SPACE DOMAIN EXPLOITATION: STRATEGIC AND DOCTRINAL IMPERATIVES

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FROM THE PAST TO THE PRESENT

The Indian space programme reached a crucial milestone when the Vikram Moon Lander achieved a soft touchdown close to the South Pole of the Moon.[1] This feat of a soft landing on the Moon has been achieved by only three other countries in the past. The erstwhile USSR was the first nation to achieve a soft landing on the Moon in 1966. It was, however, the USA that achieved the maiden feat of landing humans on the Moon in 1969. China achieved a soft landing on the Moon with its spacecraft in 2013 and followed it with two more successful attempts, including one on the dark side of the Moon. However, one cannot fail to notice the long gap between the first two feats achieved by the USSR and the USA and then later by China and India. The quest for space, or the pace of it, often termed as the "space race", was different during the 1950s through the 1970s. Back then, the two sole superpowers, the USSR and the USA, were frantically trying to outsmart each other in the space domain. It may be recalled that it was also an era when computing and electronics technologies were in

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1. PIB Release, "President of India Congratulates ISRO on Successful Moon Landing of Vikram Lander of Chandrayaan-3", https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1951520. Accessed on August 25, 2023.

After having exploded nuclear weapons in space, achieving a human landing on the Moon, carrying out Anti-Satellite (ASAT) tests and many such novel feats, the US Administration under President Reagan embarked on the Strategic Development Initiative (SDI) in the 1980s.

a nascent stage, and despite the technological challenges, remarkable feats were achieved in space-faring. The fierce competition of the Cold War diverted huge sums in these nations into research and development in space. It was not easy as the missions had to face multiple failures. The Soviet Luna series faced at least 10 failures before achieving a successful soft landing. Similar was the success rate of the US-led Ranger probes which failed 13 times before tasting success.

After having exploded nuclear weapons in space, achieving a human landing on the Moon, carrying out Anti-Satellite (ASAT) tests and many such novel feats, the US Administration under President Reagan embarked on the Strategic Development Initiative (SDI) in the 1980s, also dubbed the "Star Wars". However, the disintegration of the USSR in 1991 suddenly ended the Cold War. With the USA becoming the sole superpower, political scientists like Francis Fukuyama were quick to declare the "End of History"[2] or at least the end of contestation. The space domain in this 'unipolar' era witnessed increased collaboration among nations to enhance human understanding of its vast emptiness. From establishing the International Space Station (ISS) to performing scientific experiments, and placing telescopes in space, as well as undertaking voyages into deep space, the collective human understanding of space was enhanced during this period. This so-called 'peace and tranquillity' of space was broken when China decided to conduct an ASAT test in 2007, thereby creating more than 3,000 pieces of space debris.[3] Akin to setting the cat among the pigeons, this direct ascent ASAT test, using a modified Chinese DF-21 Intermediate-Range Ballistic Missile (IRBM), rattled the US security establishment. Space

2. Francis Fukuyama, *End of History and the Last Man* (Free Press, 1992).
3. Brian Weeden, "2007 Chinese Anti-Satellite Test Fact Sheet", https://swfound.org/media/9550/ chinese_asat_fact_sheet_updated_2012.pdf. Accessed on August 27, 2023.

leaders within the US Department of Defence (DoD) started calling out for new systems with the capabilities that their commanders would need to protect the US' critical space inventory.[4] The space race, thus, entered a new phase. Meanwhile, as the US agencies were contemplating their response strategy to China's barging into the 'space club', India tested a direct ascent ASAT weapon under 'Mission Shakti' in 2019.[5]

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While the 'militarisation' of space is a foregone conclusion, the 'weaponisation' of space is what most nations are overtly trying to prevent. In a US-led initiative, seven countries, including the US, joined the ASAT test ban in 2022.[6] Various other proposals to achieve a consensus on regulations in space and to prevent its weaponisation are being considered under the Committee on the Peaceful Uses of Outer Space (COPUOS),[7] as well as by the Prevention of an Arms Race in Outer Space (PAROS),[8] both working under the aegis of the United Nations (UN). Amid these negotiations and largely government-led space programmes, there has been a slow but steady increase in the participation by private companies in space exploitation. This privatisation of space, or 'democratisation' as one may call it, has opened up new challenges and opportunities. It has also provided a fresh impetus, rather, an urgent need, to regulate all activities in space. Crowding of the Low Earth Orbit (LEO), concerns around debris generation and debris management, legalising the exploitation of space resources extracted from asteroids, the Moon and other celestial bodies by transferring them back to the Earth and regulating space tourism are some of the areas that need a

