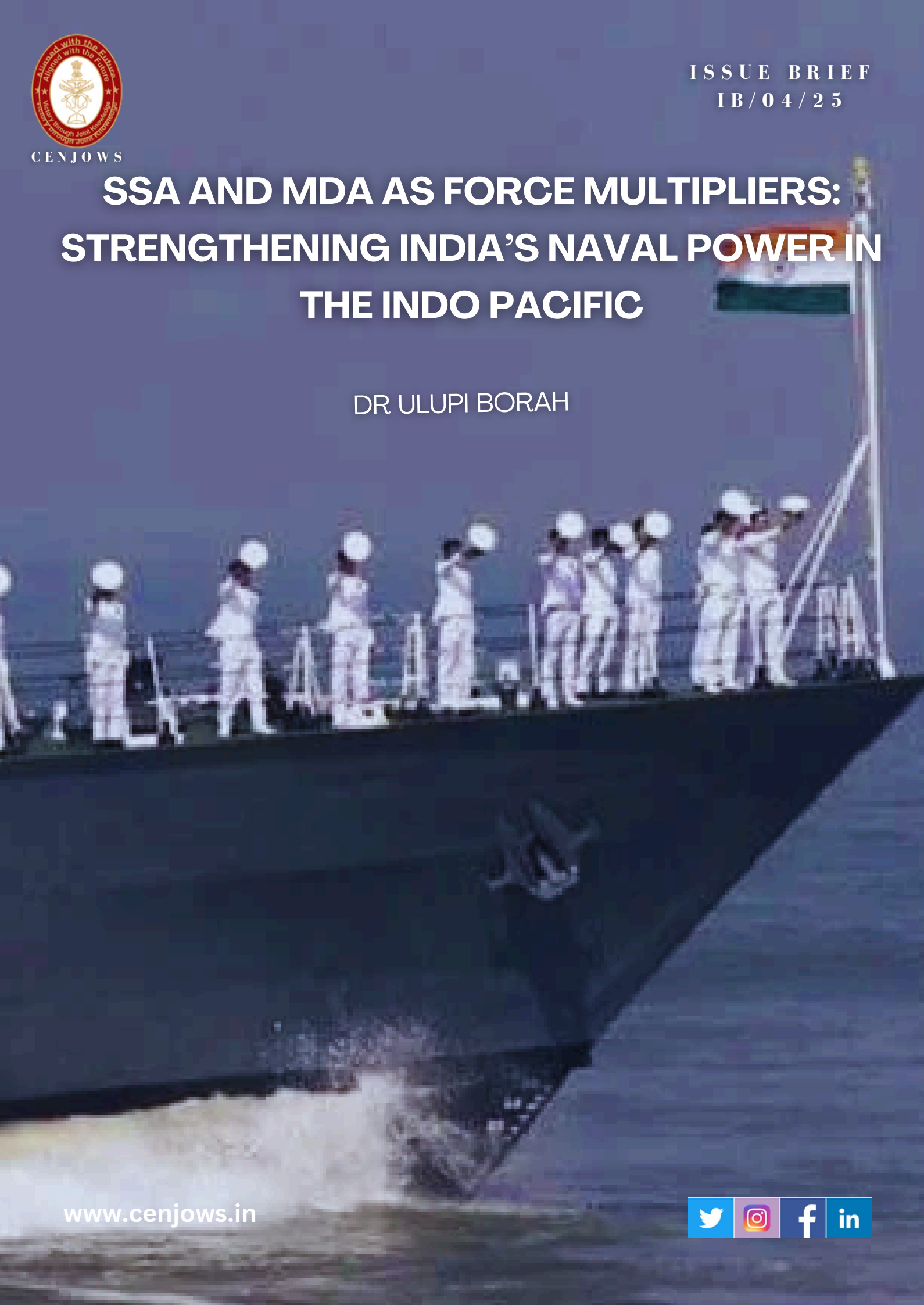
CENJOWS

ISSUE BRIEF
IB/04/25

SSA AND MDA AS FORCE MULTIPLIERS: STRENGTHENING INDIA'S NAVAL POWER IN THE INDO PACIFIC

DR ULUPI BORAH



www.cenjows.in

CENTRE FOR JOINT WARFARE STUDIES

CENJOWS

SSA AND MDA AS FORCE MULTIPLIERS: STRENGTHENING INDIA'S NAVAL POWER IN THE INDO PACIFIC

Dr Ulupi Borah, is a Senior Fellow at CENJOWS, New Delhi.

