Outer Space – Challenges & Opportunities

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Aerospace & Defence

"The Earth is the cradle of humanity, but mankind cannot stay in the cradle forever."

- Konstantin Tsiolkovsky

Capabilities : Weaponisation of Space…

	China	Russia	U.S.	France	India	Iran	Japan	North Korea
LEO Co-Orbital	🟢	🟡	🟡	🔴	🔴	🔴	🔴	🔴
MEO/GEO Co-Orbital	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴
LEO Direct Ascent	🟢	🟡	🟡	🔴	🟡	🔴	🔴	🔴
MEO/GEO Direct Ascent	🟡	🟡	🟡	🔴	🔴	🔴	🔴	🔴
Directed Energy	🟡	🟡	🟡	🟡	🔴	🔴	🔴	🔴
Electronic Warfare	🟢	🟢	🟢	🟡	🟡	🟡	🔴	🟡
Space Situational Awareness	🟢	🟢	🟢	🟡	🟡	🟡	🟡	🔴

Legend: none 🔴 some 🟡 significant 🟢

Source - International Governance of Space Activities | Secure World (swfound.org) Highlights from the 2021 Report

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Our Take

Space is the next Frontier for attempts at domination. Competition is no longer a remote possibility but an emerging reality, with Opportunities

The World is moving from 'Militarisation' of Outer Space to 'Weaponisation. As humans venture deeper into Space, more and more challenges will come up. Within the challenges are opportunities for the futuristic entrepreneur. With the population of Space, strife for Outer Space will be the norm. Unless the collective Human Race can see the light and come up with a 'binding' non-militarisation and non-weaponisation treaty, the strife would imply Humans fight FOR and IN Space.

Indian Space Research Organisation (ISRO)'s annual budget reached ₹14,000 crores in Budget 2021, growing steadily from ₹9,000 crores in 2017. As per Satellite Industry Association Report (2020), the value of the global space industry is estimated to be $360 billion and is likely to exceed $550 billion by 2025, out of which India's share is estimated at around $7 billion, about 2% of the global market. Only five per cent of this market was for rocket and satellite launch services, while the remaining 95 per cent related to ground-based systems and satellite-based services.

With the creation of the Indian National Space Promotion and Authorization Centre (INSPACe) to provide a level playing field for private companies to use Indian space infrastructure, a boost has been given to private sector participation in space activities. INSPACe will hand-hold, promote and guide private industries in space activities through encouraging policies and a friendly regulatory environment. It would endeavour to reorient space activities from a 'supply-driven' to a 'demand-driven' model, thereby ensuring optimum utilisation of the nation's space assets. Through PPPs, the Indian space sector can reach its target of being a $50 billion worth industry in five years.

The Defence Space Agency (DSA) and Defence Space Research Agency (DSRA) have also taken shape, and there work is in progress in Electronic Intelligence (ELINT), Communication Intelligence (COMINT), and areas like space-based tracking systems. This comes on the backdrop of China developing multiple counter-space capabilities to degrade and deny adversary use of space-based assets during a conflict. China can use directed-energy weapons, anti-satellite missiles, electronic jammers, cyber-attacks, and small satellites to target the those of foreign nations. Reports also indicate the Chinese development of a ground-based laser weapon that can counter low-orbit space-based sensors. India, on its part, had given a definite indication of its intent when on 27 March 2019, the DRDO demonstrated Anti Satellite (ASAT) capability by destroying a live orbiting satellite in Low Earth Orbit (LEO), of about 300 km, with an interceptor missile in a "hit to kill" mode.

Recent convergence of United States and India is a opportunity which is being realised to take their space cooperation to higher levels. Collaboration with the other two members of the Quad, Japan and Australia is also being explored. The third iteration of Indo-US 2+2 strategic dialogue, held in October 2020, had consequential issues of cooperation in space such as Space Situational Awareness (SSA). The NASA-ISRO synthetic aperture radar (NISAR) project is another example of these collaborations.

Stay tuned for a decade of opportunities in space.

