication satellite, which was relocated into Pakistan orbit in the year 2003 and became operational in 2006. It is being used for broadcasting, internet, and telecommunication purposes, extending coverage to South Asia, South East Asia, and parts of Europe.

In the sphere of remote sensing or Earth observation, Pakistan does not have any satellites of its own and remains dependent on foreign satellites.[27] However, a data processing infrastructure has been established to exploit Earth observation data received by foreign satellites.[28] Data is received from the acquisition zone of a satellite ground station and later it is processed for the application that it is being used.

National Satellite Development Program

After the last restructuring of SUPARCO under the Strategic Plans Division (SPD), renewed efforts have sought to revitalize the program to achieve self-reliance in the field of design and development of the satellite. The government of Pakistan approved the National Strategic Development Plan (NSDP) in the year 2003 to develop one communication satellite, two remote sensing satellites, and human resource development programs.

To replace Paksat-1, SUPARCO designed a prototype of a communication satellite, Paksat-1R. This project was completed in 2005. As a next step, SUPARCO was in the process of developing a small-scale engineering qualification model (EQM), a non-fly-worthy model, before building the actual satellite Paksat-1R.[29] Paksat-1R was launched in 2011, built for a lifespan of 15 years and can carry 1,000 kilograms of payload. It provides coverage to the entirety of Central Asia, the Middle East, South Asia, and parts of Africa and Europe.

Pakistan launched its first indigenous remote sensing satellite system (RSSS) in 2014.[30] The satellite had been designed for a lifespan of five to seven years and a revisit time of two to four days. Certain subsystems of prototype RSSS-1 have also been developed including a high-resolution camera, onboard computers, and satellite propulsion subsystems. After the success of the Badr series of experimental satellites, Badr-1 and 2, Pakistan launched a high-resolution remote sensing satellite system (RSSS) for satellite imagery.[31] The Badr family of satellites were all low Earth observational satellites that can take low-resolution, low-quality images of the Earth. Badr-II carried Earth imaging payload on an experimental basis, which was a success.[32]

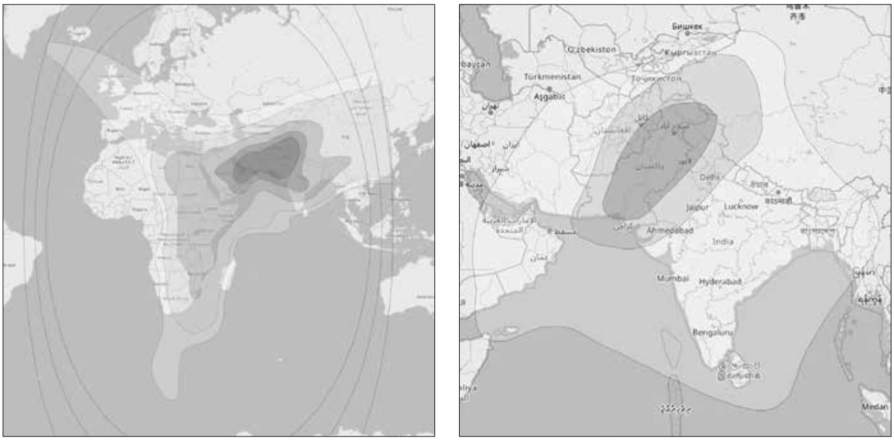
Badr-B is a follow-up microsatellite project of SUPARCO to its original Badr-A microsatellite project.[33] Badr-2 was developed in collaboration with UK industry and science institutes. Instruments monitor clouds at high resolution as well as atmospheric atomic oxygen. Badr-B is box-shaped with side dimensions of 51 cm x 51 cm x 46.5 cm and features a gravity gradient stabilization system. The satellite weighs 68.5 kg and is built and designed in Pakistan with some foreign subsystems. The camera was developed by Rutherford Appleton Laboratory (RAL) in the UK. Besides the Earth observation mission, Badr-B also used a radiation dosimeter to measure the exposure of the Sun's ionizing radiation and also studied the electromagnetic field of Earth. Additionally, Badr-B conducted studies on battery charge when it is exposed to solar flares and solar winds.