4. Anthony J. Mastalir, "The US Response to China's ASAT Test", available at https://media.defense.gov/2017/Nov/21/2001847283/-1/-1/0/DP_0008_MASTILIR_US_RESPONSE_CHINA_ASAT.PDF. Accessed on August 27, 2023.
5. Mission Shakti.
6. Arms Control Association, "Seven Countries Join ASAT Test Ban" , https:/ /www.armscontrol.org/act/2022-11/news-briefs/seven-countries-join-asat-test-ban. Accessed on August 27, 2023.
7. United Nations Office of Outer Space Affairs, "COPUOS 2023 Session", https://www.unoosa.org/oosa/en/ourwork/copuos/index.html. Accessed on August 27, 2023.
8. United Nations Institute for Disarmament Research, https://unidir.org/sites/default/files/publication/pdfs//prevention-of-an-arms-race-in-outer-space-a-guide-to-the-discussions-in-the-cd-en-451.pdf

broad consensus among all space-faring and non-space-faring nations. Space-based assets are now a quintessential part of everyday human activity. From directing aeroplanes and surface transport using the Global Navigation Satellite System (GNSS) to weather forecasting, satellite communications, television broadcasting, providing remote sensing data for various research, and now, even providing satellite-based global internet coverage, the penetration of space based assets in our lives is increasing by the day. Unfortunately, most of these capabilities that space provides are dual-use ones. Their denial or destruction is, therefore, imperilled by the interpretation by the adversary. Hence, there is a need to enhance one's perception of this domain by viewing it through various prisms. In doing so, the author hopes to achieve a level of understanding from which some strategic and doctrinal imperatives can be gleaned.

UNDERSTANDING SPACE AS A DOMAIN

Space is a unique domain. As unique as the land, sea, undersea and air domains. A construct based on multi-domain operations, identifying space and cyber as separate domains, in addition to land, sea and air, is, therefore, likely to help in a better understanding. To consider space as a domain implies that it is being considered not just as an enabler for the other domains, viz land, sea and air, but as an arena which, like other domains, would feature competition, contestation, confrontation, and, sometimes, conflict. Nations can, therefore, be expected to vie for control of this domain. While defining the doctrinal precepts of the space domain, there is going to be a natural temptation to draw inspiration from sea power theorists like Alfred Thayer Mahan and air power theorists like Giulio Douhet, who professed total 'command' of their respective domains. While present technological progress in the space arena hasn't achieved the milestone needed by any nation to achieve 'command' of the space domain, nations would nevertheless try to exert 'control' over space objects, and/ or deny freedom of its use to others. Space provides the proverbial 'high ground' to anyone who can exploit it. This has a direct bearing on the level of dominance that can be achieved in Command, Control, Communication, Networks,

Intelligence, and Interoperability (C3NI2) functions over any battlefield. It provides Position Navigation and Timing (PNT) data to weapon platforms, an essential ingredient of modern precision weaponry. Communication in battle zones increasingly relies on Satellite Communication (SATCOM) to maintain network-centricity. Also worth mentioning are various objects like ballistic missiles and Hypersonic Cruise Missiles (HCMs) that transit through the medium of space, and early warning that space-based assets can provide for possible launch sites and impact points.

The space domain also faces another peculiar challenge: that of space laws and their enforcement. Space domain laws closely match those of the maritime domain in terms of international laws, but are more relaxed in comparison to, for example, the United Nations Convention on the Law of the Sea (UNCLOS). Air power enthusiasts term space as a continuum of airspace. However, unlike airspace and maritime space, space laws do not bestow territorial rights to nations, even of their immediate geostationary/geosynchronous orbital space. Two important laws that govern the use of space are the Outer Space Treaty (OST) of 1967 and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, better known as the Moon Treaty of 1979. These laws refer to outer space as "the province of all mankind" that "shall be free for exploitation and use by all states". Over a period, these customary international laws have reached the stature of *jus naturale*, or natural law, and through consistent state practice, have now been argued by some analysts to have the stature of *jus cogens*.[9] When these laws were enacted, the geopolitical reality of the world was very different. Ambiguity in space treaties was consciously built in to provide the necessary flexibility. This ambiguity was acceptable during the Cold War, with only two superpowers competing, with a tacit understanding of each other's red lines. Freedom of the use of space provided the necessary transparency and kept the Cold War warm enough to be sustainable. With the changing world order, this *jus cogens* of international space laws cannot be taken for granted any more. There is a need, therefore, for more robust international laws in outer and deep space. The Artemis Accords, of which India became a

9. GS Sachdeva, *Outer Space, Law, Policy and Governance* (New Delhi: KW Publishers, 2014), p. 8.

Today's space technology has leapfrogged multiple times. The sophistication of this technology now provisions hitherto unthinkable capabilities, for example, reusable rocket boosters, advancement in fabricating nanosats and cubesats and ability to launch multiple satellites in a single launch.

signatory on June 24, 2023, is another attempt to bring diverse space-faring nations together to share space expertise and scientific data for the peaceful use of space.[10]

Apart from changes in the international world order, today's space technology has leapfrogged multiple times. The sophistication of this technology now provisions hitherto unthinkable capabilities, for example, reusable rocket boosters, advancement in fabricating nanosats and cubesats, and ability to launch multiple satellites in a single launch. Some of these capabilities have contributed towards making the launch of space objects much cheaper. This has led to the mushrooming of useful space objects in all types of orbital planes viz GEO (Geostationary/ Geosynchronous Earth Orbit), MEO (Medium Earth Orbit) and LEO (Low Earth Orbit). Technology has also helped in improving the thrust of rockets. Today's rockets are hauling more kilogrammes of stuff into space than ever before. A comparative analysis of the top five active launch vehicles' payload- carrying capacity is tabulated below.

Table 1

Country of Origin	Launch Vehicle	Payload GEO in Tons	Payload LEO in Tons
USA	Falcon Heavy	27	64
Russia	Angara A5	7.5	24.5
China	Long March 5	15	25
EU	Ariane 5	10	20
India	LMV III	4	8

*Open-sourced data from the internet

10. US Department of State, "Artemis Accords", available at https://www.state.gov/artemis-accords/. Accessed on September 12, 2023.