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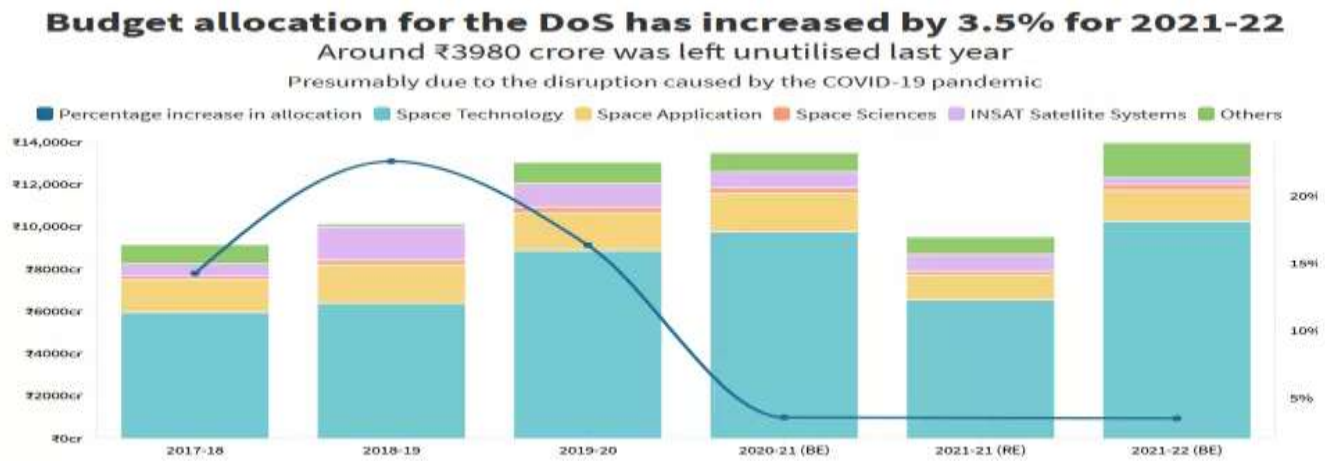
Budget allocation DoS



Source: Budget documents

Source : https://www.businessinsider.in/science/space/news/isro-will-transform-in-2021-as-india-pumps-big-money-to-draw-in-startups-for-the-second-space-age/articleshow/80683054.cms

Insights and Analysis

- Outer Space - A story of emerging expectations

The regulatory bodies and decision makers Department of Space

ISRO is the Primary space agency leading India's space activities, providing access to space and carrying research & development.

Antrix is the commercial arm of ISRO – promotes and commercially markets products and services emanating from the Indian Space program.

New Space India Limited (NSIL) is the commercial arm of ISRO with the primary responsibility of enabling Indian industries to take up high technology space-related activities. It aims to commercially leverage the research and development work of ISRO Centre's and constituent units of DOS.

Indian National Space Promotion and Authorization Centre (INSPACe) will regulate and promote the building of routine satellites, rockets and commercial launch services through the Indian industry and startups. Encouraging policies and friendly regulatory environment reforms aim to boost private sector participation in the entire range of space activities. It is also to draw up the Integrated Launch Manifest, which is expected to provide clear boundaries between the private sector, ISRO and NSIL.

Opportunities

Satellite manufacturing. Small satellites require less building and setting up time as a constellation which gives wider coverage. Shorter incubation facilitates predictability of launch and positioning. Affordable electronics make small satellites preferred options against large ones. By 2026, it is estimated that more than 10,000 small satellites will be launched in Low Earth Orbit (LEO).

Launchers. Satellite launch services have seen a rise in requirement with increase in demand for nanosats and mega-constellations of small satellites. This decade is likely to see increase in launch and manufacture of small satellites together by about 3.5 times. In a recent interview with Indian Express, Mr K Sivam, Chairman ISRO, indicated that access to ISRO facilities would be provided to INSPACe approved private industry. They could also build their own launchpad within the Sriharikota launch station. The planned commercialisation of the development of medium and heavy-lift launchers, and the launch itself, will allow India to capture a more significant portion of the international launch market.

Satellite-based Applications. There has been a rapid increase in demand for satellite-based applications such as remote sensing and communication, which is are opportunities for small start-ups.

Servicing. There is an emerging demand for servicing satellites required for in-space repair or upgrading satellites in orbit. It is estimated, the in-orbit servicing market (IOSM) size will be USD 4.5 billion by 2028. Specialised servicing spacecraft will be an inherent feature, in future.