Abstract

There is a growing influence of Space Situational Awareness (SSA) and Maritime Domain Awareness (MDA) in India's maritime security policy. This is a direct result of the evolving nature of threats that have emerged in the maritime domain. By utilising space-based intelligence and integrating it with MDA, India's surveillance, intelligence and operational readiness has improved. However, a lot more needs to be done to achieve India's desired goal of being a "net security provider" in the region. This paper seeks to explore how integrating SSA and MDA into its maritime policy can act as force multiplier for the Indian navy, enabling it to better maintain order at sea and serve the country's self-interests.

Introduction

Being a vast region that is at the heart of maritime trade and security, the Indo-Pacific is increasingly gaining significance in global decision making. It provides both challenges and opportunities for a country to exert its influence on the global stage.

With advancements in technology and shifts in policy focus, there has been significant shifts in the modus operandi of maritime threat vectors. In combination with the non-traditional maritime threats, such as coastal erosion, oil spills, IUU fishing, etc., there is a need for a more robust and technology driven approach to maritime operations.
Keeping these in mind, India's naval power is undergoing a transformation in terms of the technology used for strategic deterrence and enforcing maritime security in the Indo-Pacific. Space Situational Awareness (SSA) and Maritime Domain Awareness (MDA) have taken centre stage in this transformation. Advanced space-based and ocean-based systems have made possible the continuous and real-time monitoring as well as surveillance of the region. This allows the Indian navy to detect threats early, give swifter responses as well as control strategic SLOCs and chokepoints.

As New Delhi aims to further strengthen its presence in the region, it is imperative to fully integrate India's SSA and MDA capabilities into its naval operations. This can be supported by collaborations and information sharing with like-minded nations, ensuring regional stability. This paper seeks to highlight the pivotal role that SSA and MDA play in safeguarding India's maritime interests in the Indo-Pacific. Some key initiatives undertaken in furtherance of this objective have also been examined.

Understanding SSA

With mankind's foray into outer space, the region surrounding Earth has increasingly become filled with human-made junk that are leftovers from previous space projects. These objects, which continue to orbit the Earth, are what is known as space debris. Currently there are millions of such space debris that are in Earth's orbit. What makes them a matter of concern is their speed, which can reach upto 27,000 km/ hr (avg.) at Low Earth Orbit (LEO).[1] This is the height (2,000 km or less in altitude) at which many satellites and other operational space assets also orbit the Earth. Even a minuscule fragment of space debris can cause catastrophic harm to such space assets upon collision. Any damage to a single such asset would have a ripple effect on critical systems such as defence, power, communication, transportation, finance, etc.[2]

Apart from space debris, the satellites and operational space assets in orbit also pose a threat of collision with each other. As per the database maintained by the Union of

Concerned Scientists (USC), there are currently as many as 7560 space assets in orbit around the Earth.[3] This number is only expected to grow in the future.[4]

The long-term increase in orbital objects pose two major problems. Firstly, it could create zones where it would be impossible to operate or navigate. Secondly, the Kessler Syndrome may come into play. This refers to a situation where a collision between two orbital objects cascades into a series of collisions resulting in increasing debris, finally leading to a scenario where it becomes impossible to use outer space in any meaningful way.[5]

Space Situational Awareness (SSA)

Space Situational Awareness is the comprehensive knowledge that a space faring nation or private entity holds regarding the environment in space. It includes knowing the location of space objects and their functions, as well as the weather in space. It covers three broad areas[6]:

- Space Surveillance and Tracking (SST) - this relates to human-made objects, also called Orbiting Space Debris.[7]
- Space WEather (SWE) - includes monitoring and forecast of space weather. This is influenced by the Sun and can have a severe impact on the operation of space assets.[8]
- Near-Earth Objects (NEO) monitoring - this relates to only natural objects in space such as meteorites, asteroids or comets.[9]

SSA plays a most crucial role in monitoring and protecting a country's space assets. It helps in detecting possible collisions of such assets with space debris and other orbital objects, thus protecting the assets. It is thus a significant part of any space faring nation's space policy.