With better launch capabilities available today, space is getting crowded rapidly. The number of space objects has increased manifold, with private companies from the US and China leading from the front. In 2022 alone, Space X launched 61 orbital missions.[11] With such a massive surge in space objects and no breakthrough in enacting international laws related to the exploitation of the 'global commons' of space, the space domain is undergoing a paradigm shift. The majority of space-faring and non-space-faring nations are forced to helplessly watch the spectre of crowding of orbital planes.

Overcrowding is likely to lead to confrontation, sooner rather than later, especially when nations are simultaneously developing their counter-space capabilities.

Table 2: Payloads Launched Per Year

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Russia	22	29	33	27	14	25	23	29	21	19	50
USA	35	84	96	106	106	288	187	366	985	1231	1941
China	25	17	24	44	38	35	95	74	72	112	179
Europe	22	34	28	23	20	43	56	50	134	354	187
Other	28	41	57	31	43	65	81	60	59	94	120
Total	132	205	238	231	221	456	442	579	1271	1810	2477

Source: Jonathan McDowell, "Space Activities in 2022".[12]

This overcrowding is likely to lead to confrontation, sooner rather than later, especially when nations are simultaneously developing their counter-space capabilities. Apart from direct ascent ASAT, Rendezvous and Proximity Operations (RPOs) are increasingly becoming more sophisticated. Surface-based counter-space capabilities include the use of Electronic Warfare (EW) jammers to jam uplink/ downlink facilities, laser dazzling, and the use

11. Mike Wall, "61 Rocket Launches! SpaceX Celebrates Record-Breaking 2022", https://www.space.com/spacex-c elebrates-2022-61-launches. Accessed on August 28, 2023.
12. Jonathan McDowell, "Space Activities in 2022", https://planet4589.org/space/papers/space22.pdf. Accessed on August 28, 2023.

of Directed Energy Weapons (DEWs).[13] If one must apply a Clausewitzian theory[14] to the space domain, then we already have the 'ends' (purposes) and the 'means'—the 'ways' need to be established. One of the key factors that would determine the 'ways' is the quality of Space Situational Awareness (SSA) that one possesses.

Space Situational Awareness (SSA)[15] refers to the ability to track and predict the movement of all space objects, a quintessential requirement for exercising any form of 'control' of space or counter-space operations. Apart from SSA, terms like Space Domain Awareness (SDA), Space Surveillance and Tracking (SST) and Space Traffic Management (STM) are terms that are closely related to SSA. However, in the context of a specific mission, task or objectives, usually defined in a military context, the term SSA is generally used. The Space Development Agency (SDA), on the other hand, takes a holistic approach and includes all the means available to the actor,[16] including SSA's technical data, as well as assessment of intent, awareness of activities, space policies, strategies and other means of analysis and understanding the behaviour and intent of other actors. Space objects travel at very high velocities, albeit on predictable paths. Nations use various means to acquire SSA. On the Earth's surface, these include radars, telescopes, laser ranging stations and data centres that track and catalogue various space objects and their movements. Space-Based Surveillance Systems (SBSS), which consist of passive electro-optical payloads are also used to track and supplement SSA. The United States has the largest network of these systems that are required to be placed at locations spread all around the globe. These ground-based and space- based sensors provide

13.. Brian Weeden, "Global Counterspace Capabilities: An Open Source Assessment", https://swfound.org/media/206957/swf_global_counterspace_april2020_es.pdf. Accessed on August 28, 2023.

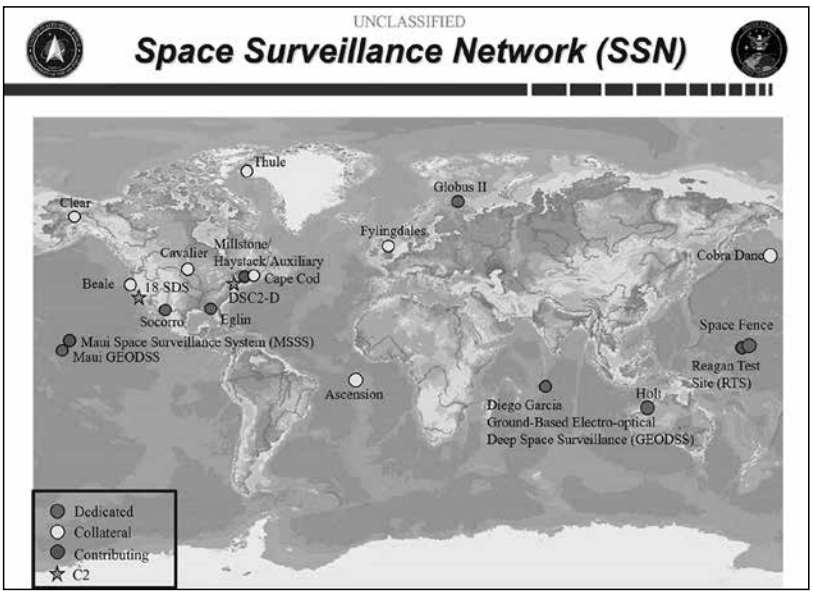
14.. A. Rothe Herberg, "Clausewitz, Carl von (1780–1831)", in *The Palgrave Encyclopedia of Strategic Management* (London: Palgrave Macmillan (2018), https://doi.org/10.1057/978-1-137-00772-8_34.