Earth observation. The Earth observation market is expected to be worth USD 4.8 billion by 2022, fueled by information products and big data solutions. The imaging data analytics industry itself will be a huge market, which is likely to grow by nearly 30% over the next decade. Technologies like hyperspectral imaging and synthetic aperture radar (SAR) are deployable on small satellites. When coupled with advanced big data analytics and improved ML algorithms, these will become vehicles for growth.

Communication. The estimated global market for satcoms, four years back, was approximately USD 130 billion. Over a third of transponders used for Indian services are leased from foreign satellites. This would increase with initiatives like 5G, Internet of Things (IoT), and BharatNet. Optical communication, to overcome the limited availability of radio frequencies, will be the new highway in Space.

Insights and Analysis

- Crystal Gazing into Space

The industry sectors which will take advantage of the Space Growth

Energy. Energy is the largest industry on Earth at over $8.4 trillion and growing at 4.1% CAGR. An in-space population will require enormous amounts of energy to live, work, and transit. This energy is likely to come from solar power and chemical rockets in the foreseeable future.

Mining. Emergence of space resource industry will give a fillip to the global mining industry. Extraction of Space resources from celestial bodies like asteroids and the Moon is being explored. Space mining will include water and water-derived propellants and thereafter transcend to structural metals for construction projects, as also precious metals needed for in-space manufacturing or possibly for return to Earth.

Transportation. Availability of propellants beyond Earth's gravitational influence will result in the creation of the first in-space superhighway. A series of fuel depots placed throughout the solar system implies potential for the transportation, energy, mining, and refining industries.

Construction. Deployment of the first orbital construction system is likely before the end of the decade. Assembly of large structures in orbit and repairing or refueling existing satellites will be possible by these robotic spacecraft.

Hospitality and real estate. Support of astronauts and tourists, to leasing space-in-space for orbital manufacturing and research and development programs will give rise to this Industry. Launch of Space habitats initially would be from Earth. As the resource supply chain expands with availability of metals from asteroids and Moon, this sector will also rely on resources sourced from space. Possibility of the first city in space would emerge with markets for real-estate in orbit.

Companies, who have the foresight and entrepreneurship to view space not as a stand-alone industry but as the next medium to conduct their business, will gain exponentially. Possibilities have no boundaries; limitations only are the ones we impose on ourselves.

New Technologies being developed by NASA

Portable Magnetic Highway. A robotics engineer at Jet Propulsion Laboratory (JPL) is exploring concept for a portable magnetic "rail" transportation system. This would facilitate transporting material such mining raw lunar ore, construction material and debris from construction etc. The concept involves laying a flat track between locations on which autonomous transport robots levitate above the track on a magnetic cushion. Carriage of loads is facilitated without friction or air resistance and, without need of constant human supervision.

Swimbots. Some Celestial bodies, such as Jupiter's moon Europa and Saturn's moon Titan, have (methane) Oceans. Normal modes of movement would have to be supplemented. JPL is developing a concept for robotic exploration vehicles that can swim in these Oceans.

Cultivating Space Soil. Asteroids are a possible source material for creating arable soil. A concept of putting Earth fungus to work, is being explored by a Researcher at Trans Astronautica Corporation. The fungus is meant to break down or "digest" sterile asteroid material into soil for growing plants.

Prefabbed Space Homes. A Carnegie Mellon University assistant professor has conceived a lightweight collapsible apparatus which is to be used as deployable building block for constructing enormous structures to engineer an artificial space habitat. This would enable accommodating a population of humans and a sustainable, even self-sufficient, ecosystem.

Generation & Distribution of Electric Power. Though concentrated solar energy systems are not new, engineering a system on celestial bodies presents technical challenges. A system design small and light enough to be transported from Earth to the lunar surface, while efficient enough to maximize energy production from the sun's rays, would be required. A researcher at NASA's Langley Research Center is developing a design to generate and distribute electrical power, using telescope optics to capture, redirect and focus sunlight.

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- Defence in Outer Space

Weaponisation of Space

While **militarisation of space** implies using space-based assets for Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance, **weaponisation of space** includes placing weapons in outer space or on heavenly bodies as well as creating weapons that will transit outer space or simply travel from Earth to attack or destroy targets in space.

