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INDO-US COOPERATION IN SPACE SITUATIONAL AWARENESS: A NECESSITY

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India has sought assistance of global space technology leaders in the past for developing its space capabilities since the beginning of India's space programme. However, Indian Prime Minister's visit to the United States in September 2021 marks a historic milestone in many ways. While the Indian PM's first meeting with US President Biden, his address at the United Nations General Assembly at New York and the first in-person summit of the Quad nations in Washington may have stolen the limelight, some of the lesser-known events have immense significance for India's strategic security. The bilateral meet between the two leaders of India and US was followed by a joint statement on September 23, 2021. The White House press statement listed many areas of cooperation between the two nations. A major point of strategic interest was the joint understanding that the United States and India must continue and expand their partnership in new domains and many areas of critical and emerging technology—space, cyber, health security, semiconductors, AI, 5G, 6G and next generation telecommunications technology, and block chain, that will define innovation processes, and the economic and security landscape of the next century. Interesting among

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these was the agreement between the leaders to work towards the finalisation of a Space Situational Awareness (SSA) Memorandum of Understanding (MoU) that will help *in sharing of space object data and services towards ensuring* the long-term sustainability of outer space activities.¹ Though India and US have had space cooperation in the past—like the Chandrayann-1 project and NISAR (NASA-ISRO Synthetic Aperture Radar)—this particular item on the agenda for further cooperation signals India's realisation of the prerequisites to become a space power of significance.

The need for a robust SSA was felt some years ago. A classic example which points towards India's lack of SSA was when India was unaware of the debris littered by the Chinese Anti-satellite (ASAT) weapon test of 2007, till it was notified by the US Space Surveillance Network.² For reasons unknown, SSA was seen as a secondary requirement by Indian Space Research Organisation (ISRO) and the focus for R&D has always been on the creamier projects like launch vehicles, satellite sensors and their integration and the ground segment. SSA activities though present, were restricted to tracking and telemetry of India's own satellites. The installation of a Multi-Object Tracking Radar (MOTR) in 2015 did give some teeth to India's SSA programme but it was still a far cry from what is needed. More radars may be in the pipeline and the capabilities may improve, but building significant SSA requires not just equipment but the ability to collate orbital information from multiple diverse sources and provide satellite operators an analysis and useful interpretation of this data. The immediate necessity of possessing adequate SSA was felt around the time of India's ASAT test of 2019, when it was realised that having visibility in a small segment of space was not adequate and there was a need for a wider space picture to have comprehensive space security. ISRO had established a Directorate of Space Situational Awareness Management (DSSAM) and on December 14, 2020, ISRO opened its

1. "U.S.-India Joint Leaders' Statement: A Partnership for Global Good", The White House Press Statement, September 24, 2021, at <https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/24/u-s-india-joint-leaders-statement-a-partnership-for-global-good/>. Accessed on September 26, 2021.
2. As narrated by Prof. S. Chandrashekhara, NIAS, during a seminar on Space Security conducted by CAPS in 2018.

Network for Space Object Tracking and Analysis (NETRA) control centre in Bengaluru.³

WHY IS SSA NECESSARY?

Space Situational Awareness in its most basic form, is the ability to see objects in space and gather meaningful information out of it. A more refined understanding of SSA would mean possessing information about the space environment and its effects on our space activities. It involves detection and tracking of space objects, their identification and characterisation, prediction of threats, preventing collisions and effects of adversarial interference. Satellites are critical orbital infrastructures that need protection. They are vulnerable to collisions owing to the rapid increase in satellite constellations making the useful orbits overcrowded. They are also vulnerable to attacks in many ways which may not even be noticed without SSA. Therefore, SSA is a foundational capability for any spacefaring nation to protect its space infrastructure which needs to be established alongside the other space capabilities. SSA also has a military quotient to it and adds a new ring to the country's overall security. The long-range radars used for SSA also provide the capability of an early warning system against ballistic missiles.