15. Almudena Ortega Azcárate,"A Lexicon for Outer Space Security", https://www.unidir.org/publication/ lexicon-outer-space-security. Accessed on August 29, 2023.

16. Ibid.

feed to the US Space Surveillance Network (SSN), which is controlled and operated by the US Space Command (USSPACECOM).

Fig 1



Source: https://nsarchive.gwu.edu[17]

Establishing such a global ground-based and space-based network is not an easy task for any single country. A collaborative approach to SSA helps to pool resources for such enterprises. Incidentally, the Indian Space Research Organisation (ISRO) has also contributed to the SSN of the US by launching a Canadian -made Sapphire satellite which uses passive electro-optical systems to track space objects.[18] While such a collaborative approach

17. National Security Archive website, "What's Up There, Where Is It, and What's It Doing? The U.S. Space Surveillance Network", https://nsarchive.gwu.edu/briefing-book/intelligence/2023-03-13/whats-there-where-it-and-whats-it-doing-us-space-surveillance. Accessed on August 29, 2023.
18. "A Gem in Space: Canada's Sapphire Satellite Continues to Shine"", https://www.canada.ca/en/department-national-defence/maple-leaf/rcaf/2023/02/gem-in-space-canada-sapphire-satellite-continues-to- shine.html updated on February 24, 2023.

is a necessity from the viewpoint of civilian space programmes, it poses a security dilemma as far as the military application of space is concerned. Moreover, over-reliance on external agencies for SSA has its own security connotations. Today, the Combined Space Operations Centre (CSpOC), which works under the USSPACECOM,[19] gives selective visibility to its users. A large amount of observed data is not shared.[20] Nations are, therefore, required to create their assets, both on the ground and in space, if they are to obtain high-grade SSA.

INDIAN SPACE ODYSSEY

The saga of the Indian space programme started with the humble beginnings of the ISRO, spearheaded by charismatic and visionary leaders like Vikram Sarabhai. Working on hamstring budgets, ISRO has provided space capabilities far beyond the reach of many other nations: from the first indigenously built satellite 'Aryabhatta', to the Indian National Satellite System (INSAT), Indian Remote Sensing (IRS), CartoSat and GSAT series; from the SLV (Satellite Launch Vehicle) to the ASLV (Augmented Satellite Launch Vehicle), PSLV (Polar Satellite Launch Vehicle) and now GSLV (Geosynchronous Satellite Launch Vehicle) Mk III; from the deep space missions of Gaganyaan, Mangalyaan to Aditya L1.[21] The last one needs special mention so that its significance is not lost on anyone. Aditya L1 is destined to be in a halo orbit at the Lagrange point L1. Lagrange points, a total of five in number, are positions in space where the gravitational forces of a two-body system like the Sun-Earth or Earth-Moon produce enhanced regions of attraction and repulsion. These can be used by spacecraft to

19. Breaking Defence, "SPACECOM Takes Over Missile Defense Ops from Strategic Command," May 23, 2023, https://breakingdefense.com/2023/05/spacecom-takes-over-missile-defense-ops-from-strategic-command/. Accessed on August 29, 2023.
20. TH Anand Rao, "Indo-US Cooperation in Space Situational Awareness: A Necessity", *Defence and Diplomacy*, vol 11, October-December 2021, Journal of The Centre for Air Power Studies.
21. "Aditya L1 Launch: India's First Solar Mission Lifts Off from Sriharikota to Study Sun", Hindustan Times News Report, https://www.hindustantimes.com/india-news/adityal1-launch-live-updates-isro-successfully-launches-solar-mission-from-sriharikota-101693631224172.html. Accessed on September 2, 2023.

reduce fuel consumption needed to remain in position.[22] This makes them of significant strategic value. These are also important from the point of view of future deep space missions and interplanetary travel. Everett C. Dolman, in his book *Astropolitik*, defined these Lagrange points as areas of geopolitical significance in the Space Age.[23]

There are many such strategic missions that ISRO plans to undertake. The renewed interest in the Moon after the reports of finding water and traces of Helium III is a case in point.[24] India's manned space missions are a prelude to the space station programme, lunar landing and interplanetary missions in the future. To undertake these missions, heavy rockets with more lift capacity would be needed. ISRO's future development programmes try to address the issue by developing the Super Heavy Launch Vehicle (SHLV), based on semi-cryogenic engine technology, aimed at lifting 16 T to the Geosynchronous Transfer Orbit (GTO) and 41T to the Low Earth Orbit (LEO). Also on the cards is the Twin Stage Two Orbit (TSTO) programme which envisions reusable flight capability that leverages a combination of air-breathing scramjets and rocket engines. The Reusable Launch Vehicle-Technology Demonstrator (RLV-TD) and Advance Mission and Recovery Experiment (ADMIRE) are aimed at reducing the costs of space missions.[25]

Despite what has been achieved so far and its plans for the future, ISRO's approach to the space programme has been criticised for not doing enough to meet New Delhi's security needs. While the case can be argued from both sides, suffice it to say that there is merit in showcasing niche space technology. This would be important when one is being considered as a serious player in the geopolitics of the Space Age.