Understanding MDA

Maritime Domain Awareness (MDA) is the comprehensive knowledge regarding maritime activities that may have an impact on the safety, security, environment or economy of a country. It is a crucial factor that determines a nation's ability to respond

to both traditional and non-traditional threats that may arise in the maritime waters. The three key components of MDA include[10]:

- Maritime Situational Awareness - this involves painting a picture of the existing situation in the maritime domain using both static and dynamic maritime data,
- Maritime Threat Awareness - this involves identifying the potential threats that may be active in the maritime domain of interest.
- Maritime Response Awareness - the resources available to respond to maritime threats are mapped and tracked in real-time to ensure their rapid deployment if the need arises.

India's Strategic Initiatives in SSA and MDA

Several initiatives have been undertaken by India in order to enhance its capabilities in SSA and MDA. Some of those initiatives are as follows:

Initiatives under SSA

- **Directorate of Space Situational Awareness and Management:** This is a special division set up by ISRO to handle the growing challenge of space congestion and threat of collisions due to the ever increasing amount of orbital objects. The primary aim of this department is to coordinate the efforts of various ISRO centres, other space agencies as well as other international agencies in monitoring and protecting space assets.[11]

- **Project NETRA (NEtwork for space object TRacking and Analysis):** Initiated by the ISRO in 2019, Project NETRA was established as an early warning system to detect any potential collisions between space debris, orbital objects and Indian space assets. It uses ground-based radars as well as optical telescopes that monitor and track space objects as part of Space Surveillance and Tracking (SST).[12]

  Additionally, the project also uses data processing units, a command centre (SSACC) as well as the indigenous Multi-Object Tracking Radar (MOTR), built and set up in 2015 at Sriharikota. MOTR boasts the capacity to carry out space

domain awareness at different launch stages for upto 1000 km. NETRA has the capability to track and monitor objects the size of 10 cm and above. This can be done for a range of upto 3400 km (i.e. in the LEO range).[13]

- **Space Situational Awareness Control Centre (SSACC):** On 2 August 2019, ISRO laid the foundation stone for its SSACC within the ISTRAC (ISRO, Telemetry Tracking and Command Network) Bengaluru. The Centre is a part of Project NETRA and acts as a hub to manage INDIA's SSA activities in a systematic manner. The aim is to protect India's high value space assets from any potential collisions with space debris or orbital objects. The Centre serves as a hub to assimilate all tracking data related to space debris and inactive/ discarded satellites, space weather as well as NEO. This helps to generate actionable data that can be used for CAM, debris removal initiatives as well as space debris modelling.[14] This Centre was formally inaugurated on 14 December 2020.[15]

- **ISRO System for Safe and Sustainable Space Operations Management (IS4OM):** On 11 July 2022, the IS4OM was launched by ISRO at its Control Centre in Bengaluru. It is a multi-domain awareness platform that aims to provide accurate and immediate information of the space environment, including collisions, re-entry risks, fragmentation, space weather, NEO hazards, as well as other strategic information regarding space.[16] This platform has improved the resilience of India's satellite systems.

  The IS4OM also compiles and releases the Indian Space Situational Assessment Report (ISSAR). The latest report was released on 2 April 2024, titled Indian Space Situational Assessment Report (ISSAR) for 2023. As per the report, India had 22 operational satellites in LEO and 29 in GEO by 31 December 2023.[17]

- **Debris Free Space Mission (DFSM):** At the IADC's 42nd Annual Meet on 16 April 2024, ISRO announced the Debris Free Space Mission (DFSM) initiative by India. Shri Somanath S., Chairman, ISRO/Secretary, DOS stated:

"This initiative aims to achieve debris-free space missions by all Indian space actors, governmental and non-governmental by 2030. India also encourages all other state space actors to follow this initiative for the long-term sustainability of Outer Space." This initiative outlines a comprehensive framework to achieve Zero Debris missions through careful planning as well as execution of outer space missions. It also encourages participation and collaboration of like-minded nations to improve the Long-Term Sustainability (LTS) of outer space and SSA capabilities of Earth as a whole.[18]