INADEQUACY OF INDIA'S PRESENT SSA

India's SSA is limited to tracking and monitoring its own satellites which is termed as positional data. For knowledge of the space environment and other objects in the vicinity of Indian satellites—situational data—India utilises the information provided by Space Surveillance Networks of some global space agencies like ESA and the Russian Space Surveillance System. India is however predominantly dependent on the US controlled Space surveillance data which is available on the open domain internet. Emergency proximity warnings are provided by the Combined Space Operations Centre (CSPOC) under the USSTRATCOM (United States Strategic Command) to all satellite operators. Though a Multi-Object Tracking

3. "ISRO SSA Control Centre Inaugurated by Dr. K. Sivan, Chairman, ISRO/Secretary, DOS", at <https://www.isro.gov.in/update/16-dec-2020/isro-ssacontrol-centre-inaugurated-dr-k-sivan-chairman-isro-secretary-dos>. Accessed on October 7, 2021.

Radar (MOTR) has been installed by India, its range is restricted to 1,000 km for an object size of 0.25 m². Optical telescopes of the Indian Institute of Astrophysics—eleven of which are currently available across the country—are selectively used for space object observation; however, there is no dedicated tasking for this purpose.

ISRO's ambitious NETRA project, although promising, has some severe constraints. The initial capability to detect objects is restricted to the Low Earth Orbit (LEO). There are plans to complement this capability with many more observational facilities like radars, telescopes, data processing centres and control centres. In the pipeline are a long-range high precision telescope at Leh, long-range radar in the North East, and integration of telescopes at Ponmudi and Mount Abu. With these developments, the NETRA project could be a stepping stone to put India on the global map in international efforts towards tracking, warning and mitigating space debris.⁴ Notwithstanding these developments, there is a need for India to have wider space coverage.

CONCERNS IN GLOBAL SPACE SURVEILLANCE NETWORKS

Despite the rapid advances in space technology, space surveillance technologies have not kept pace with the requirement to track an ever-increasing space object population. There is a viewpoint which favours a slowing down of space launches till suitable regulations and a monitoring mechanism are put in place. However, the absence of a consensus amongst states in multilateral forums has resulted in unregulated occupation of the Earth orbits. This has posed a threat of collisions which is greater than ever before, not just between satellites but also with an increasing debris population.

The US being the largest SSA provider through a single entity—CSpOC—has the onus of providing a true picture to its subscribers—barring the technical constraints which preclude an accurate analysis. This too may fall short if not integrated with the other major players in SSA like Russia, China and ESA which have independent sensors and control centres.

4. D. S. Madhumati, "ISRO initiates 'Project NETRA' to safeguard Indian space assets from debris and other harm", *The Hindu*, September 24, 2019, at <https://www.thehindu.com/sci-tech/science/isro-initiates-project-netra-to-safeguard-indian-space-assets-from-debris-and-other-harm/article29497795.ece>. Accessed on September 29, 2021.

The main concerns in the existing SSA are summarised below:

- The space object information currently available is dependent on sensor capabilities that exist in the world today and is based on a 'periodic track and revisit approach'.
- Large amounts of space debris—mainly <10 cm size—remain undetected.
- Debris is concentrated in useful orbits—these regions are becoming potentially unsustainable in future—unless debris mitigation procedures are enforced through an international protocol.
- Deficiencies in sensor technology has restricted the space object information and tracking to object sizes >10 cm. Discrimination between objects is limited by the granularity. A new 'Space Fence' radar operationalised in 2020 by US is said to have the capability of detecting objects of sizes <10 cm and up to 2-3 cm.⁵
- Global SSA capabilities have not kept pace with the rapid growth in space traffic—there are gaps in coverage and the space object catalogue maintained by CSpOC is incomplete.
- The CSpOC which manages the Space Surveillance Network—being a US military managed organisation—gives selective visibility to the users. Large amount of observed data is not being shared.
- Untapped potential of amateur astronomers, optical telescopes and private SSA providers—third party sensing—is not yet integrated into the overall picture. Hence databases are fragmented.