22. M. Thiruchitrambalam, "Lagrange Points and Future Space Wars", https://resonantnews.com/2021/04/15/lagrange-points-and-future-space-wars/. Accessed on September 2, 2023.
23. Everett C. Dolman, *Astropolitiks: Classical Geopolitics in the Space Age* (Routledge 2002).
24. *The Hill* news report, "China has Returned Helium-3 from the Moon, Opening Door to Future Technology", https://thehill.com/opinion/technology/3647216-china-has-returned-helium-3-from-the-moon-opening-door- to-future-technology/. Accessed on September 2, 2023.
25. "The Future of Indian Orbital Rockets", https://www.strategicfront.org/the- future-of-indian-orbital-rockets/. Accessed on August 28, 2023.

While further reduction of costs is expected with technological improvements, it is not always the 'costs' that drive the nation's will. It is the threat perception and self-interest that sometimes override the 'costs' concerns.

SPACE DOMAIN AND STRATEGIES

On October 3, 1942, the first man-made object entered space. It was a German- made V2 rocket. The first time an object was launched and stayed in the Earth's orbit was the Sputnik 1 in October 1957. Since then, man-made objects have been entering space, staying in space and re-entering the atmosphere. If one considers the growth trajectory of the aerospace domain vis á vis space, the aerospace sector has hit a sweet spot that space hasn't reached yet. This sweet spot, based on efficient propulsion technology in this case, has made the aerospace sector more economical. The space sector is yet to cross the propulsion 'Rubicon'. The costs of propelling objects in space are still quite prohibitive. This is despite the refinements in rocketry, metallurgy, reusability of thrusters and shrinking payloads. A case in point is an estimation that pegs ISRO's per kg cost of payload through its PSLV rocket at $25,000 in LEO. For comparisons, with its Falcon 9 rocket, Space X is understood to have charged $5,000 per kg of payload.[26]

While further reduction of costs is expected with technological improvements, it is not always the 'costs' that drive the nation's will. It is the threat perception and self-interest that sometimes override the 'costs' concerns. India's defence budget stands at 1.93 percent of its Gross Domestic Product (GDP).[27] India's Research and Development (R&D) budget is 0.7 percent of the GDP.[28] The annual budget of the Department of Space (DoS)

26. "Indian Startup Satellite Gets Tested at ISRO Facility", *Wion News*, https://www.wionews.com/india- news/indian-start-ups-satellite-gets-tested-at-isro-facility-awaits-launch-through-pslv-rocket-469393#. Accessed on August 30, 2023.
27. "Indian Defence Budget", https://www.iiss.org/en/online-analysis/military-balance/2023/04/indian-defence-budget/#:~:text=India%27s%202023%20INR5., for%20defence%20procurement%20and%20modernisation.
28. "Focus on R&D", Firstpost New Article, https://www.firstpost.com/business/budget-2023-why- driving-national-goals-with-focus-on-rd-and-digital-clusters-is-the-need-of-the-hour 12080592.html#:~:text= India%27s%20R%26D%20expenditure%20as%20a4.6%20percent%20in%20South%20Korea. Accessed on August 29, 2023.

is 0.049 percent of the GDP.[29] These figures are indicative of the government's overall threat assessment which would influence the grand strategy and, therefore, financial priorities. It is within the bounds of government policy and financial boundaries that the DoS, Defence Space Agency (DSA) under the Headquarters Integrated Defence Staff (HQ IDS) and individual Service specific Space Departments must operate. Therefore, India's space domain strategies cannot be bereft of its budgetary realities.

Defensive measures in space would require better SSA, giving warning of the enemy's counter-space actions, and thereby prompting timely evasive manoeuvres.

Apart from the costs, the strategies of the space domain will also need careful deliberation on whether the hitherto civilian-led space programme should be further 'militarised'. The Indian space sector, being civilian-led, has been advantageous for New Delhi so far in terms of obtaining technical assistance from other civil space agencies. Two factors need to be considered here. Firstly, as India forays further into the space domain, dependencies on space assets, for both civilian use and military use would increase. This means that these space assets would require protection. Defensive measures in space would require better SSA, giving warning of the enemy's counter-space actions, and thereby prompting timely evasive manoeuvres. The Indian space programme, under Project NETRA (NEtwork for space object TRacking and Analysis), envisages creating its own SSA[30] network. Its main elements are a radar, an optical telescope facility, and a control centre. Of course, while this is a humble start, creating reliable SSA would entail creating facilities even beyond the territorial boundaries and exploring ship-based assets too. Secondly, while 'privatisation' and 'democratisation' of space are likely to lead to a more robust regulatory mechanism, at the same time, the high

29. "Relative to GDP, India Spends Higher in Space", *Business Standard*, https://www.business-standard.com/economy/news/relative-to-gdp-india-s-space-spends-higher-than-half- of-g20-peers-123082300830_1.html. Accessed on August 29, 2023.
30. Official website of ISRO, GOI, "ISRO SSA Control Centre Inaugurated by Dr. K. Sivan, Chairman, ISRO/ Secretary, DOS", https://www.isro.gov.in/ISRO%20SSAControl%20Centre.html. Accessed on August 31, 2023.

investment costs of private entities would eventually increase the stakes. They would, therefore, demand space security from the state actors, even at the cost of paying indemnity.[31] If such a situation is envisaged, then a prudent approach would mandate delineating the civilian and military sides of the space programme. An analogy can be drawn from the maritime and aerospace domains. Technologically complementary, the civilian and military sides can pursue their stated objectives independently. Hence, a strategy that accords priority to the military needs while retaining technology development and testing options is what the experts have recommended.[32]

Strategies can be adversarial, that is, the nature of the adversary may dictate one's strategy. China's counter-space capabilities should drive the Indian space agencies' quest for credible deterrence. One of the crucial counter- space capabilities is the ability to carry out Rendezvous and Proximity Operations (RPOs).