Badr-B was launched with the Meteor-3M no. 1 meteorological satellite on a Zenit-2 launcher from Baikonur Cosmodrome on 10 December 2001, into a 996 by 1050 km Sun-synchronous orbit inclined at 99.7°.[34] Other piggyback payloads on the same launch were Kompass, Maroc-Tubsat, and Reflector.[35]

Pakistan's first communications satellite, PAKSAT-1R, was launched on 11 August 2011 on board China's satellite launch vehicle, the Long March 3B, from the Xichang Satellite Launch Center. The 1R has a total of 30 transponders, 12 in the C-band and 18 in the Ku-band. The satellite will be deployed at 38.0E in geostationary orbit and it has replaced the existing satellite Paksat-1.[36] Paksat-1R has a design life of 15 years and will provide TV broadcasting and internet and data communication services across South and Central Asia, Eastern Europe, East Africa, and the Far East. This satellite now enables the extension of communication services to all areas of Pakistan.

SUPARCO launched the high resolution RSSS in 2018.[37] It will be a constellation of optical and synthetic aperture radar (SAR) satellites. RSSS is a progressive and sustainable program.[38] Initially, it was an electro-optical satellite with a 2.5 m resolution at 700 km Sun-synchronous orbit that was launched in 2011, followed by a series of optical and SAR satellites. It has a revisit time of two to four days with more than five years of a designed life.[39] SUPARCO's future projects also include the satellite launch vehicle in four phases, which can carry a payload of 200 kg to one ton up to 36,000 km.[40]

Figure 1. Satellite footprint of Paksat-1R



Source: "Satbeams—World of Satellites at Your Fingertips," Satbeams.com.

Military Applications

SUPARCO established a satellite ground station (SGS) at Rawat near Islamabad in 1989, which is presently acquiring remote sensing data directly from U.S. Landsat and French SPOT-2 and SPOT-5 series of satellites of 30m, 10m and 2.5m resolutions. The acquisition zone of the station covers 26 countries wholly or partially including Central Asian and Middle Eastern countries, Western China, Iran, India, and Bangladesh. Satellite images are being used for the identification of military targets, monitoring, mapping and information updating. This station provides images of multiple resolutions from 2.5m to 30m.[41]

Reasons for Slow Development

Despite having early momentum, the Pakistani space program is still at a very initial stage and lacks the desired level of technology and technical infrastructure. One of the major reasons for the slow pace is the isolation of the space program from the public sector. India involved its commercial sector in the space program from the start. Pakistan's space program is kept isolated from the private sector and is entirely handled by state-owned SUPARCO.

There is no sound industrial infrastructure available in the country to support such large research projects. Most of the time, the space program remained dependent on the personal interest of the individual head of state. It flourished very fast in the era of Prime Minister Zulfikar Ali Bhutto and the rest of the time it remained dormant.[42]

As a government organization, SUPARCO provides fewer chances for a competitive atmosphere and healthy environment, which are the foremost requirement for research and development projects. Little incentives and limited opportunities are being offered to the scientists and researchers involved in such projects.

Comparison with the Indian Space Program

Though the Indian space program started a year later than Pakistan in 1962, the Indian program was soon institutionalized with the formation of the Indian Space Research Organization in 1969. This was later augmented by the formation of the Space Commission and Department of Space in 1972 under the auspices of the prime minister.[43] It has been almost 40 years, and the integrity of the Indian space organization has been well maintained. India achieved self-reliance in the field of satellite development with the launch of Rohini in 1980. This was followed by a series of indigenously built experimental satellites in the field of communication, metrology, and remote sensing. Today, India's major satellite programs include an Indian national satellite system (INSAT) and an Indian remote sensing satellite system (IRS).[44]

Indian National Satellite System

Presently INSAT is the largest communication system in the Asia-Pacific region for telecommunication, broadcasting, and meteorological services including disaster warning, satellite-based education, and medicine systems.[45] To date, 22 satellites have been launched out of which 12 are operational. Major Indian communication satellite series are INSAT-2C, INSAT-2D, INSAT-2E, INSAT-3A, and INSAT-4. These satellites are used for telecommunication, television broadcasts, and for meteorological purposes.