THE IMPERATIVES

Too many satellites operate in a vacuum of information about their environment. Collisions are thus no longer a theory—they will happen. The probability is increasing with every anthropogenic event, debris on debris collisions and fragmentation events. The deficiencies in the present SSA system need to be addressed urgently. Many of these solutions require all space agencies to board a common

5. "Space Fence surveillance radar site declared operational", Space News, March 28, 2020, at <https://spacenews.com/space-fence-surveillance-radar-site-declared-operational/>. Accessed on September 29, 2021.

platform, as SSA requires a geographically distributed network of sensors and a unified control and information distribution system. It needs to be realised that building a geographically distributed network is expensive for any single state to accomplish and all objects cannot be screened for possible collisions by a single entity like CSpOC. Untapped potential of private SSA providers needs to be amalgamated into a single composite space picture. The global SSA model needs to be premised on transparency, where every object is catalogued, civil or military. It is the purpose of the object or satellite in orbit and its activity in orbit that could be kept anonymous for military purposes. It goes without saying, that any action in space that may result in fragmentation or a debris creating event should be explicitly banned.

The world leaders need to take cognisance of the cooperative approach needed to establish a reliable, sustainable and transparent SSA architecture. The delay in adopting such an approach may carry the risk of making space further conflictive to a point of no return. SSA is an inherently international and collaborative venture. It requires a network of globally distributed sensors as well as data sharing between satellite owners, operators and sensor networks. SSA also forms the foundation of space sustainability as it enables safe and efficient space operations and promotes stability by reducing mishaps, misperceptions, and mistrust. Therefore, a global SSA network which is managed through international participation under the UN umbrella needs to be favoured by all spacefaring countries.

WHAT CAN THE US OFFER TO ENHANCE INDIA'S SSA?

The CSpOC data (an erstwhile function of NORAD⁶) segregated for civilian use is catalogued and made available to all space users in an open source format. This is in the form of a Two Line Element (TLE) description and summary of all space objects, which comprises the 'low accuracy catalogue'. This TLE data is utilised by many software applications to give live position estimates and future track

6. The North American Aerospace Defense Command (NORAD) is a United States and Canada binational organisation charged with the missions of aerospace warning, aerospace control and maritime warning for North America, at <https://www.norad.mil/About-NORAD/>. Accessed on September 29, 2021.

predictions. The 'high accuracy catalogue' is additionally created to provide vectors with accurate orbital data.⁷

The low accuracy catalogue and basic SSA services are made available to all registered users on the Space Track website. The CSPOC also provides emergency services for anomaly resolution to all space agencies and satellite operators which consists of the following:⁸

- Basic Emergency Conjunction Assessment (On-Orbit)
- Basic Emergency Collision Avoidance (On-Orbit)

Further, CSPOC also provides 'advanced services' like:⁹

- Launch Conjunction Assessment
- Launch Early Orbit Determination
- Early Orbit Conjunction Assessment
- Advanced Conjunction Assessment (On-Orbit)
- Advanced Collision Avoidance (On-Orbit)
- Disposal/End-of-Life Support
- De-orbit and Re-entry Support

Access to the high accuracy catalogue and advanced services can only be obtained by entering into a formal agreement with USSTRATCOM. In April 2019, the 100th SSA sharing agreement was signed by the US with Romania. India has not entered into such an agreement with the US so far, though collaboration in SSA was identified in the US-India joint statement of September 2014. However, to develop indigenous capabilities in space object analysis, ISRO signed an MoU on "scientific collaborations in the area of Space Situational Awareness" with University of Texas, Austin, USA in March 2020.¹⁰ Preliminary agreements like the Next Steps in Strategic Partnership (NSSP) of 2004 and the New Framework for India-US Defence Relationship of 2005 paved the way for further cooperation,

7. SSA Sharing, at <https://www.unoosa.org/pdf/pres/stsc2012/tech-40E.pdf> and "SSA Sharing & Orbital Data Requests (ODR)", at <https://www.space-track.org/documentation#/odr>. Accessed on September 28, 2021.

8. Ibid.

9. Ibid.

10. ISRO updates, at <https://www.isro.gov.in/update/05-mar-2020/memorandum-of-understanding-%E2%80%9Cscientific-collaborations-area-of-space-situational>. Accessed on October 14, 2021.

The NSSP identifies the need for civil space cooperation with India. Both countries have established a US-India Joint Working Group on Civil Space Cooperation.

The US space surveillance network is the only streamlined global SSA system which gathers inputs from sensors across the world. Finalisation of the MoA with the US would greatly enhance India's capability to avoid untoward incidents in space. This will necessarily come with some reciprocal arrangements which India will have to concede. The reasons for India's delay in joining hands with the US on SSA sharing are not clearly known. However, it is believed that the change in India's vision for space with a clear shift towards prioritising military space capabilities, the growing satellite inventory and the rising threat to space assets from debris and anti-satellite weapons of adversaries has accelerated a decision on the issue.

