VIEW

India's Catalytic Reforms for Space 2.0 Era

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India has one of the world's most proficient space programs, with a wide portfolio of space technologies and operations.[1] These proficiencies were achieved despite low access to technical, human, and monetary resources and in a developing economy milieu and difficult times.[2] Currently, India's space economy constitutes almost 2 percent of the global space economy,[3] which is estimated to be worth 423 billion USD.[4]

Since its inception in 1969, India's civilian space agency, the Indian Space Research Organization (ISRO), has laid a strong foundation for diverse space launch, remote sensing, space-based communications, and space science competencies. However, while pursuing these competencies, the Government of India (GoI) has made sure that the ISRO diligently focuses on socioeconomic applications and serves as an agency of constructive space diplomacy.[5] In May 2020, the GoI initiated far-reaching policy reforms in the Indian space program, taking into consideration many fast-paced global technological, geopolitical, and economic developments.[6]

If one is to sort spacefaring nations, only for a clear distinguishing analysis, India can be placed as a second-generation spacefaring nation along with the People's Republic of China (PRC), Japan, Germany, France, and Brazil. This categorization makes the United States and Russia the first-generation spacefaring countries, as they have been the only ones to utilize their World War II–era military industrial complex to make pioneering forays into outer space and sustain their space dominance.

When India emerged independent from British colonization in the mid-twentieth century, New Delhi had neither the extensive World War II military industrial complex nor the innovation ecosystems that the first-generation spacefarers had accrued. Thereafter, New Delhi attempted to balance, often successfully, space-technology imports from the West and the Soviet Union, along with simultaneous avid efforts for space-technology indigenization. India's nonalignment, despite it then being a developing economy, the ensuing geopolitical factional tug-of-war, and a hostile neighborhood have repeatedly hindered indigenization and kept space research and development (R&D) tightly under the government's control—with access to only few private sector players. Therefore, India's technol-

ogy policy makers have long realized that India's innovation prowess will be directly proportional to the consolidation of the Indian economy.[7]

With this direct proportionality in consideration, the GoI, in 2014, formulated some conducive and attractive high-technology innovation and manufacturing policies for the private sector under their flagship policy projects: Make in India for the World; Invest India; Startup India; and Digital India.[8] The Make in India for the World program has a strong space-technology component, which offers 100-percent foreign direct investment for satellite construction and operations with some oversight from the Department of Space, the government's primary space policy body.[9] These flagship policy projects were not effective enough to make the space sector future ready. This was because, New Delhi was not counting on the role of private sector in developing a vast repertoire of Industry 4.0–based space technologies that are rewriting the scope of commercial, civilian, and military space programs.[10] Neither was the GoI analyzing the progresses of the third-generation spacefaring countries—particularly, Australia, New Zealand, Luxembourg, and the United Arab Emirates—that are piggy-backing on private sector–spawned new and emerging Industry 4.0-enabled space technologies.[11] With the advent of these third-generation nations' efforts, space activities are becoming extensively democratized and privatized globally. Although the Indian space agency was performing up to its mark, the organization lacked a private sector to operate with it on an equal pedestal. The COVID-19 global pandemic, the ripples the virus has caused in the global high-value technology supply chains,[12] and India's quick policy-riposte have witnessed a positive upswing in India's techno-economic growth.[13]

This article briefly highlights the May 2020 space reforms and the domestic, geopolitical, pandemic-related, and Industry 4.0-driven causal factors that are influencing the evolution of India's space industrial ecosystems.

Domestic Factors Responsible for India's Space Reforms

Despite the disruptive impact of the COVID-19 pandemic, 2020 has been a catalytic year for the GoI, which has begun to extensively reform the nation's high-technology sector.[14] In the months prior to the COVID-19 global pandemic, New Delhi was aiming to expand India's gross domestic product to 5 trillion USD by the year 2025.[15] However, such calculations failed to anticipate a Black Swan event that would derail such progress;[16] the pandemic has spawned two distinct factions among policy makers, one claiming New Delhi's goal cannot be met by the target year and another claiming all is in order.

The GoI was quick to initiate a comprehensive pandemic rehabilitation plan: Aatmanirbhar Bharat (Self-reliant India). The high-technology component of

Aatmanirbhar Bharat is aimed at reducing India's dependency on supply chains originating from hostile nations and their proxies,[17] implementing stringent anti-dumping policies on various products originating from this cohort, imposing bidding restrictions with sunset review probes,[18] and providing incentives to high-technology companies from friendly nations willing to shift their manufacturing units to India.