- **International Collaborations:** As an active space faring nation, India is a signatory to prominent space treaties. The Long-Term Sustainability (LTS) regarding activities in outer space has always been given importance in India's space policy. Initiatives like IS4OM ensure that India meets the compliance requirements of international LST guidelines.[19] ISRO has also actively participated in space activities carried out by international forums such as IADC, International Astronautical Federation (IAF), International Academy of Astronautics (IAA), UNCOPUOS and International Organization for Standardization (ISO) to name a few. In 2023, ISRO also collaborated with IADC in their "annual re-entry campaign" in which the test object was ERS-02. On 16 April 2024, ISRO acted as the chair and hosted the 42nd Annual Meet of the IADC. ISRO has also made significant contributions to IADC's activities on space sustainability.[20]

  India has also collaborated with prominent players in the space sector such as NASA, CNES, DLR, JAXA and ESA. Such collaborations not only present India with better opportunities to build capacity, but also a platform to access and share tracking data for orbital objects with both public and private sector SSA agencies.[21]

Initiatives under MDA

- **2015 Maritime Security Strategy (IMSS 2015):** On 26 October 2015, at the Naval Commanders Conference, the IMSS 2015 was released as "Ensuring Secure Seas: Indian Maritime Security Strategy". This replaced the previously titled "Freedom to Use the Seas: India's Maritime-Military Strategy" of 2007

a.k.a. The IMSS 2007. The revised Strategy expanded the ambit of the Indian navy from primarily the northern Indian Ocean Region to include South-West Indian Ocean and Red Sea. The Strategy was India's answer to growing traditional and non-traditional threats in maritime waters of the region. It clarifies New Delhi's aim to be a "net security provider" in the region, as opposed to a "net provider of security".[22]

- **Information Fusion Centre - Indian Ocean Region (IFC-IOR):** The IFC-IOR was announced at the 2017 Leaders' Summit of the Indian Ocean Rim Association (IORA). It was launched in 2018 in Gurugram. The primary purpose of the Centre is to enhance Maritime Domain Awareness by coordinating and facilitating the sharing of information among the littoral states of the Indian Ocean. In furtherance of its mission, the Centre has managed to successfully integrate International Liaison Officers from 12 partner countries. This has strengthened the cooperation between the States for maritime security.[23]

  In July 2024, at the Foreign Ministers' Meeting of QUAD in Tokyo, early operationalisation of the "South Asia Programme" via the Gurugram IFC-IOR was announced. Deployment of a "space-based climate warning system" in Mauritius as well as 'Open-RAN network" in Palau was also announced. Both these projects will see collaboration between India and the other QUAD nations to enhance MDA in the region.[24]

- **Indo-Pacific Maritime Domain Awareness (IPMDA)**: This is a joint training and technology initiative by the four QUAD nations that was announced in the 2022 Tokyo Summit. The primary objective was to enhance Maritime Domain Awareness in the Indo-Pacific region by sharing real-time information on maritime activities.[25] Innovative technologies, like "commercial satellite radio frequency data collection", are used to increase maritime security and maintain transparency. This allows the partner states to give swift responses to any maritime challenges that may arise in the maritime waters. A picture of the common maritime operations is also established in the regional information centers.[26]

- **Security and Growth for All in the Region (SAGAR):** “Security and Growth for All in the Region” (SAGAR) is India’s strategic vision for maritime waters of the Indian Ocean. The initiative was introduced in 2015, with the aim of deepening India’s security and economic cooperation with maritime neighbours. As part of this, capacity building assistance is provided to the Indian Ocean littoral states for maritime security. Information sharing, infrastructure building and coastal surveillance are also part of the deal. In conjunction with other initiatives such as Sagarmala, mausam, Act East Policy, etc., SAGAR helps portray the leadership role that India plays in the region on a long-term basis.[27]

- **Indo-Pacific Oceans Initiative (IPOI):** Inaugurated on 4 November 2019, the main objective of the IPOI was to maintain safety, stability and security of the maritime waters on the Indo-Pacific. Apart from traditional concerts related to maritime waters, economic, environmental and developmental challenges were also made a part of this initiative. It has seven main pillars, namely- “Maritime security; Maritime ecology; Maritime resources; Capacity building and resource sharing; Disaster risk reduction and management; Science, technology and academic cooperation; and Trade connectivity and maritime transport.” The lead for each pillar was handed over to one or two nations, with others joining in. This ensured that the initiative remained inclusive and transparent. The pillars for “disaster risk management, and maritime security” were led by India.[28]