CAN INDIA HAVE AN INDEPENDENT SSA?

The debate on the requirement and means to achieve SSA can be unending. Nonetheless, the impracticality of having an independent SSA needs to be realised by every spacefaring nation. The character of SSA requires states to collaborate for placing geographically dispersed sensors and constructing a composite space situation picture. Hence, national SSA programmes have to be *Interdependent* rather than *Independent*. Be that as it may, India cannot be satisfied with a *dependent* SSA. India's space agencies—both civil and military—need to realise that our nation's interests in space have to be protected. For that we need to have the big picture, and not a selective picture. When it comes to a security dimension, for military utilisation of space, or may be even space defence, having the bigger picture clearly matters. Therefore, while India meets its immediate requirements through gathering inputs from the US space surveillance networks, there needs to be a dedicated effort towards building own SSA capabilities. This will also elevate India's status to that of a larger stakeholder in Global SSA efforts.

HOW CAN INDIA CONTRIBUTE TO GLOBAL SSA

India is steadily progressing on the path to attain a basic level of SSA which will meet its space security requirements. Project NETRA has been put on track and the vision is promising. However, the pace

of installation of additional infrastructure, like radars, needs to be accelerated. Besides, India can explore the possibility of installing long-range radars and telescopes in the neighbourhood as well as at offshore locations in the Indian Ocean Region (IOR) and South East Asia. ISRO already has tracking ground stations at Mauritius, Brunei and Biak (Indonesia).¹¹ India is also building a mega data receiving and tracking ground station in Vietnam for ASEAN countries.¹² Having geographically dispersed sensors will give a wider coverage of the space segment and will also facilitate a continuous tracking on this side of the globe. It is pertinent to mention that the southern hemisphere has a very low density of space tracking radars and telescopes which presents an opportunity for India to increase its footprint in any global SSA effort.

While enlarging the SSA footprint in and around the Indian subcontinent with multiple sensors is a necessity, an SSA sharing agreement with USSTRATCOM for access to advanced SSA services and the high accuracy catalogue will give a reliable space situation picture, thereby enhancing India's space security. India also needs to seriously consider the possibility of sharing space object data with CSPOC and any future global SSA network. This would translate into India becoming a regional SSA provider, which will accrue spin-offs in space cooperation with US and allied countries. In short, India needs to be a larger stakeholder in any global SSA regime of the future.

Also, Space Traffic Management (STM) is an emerging area gaining momentum, and will necessitate establishing regional STM centres around the world. India is geographically suitable and favourably positioned to migrate to the role of operating a regional STM centre as part of a global STM architecture.

CONCLUSION

The path to self-sufficiency in SSA is boundless. No country can achieve an independent SSA; rather, SSA has to be interdependent.

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11. "ISRO Telemetry, Tracking and Command Network (ISTRAC)", at <https://www.isro.gov.in/about-isro/isro-telemetry-tracking-and-command-network-istrac>. Accessed on October 14, 2021.
 12. Chetan Kumar, "Space diplomacy: India building ground station for ASEAN countries in Vietnam", *The Times of India*, July 2, 2021, at <https://timesofindia.indiatimes.com/>. Accessed on October 14, 2021.

A comprehensive SSA picture requires inputs from sensors from dispersed locations across the globe. This needs to be complemented by space-based sensors in layered orbits. Besides placing the infrastructure, there is a need for tracking, monitoring and controlling stations which also need to be located at different parts of the globe to handle space traffic during launch, recovery and deconfliction with airspace traffic. No nation could possibly establish such a network independently. Hence, space, while being contested, congested, competitive and conflictive, is also an area of cooperation and collaboration between states. International cooperation in SSA will become essential to maintain a rules-based order in space. This cooperation should thus form the basis of making outer space deconflictive.

Hence, the Indian Prime Minister's visit to Washington and the joint statement to work towards finalisation of a MoU for SSA sharing is a significant development and marks a historic milestone. It is only hoped that India emerges as a major contributor to the global SSA picture.