These dual-use operations are considered better as they don't produce space debris. The US carried out the Demonstration of Autonomous Rendezvous Technology (DART) launch in 2005 as part of the autonomous RPO demonstration, although, instead of its planned rendezvous, it collided.[33] This was followed by successful RPO missions under the Experimental Satellite System (XSS) series. Between 2016 and 2018, the Geosynchronous Space Situational Awareness Programme (GSSAP) satellites conducted eight RPOs, including those targeting Russian and Chinese space assets.[34] Russia and China aren't far behind and have demonstrated RPO operations in the past decade. Orbital planes like the X-37B of the US[35] and the Chinese-made

31. Anthony J. Mastalir, "The US Response to China's ASAT Test", *Drew Papers,* 2009, https://media.defense.gov/2017/Nov/21/2001847283/-1/-1/0/DP_0008_MASTILIR_US_RESPONSE_CHINA_ASAT.PDF. Accessed on August 30, 2023.
32. S. Chandrashekhar, "Space, War and Security: A Strategy for India", National Institute of Advanced Studies, Bangalore.
33. "Multiple Errors Caused DART Rendezvous Mission Mishap", 2006, https://spacenews.com/multiple- errors-caused-dart-rendezvous-mission-mishap/. Accessed on August 30, 2023.
34. Rao, n.20, p. 59.
35. Boeing official website, https://www.boeing.com/defense/autonomous-systems/x37b/index.page. Accessed on August 31, 2023.

Shenlong[36] also offer substantial capabilities that can be exploited during hostilities. After the successful demonstration of the direct ascent ASAT during the 2019 Mission Shakti, there is a need to develop the capability to execute RPOs as well. ISRO plans to conduct a Space Docking Experiment (SPADEX) using a target and chaser microsatellite.[37] This would be an important milestone towards creating credible counter-space deterrence. Also on the cards is ISRO's own orbital plane, the Reusable Launch Vehicle-Technology Demonstrator (RLV-TD) the trials of which were conducted recently.[38]

Strategies can be need-based. The most urgent need for space-based assets from the national security perspective is the requirement of C3NI2.[39] With the changing nature of war, competition, contestation, low-grade conflict, short- term resolution and then back to competition, remain in a constant continuum. Sean McFate puts this more eloquently when he describes his new rules of wars and says, "There Is No Such Thing as War or Peace—Both Coexist, Always."[40] He, however, also professes that "Technology Will Not Save Us". Well, certain technologies have the capability to preempt, if not prevent, wars. Space-based Intelligence, Surveillance, Reconnaissance (ISR) would play a crucial role well before battlefields are demarcated. ISR, when coupled with information war, can be skillfully used to create situations where the military escalation ladder can be dominated. ISR itself is getting privatised and democratised, with private players providing on-demand imagery intelligence. In the ongoing Russia-Ukraine War, private companies like ICEYE, Usra Space, and MDA gathered and analysed imagery through their privately owned synthetic aperture radar satellites to provide early

36. Mike Wall, "China's Mysterious Space Plane Returns to Earth After 9-Month Orbital Mission", https://www.space.com/china-space-plane-lands-may-2023. Accessed on August 31, 2023.
37. Gunters Space Page, "SPANDEX", available at https://space.skyrocket.de/doc_sdat/spadex.htm. Accessed on August 30, 2023.
38. "ISRO's Reusable Launch Vehicle Aces Landing Test", *The Hindu* news article, https://www.thehindu.com/sci-tech/science/isro-successfully-conducts-landing-experiment-of-the-reusable-launch-vehicle/article66690655. ece. Accessed on August 31, 2023.
39. IAF Doctrine 2022, available at https://indianairforce.nic.in/wp-content/uploads/2023/01/2MB.pdf. Accessed on August 31, 2023.
40. Sean McFate, *The New Rules of War* (William Marrow Paperback, 2020), p. 13.

warnings.[41] In the Indian context, the military's ISR needs are constantly expanding as India's Area of Interest (AoI) is rapidly expanding. From the Gulf of Aden to the Ombai Wetar Strait in the Indian Ocean and further into the South China Sea, the areas that require surveillance are demanding an increase in space-based ISR assets. As of 2022, India had a total of 53 operational satellites in space providing various identified services to the nation. Out of 53 operational satellites, 21 are communication satellites, 8 are navigation satellites,[42] 21 are earth observation satellites and 3 are science satellites. These are considered to be insufficient for the task at hand. Backed by the Indian Space Policy 2023 which supports privatisation by creating the Indian National Space Promotion and Authorisation Centre (INSPACE)),[43] Indian Space Association (ISpA) and New Space India Limited (NSIL), the Indian stage is all set for joint public-private efforts to meet ISR demands. ISRO's Small Satellite Launch Vehicle (SSLV), private space start-ups like Skyroot Aerospace, Agnikul, Pixxel, Cosmos, Dhruva Space and Bellatrix Aerospace, along with advancements in the fabrication of smallsats, cubesats and nanosats can provide the numbers needed for effective ISR.[44]