The GoI has started a production-linked incentive (PLI) scheme to boost manufacturing of assembly, testing, marking, and packaging (ATMP) units such as logic microprocessors, microelectromechanical systems, light-emitting diodes, memory chips, semiconductor manufacturers, fabs, and foundries,[19] which had long been elusive to India's electronics industry landscape. In the short span of six months, the GoI successfully attracted numerous electronics and semiconductor manufacturers to India.[20] Given the timeliness and efficacy of Aatmanirbhar Bharat and despite a near manufacturing standstill in the months of April and May 2020, India recorded a Purchasing Managers' Index of 56.8 in September 2020, the highest in the past eight years.[21]

The GoI, with the space reforms of May 2020, has expanded the scope of the Indian space program from the confines of the ISRO and has committed to create a favorable policy environment for the private space sector to flourish by giving it a level playing field and generating large-scale employment through privatization. To this end, the Indian National Space Promotion and Authorization Centre (IN-SPACe), a new facilitating agency was established in May 2020.5 The IN-SPACe will provide the private sector enabling innovation and industrial policies, steering companies through simplified and promising guidelines and friendly regulations and giving them the necessary access to use ISRO-built space infrastructure. In 2019, to complement IN-SPACe, the GoI had already established a public-sector company, the New Space India Limited (NSIL), to offer a huge repertoire of ISRO-built technologies and spin-offs to the private sector for commercial applications.[22]

The new space reforms and the establishment of IN-SPACe and NSIL are aimed at enabling the Indian industry and innovation ecosystems to be vital players of the global space economy and increase India's share in that market from the current 2 percent. As a sign of progress toward this goal, many Indian space start-ups and technology companies, amid the ongoing pandemic-related lockdowns, have accrued inward investments; demonstrated progress in the R&D of their space-technology prototypes; formed strategic partnerships with their US,[23] Australian,[24] French,[25] Canadian,[26] and British[27] counterparts; and made outward strategic investments in global space-technology companies, particularly in the telecommunications, space-launch, and remote-sensing verticals.

Geopolitical Factors Responsible for India's Space Reforms

India's space reforms have been influenced by the geopolitical game, particularly as played by the PRC in the Indo-Pacific. A belligerent PRC attempted to encircle India with a String of Pearls in the first decades of the current century. The PRC has made geopolitically motivated investments in India's growing digital and electronics market.[28] Beijing has prompted countries indebted to it via Belt and Road Initiative (BRI) loans and grants to undertake covert actions against India,[29] through guerilla actions and noncontact warfare.

The United States is a key driver of the global space economy and is a major benefactor to many of the new third-generation spacefaring countries and their Space 2.0 industries, start-ups, and commercial R&D laboratories.[30] China, in a bid to compete with the United States, has been attempting to develop its own quasi-private-sector space industrial ecosystems, capitalizing on markets in countries that are politically aligned with Beijing and those that are indebted to China under BRI-related commitments. The PRC is carrying out its satellite diplomacy with countries like Venezuela, Laos, Pakistan, Algeria, Nicaragua, Bolivia, and Belarus, and the People's Liberation Army (PLA) has set up overseas satellite and spacecraft telemetry, tracking, and deep-space communications ground stations in Namibia and Argentina.[31] The PRC's antisatellite test of 2007, its pathbreaking progress with quantum-encrypted satellite-based communications, and the completion of the Beidou navigation satellite constellation,29 with the closest ground station merely 100 kilometers away from the Line of Actual Control in the Ngari Prefecture of Tibet[32] have prompted New Delhi to reduce the technology gap with the PRC and cut trade with China that is inimical to India's national security.

Although China is engaging in a great-power contest with the United States, Beijing views India and its other neighbors—particularly Japan, Russia, and Vietnam—as challengers. The PRC also realizes that a hot war with any of these four will be perilous, hence Beijing is focusing on developing technological competence to undertake informationized warfare and achieve space dominance. To this end, the PLA Strategic Support Force, with its constituent Network Systems Department and the Space Systems Department, which were created in 2015, is playing a vital role.[33]

China's expansionist attitude in the subcontinent, its repeated territorial claims over Indian sovereign territory, and Beijing's sponsorship of state and nonstate proxies against India, in addition to China's growing military space operations, have forced New Delhi to restructure India's civilian-only national space program into a more comprehensive one with ample scope for commercial, civilian, and military space operations. Therefore, in 2019, India not only demonstrated deter-

rence capabilities with the Mission Shakti kinetic hit-to-kill antisatellite test[34] but also immediately established the Defence Space Agency (DSA)[35] as a new tri-service unit under the Chief of the Defence Staff.