Indian Remote Sensing Satellite System

India's remote sensing satellite system is one of the largest constellations of remote sensing satellites in the world, providing data in multiple disciplines.[46] At present, it consists of 11 operational satellites providing images up to 5m resolution.[47] This program was initiated to develop an indigenous capability to image Earth, the Indian Ocean region in general, and Pakistan and India in particular. Its civil utilizations include groundwater exploration, land uses, and forest and flood mapping. Some important IRS satellites are IRS-1C/1D, IRS P-3, IRS P-4 (OCEANSAT-1), IRS-P5 (CARTOSAT-1), and Technological Experiment Satellite (TES). Cartosat-2B is an Earth observation satellite launched on 12 July 2010 in a Polar satellite launch vehicle (PSLV) rocket from the spaceport at Sriharikota. The latest IRS-R2 (ResourceSat-2) satellite was launched successfully by PSLV-C16 on 20 April 2011 and is under trial.[48]

India's progress in the field of satellite launch vehicles (SLVs) is even more promising. The Indian launch program has progressed steadily since the first launch of a satellite launch vehicle in 1979. To date, India has conducted 22 launches with a success rate of 84 percent. The launch program started with satellite launch vehicles and progressed steadily to geostationary SLVs or GSLVs. However, it has been the Polar SLV that is considered the workhorse of the Indian space program. The Polar SLV removed India's dependence on Russian launch vehicles for deploying its remote sensing satellites. In space science, India is preparing for two important scientific missions. Chandrayaan-1 was India's first scientific mission to the Moon carrying optical imaging and laser ranging instruments.[49] The satellite is completely designed and developed indigenously. Astrosat is a nationally developed scientific mission, which will enable multi-wavelength studies of a variety of celestial sources by using a cluster of X-ray astronomy instruments and an ultraviolet (UV) imaging telescope.[50]

The same is the case in the reconnaissance field. India has been trying to improve the accuracy of its satellite imagery since the launch of the Cartosat series of satellites in 2001. The latest Cartosat-2B satellite, which was launched on 12 July 2010, has finally enabled India to have the satellite capacity to provide imagery to the accuracy of approximately 1m resolution. It is believed in military circles that this satellite was specifically developed to keep a watch on developments in neighboring Pakistan and China. Besides these indigenous developments, India has also been collaborating with technology and information-sharing deals with Israeli space agencies. Israeli satellite Ofeq-7 can provide half-meter resolution images that can bring qualitative improvements to India's intelligence database. India is also planning to convert SLV-3 into an intermediate-range ballistic missile (IRBM) with a range of 1,500 km.[51]

The Indian Regional Navigation Satellite System (IRNSS) consists of a constellation of eight satellites, with two additional satellites on ground as standby. IRNSS provides accurate real-time positioning and timing services comparable to other global constellations like GPS.[52] The first satellite of the proposed constellation was launched on 1 July 2013 while the other six were launched between a time frame of April 2014 to April 2016. However, the eighth satellite failed to deploy on 31 August 2017 as the heat shields failed to separate from the fourth stage of the rocket. Another satellite was launched on 12 April 2018 to replace it.[53]

Pakistan's Available Response Options

Space technology is the perfect tool for gathering intelligence and early warning about future threats. A country possessing such capability enjoys a great advantage while using this technology. They can be used to monitor enemy force structure and nerve centers, especially their warmaking potential. It is also helpful in area mapping and tracking asset movements. Knowledge gathered through satellites helps military planners not only assess the enemy's force structure and deployment pattern, but with very high-resolution imagery being provided by the latest reconnaissance satellites, the targeting process has also become very effective. This is further augmented by data from remote sensing satellites that can determine the exact construction of the target, thus asserting the right type and number of loads required for its neutralization.

The Implication of Indian Satellites

India has launched communication and remote-sensing satellites several times. Apart from their commercial use, these satellites, in a military role, are utilized for intelligence, surveillance, and reconnaissance (ISR) as well as communication and weather monitoring roles. Cartosat-2A/2B with high resolution presents spot imageries with a swath of 9.6 km.[54] This satellite has a revisit time of four days, which can be improved to one day as well. The ability to maneuver the orbit will provide a tremendous boost to ISR capabilities under the net-centric operations scheme of the Indian armed forces. Although no dedicated military satellite has been launched so far, the Indian Air Force has in the past made use of Indian Space Research Organization (ISRO) satellites for ISR, communication, meteorology, search and rescue, as well as imagery.[55]

The Indian remote sensing satellites integrated with ground-based surveillance stations will support surveillance on Pakistani territory with focused attention on logistic supplies, missile stores, and mobilization of military forces. Satellite surveillance and reconnaissance systems would considerably increase the Indian ability to monitor security interests and military developments in the region. Indian satellite imagery is likely to be upgraded by the installation of infrared sensors and radar in the future, which will increase India's night satellite imagery capability.