Close on the heels of open-sourced imagery is the ubiquitous availability of satellite communication and networks. In the Russia-Ukraine War, Space X's Starlink terminals give military units access to a stable network of LEO satellites that connect sensors to processors anywhere on the battlefield.[45]

Military-grade networks and communications are also migrating to space-based platforms. After GSAT 7 Rukmini for the Indian Navy and GSAT

41. Audrey Kurth Cronin, "Innovations Are the Key to Ukraine's Strategic Resilience" , available on https://warontherocks.com/2023/08/open-source-technology-and-public-private-innovations-are-the-key-to- ukraines-strategic-resilience/. Accessed on August 31, 2023.
42. PIB Release February 22, 2022, "Union Minister Dr. Jitendra Singh says, ISRO has Launched a Total of 129 Satellites of Indian Origin and 342 Foreign Satellites Belonging to 36 Countries since 1975", https://pib.gov.in/PressReleasePage.aspx?PRID=1797196. Accessed on August 31, 2023.
43. Indian Space Policy 2023, https://www.isro.gov.in/media_isro/pdf/IndianSpacePolicy2023.pdf.
44. Air Marshal Anil Chopra, "Small Quick Launch Satellites: India's Future in Space Action", Firstpost, https://www.firstpost.com/opinion/small-quick-launch-satellites-indias-future-in-space-action-13054012.html. Accessed on September 1, 2023.
45. Cronin, n.41.

7A for the Indian Air Force (IAF), the Indian Army will also get its own communication GSAT 7B by 2026.[46] These satellites can be greatly bolstered with a constellation of small satellites. It would add redundancy for Ka-band and Ku-band communications and can provide jam-resistant relays.[47]

The Navigation with Indian Constellation (NavIC) is another important capability that ISRO has achieved. With seven satellites in the constellation, three in geostationary and four in inclined geosynchronous orbits, NavIC provides the Standard Position Service for civil users and Restricted Service for strategic users.[48] Although presently limited in coverage to 1,500 km beyond Indian borders, this system provides weapon-grade PNT data accuracy of 20 m or less, thereby reducing the dependency on the Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS). NavIC is scheduled for expansion and is likely to have 11 to 12 satellites.[49] With this, issues of redundancy, compatibility and coverage are likely to be addressed. However, technology support in terms of NavIC chip manufacturing requires a more focussed approach. It is only then that the full capability of the system can be exploited, especially for meeting national security needs.

A major capability to overcome an adversary's counter-space operations is the ability to have a 'launch on demand' capability. The Defence Research and Development Organisation's (DRDO's) Visualisation Explosion and Data Analysis (VEDA) project is a step in this direction. VEDA will enable India to launch satellites on demand within a very short period – some reports suggest it can be ready to launch satellites within 72 hours.[50] This road-

46. "After Navy & IAF, Army to get Dedicated Satellite Gsat-7B as MoD Inks Rs 3k cr Deal with NSIL", *The Times of India* news report, https://timesofindia.indiatimes.com/india/after-navy-iaf-army-to-get-dedicated-satellite-gsat-7b-as-mod-inks-rs-3k-cr-deal-with-nsil/articleshow/99129740.cms?from=mdr. Accessed on August 31, 2023.
47. Air Marshal Anil Chopra, "Small Quick Launch Satellites: India's Future in Space Action", Firstpost, https://www.firstpost.com/opinion/small-quick-launch-satellites-indias-future-in-space-action-13054012.html. Accessed on September 1, 2023.
48. ISRO Official website, "Satellite Navigation Services", https://www.isro.gov.in/SatelliteNavigation Services.html. Accessed on September 12, 2023.
49. Dr Ajay Lele, "From NavIC 1.0 to 2.0, ISRO Needs to Learn from Mistakes", https://www.financialexpress.com/business/defence-from-navic-1-0-to-20-isro-needs-to-learn-from-mistakes 3106112/. Accessed on September 12, 2023.
50. Indian Defence Analysis, "DRDO's Project VEDA – Defense Satellite Launch Vehicle", https://indiandefenseanalysis.com/2023/03/27/drdos-project-veda-defense-satellite-launch-

Ground-based radar systems would be limited by the radar horizon to pick up incoming projectiles, thereby causing delays in taking offensive or defensive counter-measures.

mobile, canister launch system may house a nanosatellite that can be used in a variety of ways. It can provide mission- specific services over battle spaces, can replenish satellites crippled/ destroyed due to enemy action or inject killer nanosats to target the enemy's assets for a tit-for-tat action or any other short-notice task. Another area of concern that needs a space-based solution is missile launch detection capability. Since both ASAT and Ballistic Missile Defence (BMD) weapons draw upon the same domains of technology and knowledge, capabilities in one also necessarily mean that capabilities exist for doing the other. The distinctions between defensive and offensive orientations are, therefore, blurred and grey.[51] India's BMD programme has matured over the years. The system consists of an exo-atmospheric interceptor, also referred to as the Pradyumna ballistic missile interceptor and an endo-atmospheric interception system, also called the Ashwin ballistic missile interceptor. It also consists of a long-range tracking radar and a multifunction fire control radar.[52] Recently, a maiden sea-based endo-atmospheric interceptor test was also successfully conducted.[53] But what it lacks is the capability to detect the missile plume, thereby providing early warning of missile launch.[54] Ground-based radar systems would be limited by the radar horizon to pick up incoming projectiles, thereby causing delays in taking offensive or defensive counter-measures. Presently, only the US and Russia have the capability of detecting missile plumes through their space-based assets. The US' Space-Based Infrared System (SBIRS), a

vehicle/. Accessed on August 31, 2023.