- **Naval Exercises:** MALABAR began as a bilateral exercise between the US and India in 1992. Later, Japan and Australia joined in, making it a naval exercise for QUAD. In 2010, geopolitical tensions led Japan and Australia to withdraw. However, 2014 saw Japan returning to the exercise while Australia joined back in 2020. Ever since then, the exercise has seen annual participation by all four countries. The primary objective of the exercise is to maintain a free and open Indo-Pacific by strengthening the interoperability and cooperation between the nations.[29]

  MILAN began in 1995 as a “biennial multinational naval exercise” hosted by the Indian Navy. The aim of the exercise is to boost maritime cooperation, interoperability, information sharing and security in the region. In 2024, it saw

the participation of around 50 countries including the US, Bangladesh, Malaysia, Indonesia, France, Vietnam, Australia, South Korea and Japan.[30]

JIMEX is a bilateral exercise carried out between the navies of India and Japan, in furtherance of their shared commitment to maintain peace and security in the Indo-Pacific maritime waters. Beginning in 2012, the purpose of this interaction was to share information and strengthen the interoperability of the two naval forces. The exercise includes a harbour phase and a sea phase. In 2024, the exercise was hosted in Yokosuka Japan where India was represented by the Stealth Frigate INS Shivalik and Japan was represented by the Guided Missile Destroyer JS Yugiri.[31] These exercises not only strengthen India's maritime domain awareness, but also its SSA capabilities via information and technology sharing.

- **National Initiatives:** India has signed maritime cooperation and capacity building agreements with multiple nations, such as Seychelles, Sri Lanka, Maldives and Japan. These agreements are pivotal for enhancing maritime surveillance and maintaining the security of the region. For example, India has collaborated with Sri Lanka, Maldives, Seychelles and Mauritius to establish "coastal radar systems and stations". Similar projects have been offered to Bangladesh and Myanmar for enhancing maritime domain awareness.[32] India has also been an active participant of joint initiatives under ASEAN forums and IORA.

SSA, MDA and Indian Naval Power

The Indian Ocean Region (IOR), and recently, the Indo-Pacific, has been a prominent area of interest in India's foreign policy. Combining India's capabilities in SSA and MDA can augment the power of the Indian Navy in maintaining the peace and security in the region. This would enhance India's role as a key player in the region and also further the nation's self-interests.

- **Strengthening Surveillance**: India places a lot of reliance on its satellites for gathering information and monitoring the activities in the surrounding maritime waters. Combined with the various maritime awareness initiatives, a

comprehensive intelligence network is formed. This network is pivotal for maintaining the maritime security of the region. By utilising space-based technology such as the RISAT (Radar Imaging Satellites) and Cartography Satellite (CARTOSAT) and GSAT series as well as ocean-based technology like Integrated Coastal Surveillance System, the Indian navy can perform continuous monitoring and surveillance of the Indo-Pacific. This would enable the navy to swiftly detect and respond to maritime threats.

- **Countering China**: China has increasingly become a major force in the region. Its footprints are not limited to naval presence, but also include infrastructure development and partnerships with the Indian Ocean littoral states as well as India's neighbours. As many of its key trade routes are located in the Indo-Pacific, Beijing considers the securing of its Sea Lines of Communications (SLOCs) to be vital. In light of this, it has expanded its reach in the region. China's overseas military base in Djibouti is a testament to this. The growing number of military deals between Beijing and Indian Ocean littoral states has also been a cause of concern for New Delhi. China's policy indicates that it aims to continue increasing its presence in the region.[33]

  The Indian Navy has a crucial role to play in this race for increasing footprint in the Indo-Pacific. Enhanced surveillance using SSA and MDA technology would enable India to accurately monitor Chinese activity in the maritime waters of the region and take prompt action. Active collaboration with like-minded nations, including information and technology sharing, would be critical in bolstering the capabilities of the Indian navy.