Implications for Pakistan's Strategic Assets

India is also planning to integrate long-range missiles with satellite guidance. The reliability and accuracy of these missiles will increase manifold, thus assuring Indian second-strike capabilities. Indian satellite Cartosat-2A/2B, while getting images of Pakistan's strategic nuclear assets, has significant implications for Pakistan's strategic nuclear deterrence. Pakistan needs to understand the fact that, after achieving nuclear and missile technology, the next logical front should be space technology. This technology is vital for making the nuclear command and control mechanism "credible." Pakistan would need to reenergize its space program on a war footing to reduce the technological gap between the two nuclear-armed rivals in South Asia.

While continuously monitoring Pakistan territory by satellite, India can gain information on logistics lines that can be later exploited for strategic targeting.[56] Additionally, this technology will help Indians obtain intelligence of all types of equipment and infrastructure, especially relating to coastal defense, jetties, and harbors for countermaritime operations. Moreover, Indian spy satellites can detect any major mobilization of troops, naval, and air force assets by continuous surveillance of the region.

Implications on Tactical Fronts for India

India currently has a good command and control system of modern force that enhances its fighting efficiency.[57] India's improved command and control system supported by the satellite network will enhance coordination through the network-centric capabilities of the Indian armed forces, thus giving an edge over Pakistan's military forces.[58]

Future Indian satellites with electronic warfare and signals intelligence payloads would be posing the greatest threat to Pakistan.[59] It can effectively intercept and in the future will jam microwave and digital communications signals and even radar transmissions.[60] In maritime air operations, satellites as force multipliers ensure information about the war theater. Thus, dominant situational awareness enhances operational plans and helps in tactical decisions.[61]

In the future, India may be able to detect submarines with blue/green lasers with the collaboration of U.S. space agencies.[62] A potential missile attack by the Pakistan Navy submarines can be monitored, thus providing early warning to India. The satellites can also provide essential guidance data for Indian long- and short-range missiles thus enhancing their credibility, especially on land targets.[63]

Tactical Options Available to Pakistan

Pakistan's response option for military applications of the Indian space program can be discussed under two broad considerations.[64] They include passive and active measures to deny, disrupt, degrade, or destroy the space capability. The most viable response against military applications from space-based assets under the prevailing environment can best be generated by developing a potent space capability. The current economic state of the country does not entail heavy spending on military space programs. The availability of requisite financial resources for even the ongoing projects has become questionable. Initially, the first focus is on the part of Pakistan's response through which it can minimize the military use of Indian satellites against Pakistan. As already discussed, the main military application of Indian satellites is in the domains of communications and ISR functions.

There are various passive and active measures that can be adopted to limit or reduce such applications. Camouflage and concealment is a passive measure to deny electro-optical and infrared imaging by satellites. Military installations are painted in camouflage paints and sensitive buildings have earth backfilled over roofs for denying infrared signatures and visual acquisition. This second technique seems more viable. Besides that, infrared absorbent paints are also available. These techniques can be applied as a standard operating procedure on all new infrastructure and old sensitive installations. The construction of buildings at strategic sites and transportation of strategic assets need to be masked. However, for effective masking, the availability of data regarding the trajectory and orbital timing of enemy imagery satellites is a prerequisite. Lastly, there is a need to construct replacement dummy structures, aircraft, or radar antennas with fake infrared signatures, etc. to deceive the enemy.[65]