The PRC aside, the founding of the DSA is concomitant with the other new military space units established all over the world. France founded its Joint Space Command in 2010,[36] Russia created the Russian Space Forces in 2015,[37] Germany created the Cyber and Information Domain Service Headquarters in 2016,[38] United States with its US Space Force in 2019,[39] and Japan established the Space Operations Squadron under the Air Self-Defense Force in 2020.[40] India's space reforms are aimed at creating a vast self-reliant industrial ecosystem that succors the DSA along with the civilian and commercial sides of the Indian space program.

The Role of COVID-19 in India's Space Reforms

India's socioeconomic goals and projections for the decade of 2020s were taking into consideration a robust Chinese economy and China's continuing clout over the global supply chains. The projection estimates were not anticipating any Black Swan events, like the COVID-19 global pandemic has turned out, nor a series of events that could stir India's indigenization goals or rapidly shift high-technology manufacturers from the PRC to India. The COVID-19 pandemic, the dispute initiated by the PLA in the Ladakh–Tibet region in June 2020 during a period of economic lockdown, and the strong military and economic riposte by the GoI has unpredictably kick-started these aspirations.[41]

India does not intend to replace the PRC as a global manufacturing hub only by increasing exports via the backward participation of multinational manufacturers. New Delhi's aspirations are holistic, as India also aims to increase exports via forward participation and by creating national, regional, and continental champions.[42]

New Delhi has begun to comprehend that the successful implementation of space reforms resides in developing a robust foundational innovation and industrial ecosystem, including the missing link of electronics and semiconductor R&D and manufacturing. For that, in addition to the Production Linked Incentive Scheme for Electronics Manufacturing, India has initiated numerous new policies in the electronics system design and manufacturing (ESDM) sector. These include the Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS)—aimed at meeting the growing domestic demand in this sector, generating skilled employment and increasing value addition—and the Modified Electronics Manufacturing Cluster Scheme (EMC 2.0), which seeks to strengthen supply-chain responsiveness and reduce time to market by

providing incentives to develop common facility centers, ready-built factories, sheds, and plug-and-play facilities.[43]

New Delhi is also planning to initiate production-linked incentive schemes for the automobile, solar-power, specialty chemicals, pharmaceutical, and other high-tech industries.[44] These policy regulations, triggered by the COVID-19 global pandemic, are expected to create an immense supply-chain bandwidth for the private space sector, which largely depends on these allied sectors for provisions of raw materials and components.

The Role of Industry 4.0 in India's Space Reforms

Another major driver of India's space policy reforms is the impending Fourth Industrial Age that is redefining the technical specifications of existing space technologies as well as complementing many new and emerging Industry 4.0 technologies for space applications. For many years, the ISRO largely interacted with the private sector through the classical vendor-supplier relationship. This private sector was mostly working on the templates offered by the ISRO and had little scope for innovation. Today, New Delhi realizes that although the ISRO and its sister national laboratories possess the necessary competence and wherewithal in terms of conventional space technologies, the private sector is present on equal footing in terms of its know-how in R&D, manufacturing, and commercialization of Industry 4.0–enabled space technologies.[45] The privatization of the US, European, and Japanese space programs and the new operating models demonstrated by third-generation spacefaring countries have influenced New Delhi's space privatization drive. New Delhi now aims to increase India's share in the global space economy using this privatization.

Unlike the United States, which has global private-sector behemoths with specific space, aerospace, defense, electronics, advanced materials, information-communication technologies, and semiconductor portfolios, India's largest private-sector companies are mostly multisector conglomerates or are from the automobile, oil and gas, and information-communication technology sectors. Those companies that have had the history of liaising with the ISRO are anticipated to begin innovating and enhancing technologies they have been working on for several years. Those companies that have less frequently worked with the ISRO will become intrepid. In either case, India's private sector—including the large players, smaller enterprises, and start-ups—will plug into the global space economy in no time. Bharti Global's majority purchase of the US-based global communications company OneWeb[46] and the cooperation agreement between Nelco, a Tata subsidiary known for a satellite-ground station technology, and the Canadian satellite communications provider Telesat[47] are two recent examples that

highlight such rapid connectedness. Early-stage Indian space start-ups are also seeking access to commercially favorable partners and investors from across the world, particularly from Australia, the United States, and other friendly countries.