  Securing strategic Choke-Points and Trade Routes: The Indo-Pacific region holds many key trading routes and strategic choke-points. For example, India's route to the Persian Gulf for energy and trade lies in these waters.[34] New Delhi has always considered the International Shipping Lanes (ISL) and choke-points of the Indo-Pacific (like the Lombok Straits, Malacca Straits, etc.), of prime importance. These have always featured on the country's naval strategy. In the IMSS 2015, two additional choke-points were included - the Mozambique Channel in south-west Indian Ocean and the Ombai-Wetar Straits in south-east Indian Ocean.[35]

By continuous and vigilant monitoring of these passages, India can avoid potential blockades and ensure the free flow of trade. Enhanced situational awareness would also enable New Delhi to take swift action against any traditional and non-traditional threats that may arise in these waters.

- **Strengthening India's Blue Economy and Maritime Law Enforcement**: Non-traditional threats such as Illegal, Unreported and Unregulated (IUU) fishing, coastal erosion, sea-piracy, oil spills etc. are a threat to the blue economy. Advanced surveillance using SSA technology would aid in enforcing maritime law and protect the seas from harmful environmental as well as economic threats.

Navigating the Challenges

- **Inadequate Space Surveillance and Tracking (SST)**: In terms of terrestrial observational facilities, optical telescopes and radars play a key role in monitoring orbital objects. However, catalogues and tracking maintained by space surveillance networks are currently limited to larger objects - above 10 cm for Low Earth Orbit (LEO) and above 0.3 - 1 m for Geosynchronous orbits (GEO).[36] Objects smaller than these are nearly impossible to track due to observational and technological constraints. This leads to inaccuracies and gaps in the available data, which hinder accurate Collision Avoidance Measures (CAM).

  India primarily relies on a mixed intelligence from both domestic and foreign sources (like NORAD) for orbital objects. As the congestion in space grows, the risk of collision for critical satellite systems such as NavIC, RISAT, etc. also grows. The dependence on foreign data limits New Delhi's capacity in real-time monitoring and tracking of orbital objects while also posing a threat to the country's security autonomy.

- **Cyber Warfare Risks**: In the current digital age, traditional warfare is augmented by cyber warfare. Space-based technology is especially vulnerable to such attacks from both state and non-state actors. Any such attack can disrupt C4ISR (Command, Control, Communications, Computers, Intelligence,

Surveillance and Reconnaissance) and lead to crippling effects on national security and economy.

- **Expanding Presence of China**: China's expanding naval footprint in the Indo-Pacific is an active threat to India's presence in the region. Be it China's BRI initiative, the submarine and warship operations in IOR or close diplomatic ties with littoral states, Beijing's policy for the Indo-Pacific is clearly targeted to strengthen its influence in the region. This presence is not just limited to the terrestrial domain. It has also expanded to outer space. China is a space faring nation with anti-satellite capabilities, which pose a significant threat to Indian space assets.

- **Dependence on Foreign Technology**: India still relies on foreign technology for its SSA and MDA capabilities. The undersea monitoring capability of India is limited and lacks fully indigenous systems. This dependency makes it vulnerable to foreign influence and breaks in supply-chain.

Recommendations

- **Augmenting India's Naval Technological Edge**: The Indian navy's edge can be further strengthened by developing advanced technology for Unmanned Underwater Vehicles (UUV) and Unmanned Aerial Vehicles (UAVs), for maritime surveillance and law enforcement. Seabed Sonar Arrays can also be deployed at strategic choke-points. This can be supported via satellite surveillance through dedicated indigenous systems and large constellations. This would ensure continuous and real-time monitoring of the region. It would also reduce the dependency on foreign technology and intelligence, while ensuring the security of strategic communication.

- **Strengthen SSA Capabilities**: India can further strengthen its SSA capabilities by developing more indigenous systems such as NETRA and MOTR. New Delhi could promote its tracking capabilities and detection measures. It should not be merely limited to LEO. The role of radar and electro-optical sensors is immense here. Nonetheless, there focus should also be in setting up of strict rules and regulations to maintain the security of national interests.

- **Commence Operations Involving the Military, Space and the Maritime Domain**: Integration of assets both from space and maritime domain are of great importance. This could be done by the Defence Space Agency enabling New Delhi bolster its intelligence network to counter any challenges arising in the region. It is also believed that such integration has the ability to enhance coordination, which could eventually address threats with agility. Furthermore, New Delhi could strengthen its collaboration with its partners to buttress such operations.