51. Chandrashekhar, n.32.
52. "India's Ballistic Missile Defence System: Why Should we Need it?", https://www.clearias.com/indias-ballistic-missile-defence-system/. Accessed on August 31, 2023.
53. "India Conducts Maiden Test of Sea-based Ballistic Missile Defence System", *The Times of India* news report, https://timesofindia.indiatimes.com/india/india-conducts-maiden-test-of-sea-based-ballistic-missile-defence-system/articleshow/99697459.cms?from=mdr. Accessed on September 1, 2023.
54. Chandrashekhar, n.32.

follow-on capability to the highly successful Defence Support Programme (DSP), provides global coverage through its satellites placed in GEO and HEO (Highly Elliptical Orbit).[55] Such a capability is of immense importance to India considering the threat it faces from the People's Liberation Army Rocket Force (PLARF). It would not be easy to acquire this capability, as it is for every other capability in space, however, it would be worth the effort.

More assets in space would mean a stronger voice in international fora whenever space regulations are being discussed. Hence, in the space domain, as is true for other military domains, quantity will have a quality of its own.

Strategies would also have to work around international laws, norms and policies. The International Telecommunication Union (ITU) which regulates the allocation of frequencies and orbital spaces among the member states, coordinates activities in space to prevent warehousing of orbital slots. One such law necessitates utilising the allotted satellite frequency slot within seven years. It also defines the time-lines to be achieved for launching constellation satellites in terms of percentages in two, five and seven years. All these highlight the fact that orbital frequencies are finite and so are orbital slots. There is a need to occupy orbital slots in LEO, MEO and GEO. More assets in space would mean a stronger voice in international fora whenever space regulations are being discussed. Hence, in the space domain, as is true for other military domains, quantity will have a quality of its own.

Strategies don't exist in a vacuum. They must align the course of action with policy. The recent Indian Space Policy 2023 and vision document of Opening up of the Space Sector[56] clearly emphasised reforms. The Prime Minister's (PM's) statement, "There should be no 'space' between the common man and space technology" is indicative of the government's desire to harness space for the overall development of the nation. It is also

55. Space Operations Command, "Space-Based Infrared System", https://www.spoc.spaceforce.mil/About-Us/Fact-Sheets/Display/Article/2381702/space-based-infrared-system. Accessed on September 1, 2023.
56. Colin S. Gray, *The Strategy Bridge: Theory for Practise* (New York: Oxford University Press, 2010).

important that the space domain and the security of space assets are given due importance from the national security perspective.

Strategy is also the bridge between policy and action.[57] In the Indian context, one can hardly expect a clearly articulated National Space Strategy, given the fact that India's National Security Strategy (NSS) is yet to see the light of the day. The next best guiding document can, therefore, be the Indian Space Doctrine. Doctrines are vital inputs to strategic practice while, at the same time, acting as a guide to policy-makers and practitioners. Policy, strategy and doctrine are, therefore, interrelated, although not interchangeable. Formulating the Indian Space Doctrine would, therefore, be our best bet to throw light on the pathway of our space strategy. It should be a 'joint' doctrine in all its essence.

So far, various strategic imperatives have been discussed. However wishful one may be, resources would always be limited. Therefore, there is a need to have a well-defined pathway to achieve the stated objectives. A summary of these objectives that are recommended to be achieved is given below:

For providing security to the space domain, SSA is quintessential. Creating one's own Space Surveillance Network (SSN), with ground-based, ship-based and space-based assets, is a must. ISRO, after initial hand-holding, must hand over the responsibility of SSA to the Defence Space Agency (DSA).

NavIC-compatible weapon platforms are required to be operationalised at the earliest. This would require a focussed 'all hands on deck' approach. ISRO must enhance offensive counter-space capability by acquiring the ability to undertake RPOs.

Indian BMD needs to be augmented with space-based assets to improve warning and detection capability.

As the criticality of space assets and their vulnerability increase, there will be a need to synergise as well as delineate civil and military functions. Eventually, SSN, C3NI2, BMD and ASAT functions, i.e. both defensive and offensive counter-space capabilities, should be placed under one commander.

57. IAF Doctrine 2022, p. 21.

This is where the first contours of the 'Space Command' will appear. As space assets increase, the DSA must be upgraded to the Defence Space Command.

ISRO must continue to push the limits of space technologies by throwing all its energies into acquiring the next-level strategic capability.

The space domain is at the cusp of a colossal shift. Advancement in technologies, reduction in launch costs, increasing participation of private entities and growing reliance on space-based assets, for both civil and military use, have created new dimensions from an overall national security perspective. While demarcating civilian use from the military has always been a challenge for the space domain, delay in achieving consensus on international space laws is only adding to the ambiguity with each passing day. China's progress in the space domain and an ever-increasing technological gap vis-a-vis India is a cause of concern. In such a milieu, the Indian armed forces need to be provided resources and means to address India's security interests in the space domain. While private companies can provide some means to fill the capability gaps, there is also a need to create the required institutional structures to support such capabilities. Most importantly, the Indian space programme is in dire need of a space doctrine which can channel the collective efforts of all Indian entities in the right direction.