There is no global regulatory regime to address the growing weaponisation in space except two treaties; 1. **Limited Test Ban Treaty 1963** prohibiting nuclear tests and any other nuclear explosions in outer space 2. **Outer Space Treaty 1967 which** prohibits only weapons of mass destruction in outer space, not ordinary weapons. *India is signatory to both the treaties.*

Despite the growing concern voiced also in United Nations, including India, weaponisation of outer space is growing at a faster rate. China has made great progress in this field, to include Directed Energy Weapons and Cyber in addition to Anti-satellite (ASAT) missiles beyond LEO and, is developing potential orbital weapons with dual-use space platforms. India cannot afford to be left behind. It is in this light that "Mission Shakti" was carried out by launching a ballistic missile into outer space to destroy an Indian satellite about 300 kilometers above the earth's surface, in LEO. To further planning & development of Space Defence cabilities two exclusive Defence Agencies were formed.

Defence Space Agency (DSA) was formed in April 2019. It will operate systems to protect Indian interests in outer space and will deal with potential space wars. It will also develop a space warfare strategy. Space Command is intended to come up on it which will command the space assets of the three services, including the anti-satellite capability.

Defence Space Research Agency (DSRA) was approved in Jun 19. It is responsible for developing space-warfare systems and technologies for the DSA.

Opportunities for Private Industry

Space Situational Awareness (SSA). Mapping and cataloguing space-borne objects for the purpose of devising suitable counter strategies. It requires development and deployment of a vast network of telescopes, long-range radars, and space-based sensors.

SIGINT/COMINT/ELINT/IMAGEINT Satellite. For active and passive intelligence gathering involving communication mapping and imaging.

Launch on Demand. Rapidly deployable launch vehicles, launch facilities (mobile and stationary) and reconfigurable / retrievable launch vehicles, in order to meet urgent requirements of launching satellites in a matter of a few hours.

Directed Energy Weapons (DEW). Systems such as high-power microwaves, precision high power lasers and light-directed energy capabilities.

Electronic Warfare (EW). Involve jamming and spoofing technologies to disturb the electromagnetic (EM) spectrum and other mission critical systems, which are essential for conducting operations in a network centric environment, in Space.

Rogue Satellites. These cause damage to adversary assets and use a combination of kinetic kill vehicles, high-power microwaves, lasers, jammers, robotic instruments and chemical sprayers.

Greater Sophistication of ASAT. Continuous upgradation is required, in terms of miniaturisation of the missile and multiple launch options (ground, air and sea-based) to make it more effective.

*The DSA has invited proposals, in Jan 21, on technologies providing **space situational awareness solutions**, which can "detect, identify and track enemy assets while also warning about any impending attacks". The technology should be able to predict threats from ASAT, space debris, DEWs, and EW. The agency is also looking for a system that can be enhanced to play an offensive role in the future.*

About Primus Partners

Primus Partners has been set up to partner with clients in 'navigating' India, by experts with decades of experience in doing so for large global firms. Set up on the principle of 'Idea Realization', it brings to bear 'experience in action'.

'Idea Realization'— a unique approach to examine futuristic ideas required for the growth of an organization or a sector or geography, from the perspective of assured on ground implementability.

India is and will continue to be a complex opportunity. Private and Public sector need trusted advisory partners in order to tap into this opportunity. Primus Partners is your go-to trusted Advisory for both public and private sector organizations involved intricately with nation building, and the creation and growth of robust corporations as engines of progress.

Our core strength comes from our founding partners, who are goal-oriented, with extensive hands-on experience and subject-matter expertise, which is well recognized in the industry. Our core founders form a diverse cohort of leaders from both genders with experience across industries (Public Sector, Healthcare, Transport, Education, etc), and with varied specialization (engineers, lawyers, tax professionals, management, etc).

Primus Partners brings experience of working in more than 30 countries with private and public sector, including working with Government of India, building and leading large consulting teams at the leadership level, and creating one of the largest public sector consulting practice in India. They also represent 200 person years of experience in leading global and Indian consulting firms and the public sector.

The founding team is supported by a distinguished advisory board that includes experts with leadership experience across government, large corporate and notable civil society organisations.

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