INSAT series satellites are commercial satellites that are being used for communications by the Indian armed forces satellites that, like any civil satellite, can be jammed from the ground or in space. The close vicinity of communication satellites might cause jamming spillover on neutral satellites.[66] However, for its effectiveness, accurate fingerprints about the concerned satellite by electronic intelligence measures are essential. Localized antisatellite communication jamming can be conducted through the readily available off-the-shelf jammers in the international market.[67] Computer hacking is the biggest dilemma faced by the United States even today.[68] Cyber warfare is considered to be an essential element of information warfare. With proper hardware, software, and human expertise, any computer-based system in the world can be infected. Depending on the expertise, computer viruses can cause significant corruption and disruption even in the presence of advanced safety features. Satellites and their functions can also be disrupted by computer hacking.[69]

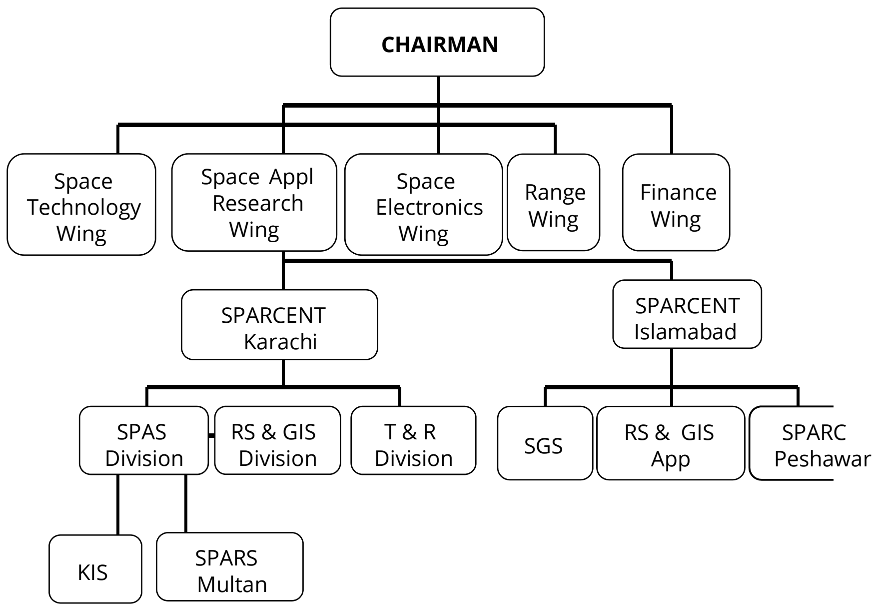
The United States, Russia, China, and India have already tested antisatellite missiles. Destruction of a satellite is the most potent means to deny the enemy strategic high ground.[70] While the destruction of medium Earth orbit satellites is difficult, the LEO satellites can be destroyed, which would deny real-time surveillance capability.[71] The makeup of this capability includes a satellite tracking system and an antisatellite missile. Pakistan already partially possesses these components in the shape of the surface to surface missile rocket motors and SUPARCO's Satellite Telemetry, Tracking, and Command Station located at Lahore.[72] It would be prudent to initiate the preparatory work on Pakistan's end to achieve this objective during the war. Indians have two satellite mission control centers (MCCs) and seven satellite ground receiving stations (GRSs) located in Indian territory. All of these facilities have fixed locations. However, most of these facilities lie outside the Pakistan Air Force's existing strike range. However, the targeting of these facilities can deny India the military application of its space assets to a great extent. The other option is targeting these sites through conventional surface to surface missiles.

The available information about the Indian space program is only through open-source material. In the case of the Indian space program, Pakistan needs to develop a more complete picture of its capabilities, which can be accomplished by developing multiple human intelligence ingresses into the system. India, being a poor country, offers a wide scope for such undertakings due to an abundance of workers. Moreover, there is a large turnover of ISRO employees who tend to move to Western countries to explore high-paid job opportunities. The employed workforce can be exploited on these lines to disclose desired information. The development of human intelligence ingress into ISRO permanently is the most vital requirement for developing all aspects of Pakistan's response to preparing the most appropriate response option against any given space system.

Response Options at the Government Level

It is practically difficult for Pakistan to develop an indigenous satellite for commercial and military use due to budget constraints. However, multipurpose satellites (military and civil) are the most suitable option available for a country

Figure 2. Organizaion of SUPARCO



Source: courtesy of authors, adapted by MCUP.

like Pakistan. Private ventures can easily be formed to develop communication satellites as it is a speedy and reliable means of communication. Having an indigenous satellite provides Pakistan with total control over the satellite. Indigenous-built satellites cover the security aspect and also ensures availability during wartime.