- **Advanced Navigation and Missile Warning Systems**: India's indigenous navigation system, NavIC, is currently operational only in the IOR. Efforts should be made to extend its coverage and also integrate advanced imaging technology in it. This would enhance the navigational safety and accuracy of India's vessels in the region. India should develop its own space-based missile warning systems, similar to NORAD. This would enable real-time monitoring of threats and swifter responses.

Conclusion

As a space-faring nation, India's space policy is oriented towards increasing its SSA capabilities by developing its own indigenous systems as well as collaborating with like-minded nations. Not just SSA, but New Delhi's advanced capabilities in MDA would give it the leverage to create further opportunities in the maritime domain in Indo-Pacific. Considering Beijing's growing presence in the region the role of Indian Navy is crucial especially for enhanced maritime preparedness in the region. As a result, India's focus should be to reduce its dependency on foreign imports and follow the path of "Atmanirbharta" to indigenously create its technologies and achieve its objectives in the region.

DISCLAIMER

that the facts and figures quoted are duly referenced, as needed and are believed to be correct.

Endnotes

[1] ISRO, (2021), “Space Situational Assessment 2021”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/SSA.html
[2] Ibid
[3] Reports & Multimedia, (2023) “UCS Satellite Database”, Union of Concerned Scientists, [Online Web], Accessed on 25 February 2025, URL: https://www.ucsusa.org/resources/satellite-database#:~:text=Kyle%20Ann%20Sebastian&text=Assembled%20by%20experts%20at%20the,of%20commercial%20and%20civil%20satellites.
[4] ISRO, (2021), “Space Situational Assessment 2021”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/SSA.html
[5] Ibid
[6] SATCEN, “Space Situational Awareness”, EU, [Online Web], Accessed on 25 February 2025, URL: https://www.satcen.europa.eu/page/ssa
[7] John A Kennewell and Ba-Ngu Vo, (2013), “An Overview of Space Situational Awareness”, Australian Space Academy, [Online Web], Accessed on 25 February 2025, URL: https://ba-ngu.vo-au.com/vo/KV_SSA_FUSION13.pdf
[8] Ibid
[9] Ibid
[10]Maritime Security, “Maritime Domain Awareness”, IMO, [Online Web], Accessed on 25 February 2025, URL: https://www.imo.org/en/OurWork/Security/Pages/Maritime-Domain-Awareness.aspx
[11] ISRO, (2023), “ISRO SSAControl Centre Inaugurated by Dr. K. Sivan Chairman ISRO/ Secretary DOS”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/ISRO%20SSAControl%20Centre.html
[12] Ibid
[13] D.S. Madhumati, (2019), “ISRO initiates ‘Project NETRA’ to safeguard Indian space assets from debris and other harm”, The Hindu, [Online Web], Accessed on 25 February 2025, URL: https://www.thehindu.com/sci-tech/science/isro-initiates-project-netra-to-safeguard-indian-space-assets-from-debris-and-other-harm/article29497795.ece
[14] ISRO, (2023), “Foundation stone of Space Situational Awareness Control Centre by Chairman ISRO”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/Foundation%20stone%20of%20Space.html
[15] ISRO, (2023), “ISRO SSAControl Centre Inaugurated by Dr. K. Sivan Chairman ISRO/ Secretary DOS”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/ISRO%20SSAControl%20Centre.html
[16] PIB, (2022), “Around 60 StartUps have registered with ISRO since unlocking of the Indian Space sector recently by Prime Minister Narendra Modi”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://pib.gov.in/PressReleseDetail.aspx?PRID=1840795&reg=3&lang=1
[17] ISRO, (2024), “Indian Space Situational Assessment Report (ISSAR) for 2023 Released”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/Indian_Space_Situational_Assessment_Report_ISSAR2023.html
[18] ISRO, (2024), “India’s Intent on Debris-Free Space Missions - Explained”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/Debris_Free_Space_Missions.html
[19] ISRO, (2024), “Indian Space Situational Assessment Report (ISSAR) for 2023 Released”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/Indian_Space_Situational_Assessment_Report_ISSAR2023.html
[20] Ibid