The ISRO has also initiated a Space Entrepreneurship & Enterprise Development (SEED) project to assist space-related start-ups that seek greater support. The GoI's premier technology-policy think tank—the NITI Aayog—has inculcated Industry 4.0 technologies including green, electric, and advanced air-breathing propulsion, robotics, augmented and virtual reality, and machine learning and artificial intelligence for geospatial applications for the upcoming rounds of funding, under its Grand Challenges program.[48]

Space Reforms and India's Path Forward in the Indo-Pacific

India's space reforms cannot be presumed to a be a strictly sectoral undertaking. They must be understood in the context of earlier reforms undertaken in other sectors that have resulted from domestic economic needs, geopolitical drivers, COVID-19–related aftereffects, and Industry 4.0 ramifications. It is certain that the outcome of the space reforms will contribute to India's positioning in the Indo-Pacific, the new geopolitical pivot of the world. The PRC's back-to-back hostilities in the otherwise relatively peaceful and COVID-19—afflicted neighborhood have pushed a strategically reticent New Delhi to review India's role in the Indo-Pacific. New Delhi appears more sure-footed than ever.

India has a successful track record of using space affairs for diplomatic purposes. It has launched satellites for numerous countries, shared space data, assisted in times of disasters and crises, and mentored countries from the developing world. With a comprehensive expansion of India's space capabilities, New Delhi is bound to increase the nation's space-related diplomatic pursuits at bilateral, multilateral, and minilateral levels.

India's space diplomacy has long been dependent only on space agency–level cooperation agreements. With greater private-sector participation and Indian companies' eagerness to join the global space economy, industry-led bilateral and minilateral space cooperation agreements will come into vogue. However, the first preference for cooperation can be extended to friendly and economically and politically stable countries—particularly with those with negligible investments from the Chinese Communist Party. Therefore, the space diplomacy and other industrial engagements are bound make an impact on the growing protectionism within the global economy.

With greater multipolarization of global geopolitics, New Delhi will engage India's strategically important space industry only with countries with whom it shares comprehensive, special, and strategic partnerships. It is very likely that In-

dia will forge greater agency-, industry-, academia-, and start-up–driven partnerships with many countries, including the United States, Australia, Japan, Israel, Germany, France, South Korea, and Russia.

New Delhi's ability to defend India's interests and uphold a consensus-driven global order in the Indo-Pacific will depend heavily on the utilization of cutting-edge space competence and swift bilateral, minilaterals, and multilateral space diplomacy. Where, the ISRO has been at the forefront of numerous bilateral diplomatic initiatives—the South Asia Satellite launched in 2017 being a solid exemplar—the space component of the Quadrilateral Security Dialogue (better known as Quad, and comprised of India, Australia, Japan, and the United States) will largely include private space players from all the member countries. India will also exhibit its private space sector's prowess as it engages in space diplomacy with Indian Ocean and Pacific Rim countries, South Asian neighbors, and Oceania.

After the recent space reforms, New Delhi is certain to use space diplomacy to bolster India's outreach via joint industrial and economic partnerships, academic cooperation, joint start-up ventures, acquisition of subsidiaries, attraction of investments, and strategic overseas investments. This outreach will be synchronized with the existing governmental policy megaprojects—the Aatmanirbhar Bharat, Make in India for the World, Digital India, and Startup India—that have been discussed above.

Conclusion

India's space activities were unusually discreet during the early months of the COVID-19 pandemic. Nonetheless, the government has been successful in pushing long-pending space-sector reforms. These reforms have created ample latitude for India's private sector to participate in national space activities in cooperation with the more space-experienced ISRO and to venture out into international space activities autonomously.

The space industrial ecosystem in India is growing at a pace faster than ever. This growth can be further accelerated with the enactment of a comprehensive set of parliamentary space activities legislation; a policy framework for the private sector participating in space hardware and software services, manufacturing, and operations; and a clear national space vision illustrated by the prime minister.

However, beyond these domestic rearrangements, what will be of far greater importance is the way these reforms assist the Indian space sector in engaging with the global space economy. This engagement will depend on strong bilateral and multilateral strategic space partnerships with the United States and other friendly countries. India has so far been a bright spot in the global economy, and

if it continues with this favorable economic standpoint, New Delhi is likely to become one of the key drivers of the global space economy. ✪

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