At the national level, Pakistan should seek partnerships with China and friendly Muslim countries for which the forum of Inter-Islamic Network on Space Sciences and Technology (ISNET) already exists.[73] Moreover, consistent efforts at the government level to strengthen SUPARCO to gradually increase the strength of its imaging satellites should also be undertaken.[74] The availability of more satellites owned by SUPARCO could be the first step toward self-reliance. Continuation of hiring satellite services is a short-term solution for Pakistan, which only provides temporary relief, not a cure.[75] Moreover, its operating cost is very high, and at the same time the country has to be dependent on others, which gives less assurance during wartime.[76] This option may also lead to security compromises.

Recommendations

The following recommendations are highlighted for Pakistan's space program. SUPARCO should carry out extensive efforts to gain sufficient expertise in space-based technologies. India is known to have inducted a large number of experts from the former Soviet Union, Yugoslavia, and the Czech Republic.[77]

Pakistan can adopt a similar assistance package. Better coordination should be developed among military headquarters and SUPARCO for the exchange of satellite information. SUPARCO should be part of or at least have a fair representation in the planning and conduct phases of military operations.

Pakistan needs to develop extensive, all-directional bilateral space cooperation with other countries. In particular, Pakistan must fully exploit Chinese space potential expertise and support from the Islamic countries. The space program requires long-term partnerships and continuous assistance from collaborating countries until it matures. Therefore, focused diplomatic efforts should be made in this regard. Diplomatic policies toward these countries should also be steady. There is an urgent requirement to collaborate within international consortia for the development of a remote sensing system with at least a one-meter resolution to correct the regional technological imbalance.

So far as strategic surveillance is concerned, studies relating to classified areas with some time delay can be provided by SUPARCO using data from U.S. Landsat/IKONOS and French SPOT satellites.[78] However, to maintain continuity in strategic data acquisition, Pakistan must possess a remote-sensing satellite of its own. This need was amply demonstrated during the Afghan War after the 9/11 events when a ban was placed on the supply of these data to the world user community.[79] As a result, Pakistan could not receive data for more than three months, which was a "black-out" period for the SUPARCO.

While indigenization in satellite development may continue at its logical pace, Pakistan must augment the potential of its only geosynchronous satellite by replacing it with a multipurpose satellite with foreign assistance. This quick-fix solution may bring in some form of balance in space capability with India. On the ISRO–Defense Research and Development Organization model, SUPARCO should also have indirect collaboration with the Dr. A. Q. Khan Research Laboratories for the development of space launch vehicles from expertise in intermediate-range ballistic missiles or medium-range ballistic missiles.

The Indian government has improved the middle-class status so that their contribution to the development of the country has increased.[80] Pakistan should also adopt the same measures to encourage middle-class talent in this field. Incentives must be introduced to talented people to encourage them to develop national projects instead of having talent drained toward other countries. Major reforms are needed in education systems to be at parity with other countries.[81] Strong technical and IT infrastructure needs to be developed, along with heavy industry to support the indigenous space program. Sufficient funds are needed to undertake various space projects.

Conclusions

Information and space have propmted a revolution in which neither mass nor mobility will decide outcomes; instead, the side that knows more can turn the tide in their favor. Despite the immense benefits for the economic well-being of a country, space has also become the new high ground for future conflicts. Space technology now promises to resolve many traditional problems of a military commander by becoming their eyes and ears. India has achieved its space capabilities in a steady and sustained manner. At present, there is no comparison between India's and Pakistan's space program. The tremendous achievements made by India in its space program have given it the capability against which Pakistan can do very little to hide its activities, which are strategically or tactically geared to bolster offensive or defensive design. To offset this advantage and maintain equilibrium in this very important field, Pakistan has no choice but to accelerate its indigenous satellite program to prepare for potential conflict. This fact needs to be recognized and addressed. This may be a very long-term solution and results may not be visible shortly, yet its importance cannot be overstated. Under the present circumstances, it may not be viable for Pakistan to run an expensive indigenous development program so the key lies in diversifying its bilateral space cooperation.

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