[21] B. R. Guruprasad, (2018), “Understanding India’s International Space Cooperation Endeavour: Evolution, Challenges and Accomplishments”, India Quarterly, [Online Web], Accessed on 25 February 2025, URL: https://doi.org/10.1177/0974928418802077

[22] Gurpreet S Khurana, (2015), “‘Net Security Provider’ Defined: An Analysis of India’s New Maritime Strategy-2015”, NMF, [Online Web], Accessed on 26 February 2025, URL: https://www.maritimeindia.org/View%20Profile/635838396645834619.pdf

[23] Sayantan Haldar, (2024), “Prioritising maritime domain awareness in the Indian Ocean”, ORF, [Online Web], Accessed on 26 February 2025, URL: https://www.orfonline.org/expert-speak/prioritising-maritime-domain-awareness-in-the-indian-ocean

[24] Ulupi Borah (2024), “India Japan Maritime Partnership: A Vision for Connectivity, Security, and Resilience”, Centre for Joint Warfare Studies, IB/29/24, [Online:web], Accessing 10 February 2025, URL:https://cenjows.in/pdf-view/?url=2024/12/Dr_Ulupi_Borah_Issue_Brief_Dec_2024_CENJOWS.pdf&pID=26309

[25] Drishti IAS, (2023), “The Indo-Pacific Maritime Domain Awareness”, [Online Web], Accessed on 26 February 2025, URL: https://www.drishtiias.com/daily-updates/daily-news-analysis/the-indo-pacific-maritime-domain-awareness

[26] Department of the Prime Minister and Cabinet, (2023), “Indo-Pacific Partnership for Maritime Domain Awareness”, Australian Government, [Online Web], Accessed on 26 February 2025, URL: https://www.pmc.gov.au/resources/quad-leaders-summit-2023/indo-pacific-partnership-maritime-domain-awareness

[27] Drishti IAS, (2020), “SAGAR Vision”, [Online Web], Accessed on 26 February 2025, URL: https://www.drishtiias.com/daily-news-editorials/sagar-vision

[28] Ulupi Borah (2024), “India Japan Maritime Partnership: A Vision for Connectivity, Security, and Resilience”, Centre for Joint Warfare Studies, IB/29/24, [Online:web], Accessing 10 February 2025, URL:https://cenjows.in/pdf-view/?url=2024/12/Dr_Ulupi_Borah_Issue_Brief_Dec_2024_CENJOWS.pdf&pID=26309

[29] Sayantan Haldar, (2024), “Malabar Exercise: Strengthening synergy among Quad nations”, ORF, [Online Web], Accessed on 26 February 2025, URL: https://www.orfonline.org/expert-speak/malabar-exercise-strengthening-synergy-among-quad-nations#:~:text=India%20is%20hosting%20this%20year%27s,participation%20from%20Canada%20and%20Singapore.

[30] PTI, (2024), “India hosts 'Milan' naval exercise; around 50 countries participating”, Deccan Herald, [Online Web], Accessed on 26 February 2025, URL: khttps://www.deccanherald.com/india/india-hosts-milan-naval-exercise-around-50-countries-participating-2901095

[31] Ulupi Borah (2024), “India Japan Maritime Partnership: A Vision for Connectivity, Security, and Resilience”, Centre for Joint Warfare Studies, IB/29/24, [Online: web], Accessing 10 February 2025, URL:https://cenjows.in/pdf-view/?url=2024/12/Dr_Ulupi_Borah_Issue_Brief_Dec_2024_CENJOWS.pdf&pID=26309

[32] Darshana M. Baruah, (2022), “Maritime Competition in the Indian Ocean”, Carnegie Endowment for International Peace, [Online Web], Accessed on 26 February 2025, URL: https://carnegieendowment.org/posts/2022/05/maritime-competition-in-the-indian-ocean?lang=en

[33] Ibid

[34] Ibid

[35] Gurpreet S Khurana, (2015), “‘Net Security Provider’ Defined: An Analysis of India’s New Maritime Strategy-2015”, NMF, [Online Web], Accessed on 26 February 2025, URL: https://www.maritimeindia.org/View%20Profile/635838396645834619.pdf

[36] ISRO, (2021), “Space Situational Assessment 2021”, Government of India, [Online Web], Accessed on 25 February 2025, URL: https://www.isro.gov.in/SSA.html