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Wide-Area Ocean Electronic Intelligence Satellites: Vital MDA Tool for Detecting Proponents of China's Grey Zone Operations in The Indian Ocean

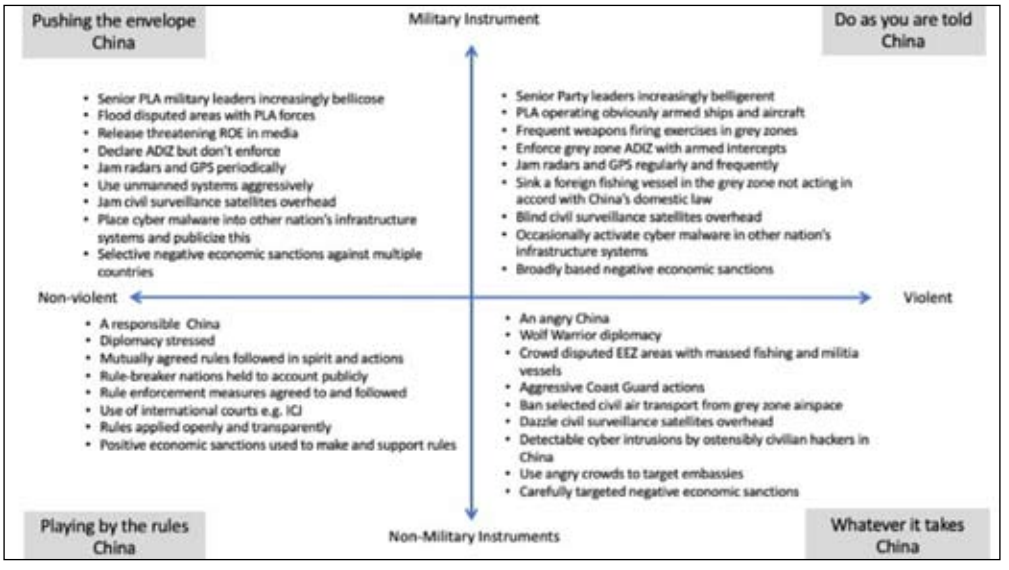
Captain Kamlesh K Agnihotri (Retd)

ABSTRACT
China has been engaging in grey zone warfare for a long time in order to meet its political ends vis-à-vis its opponents and adversaries without engaging in direct use of its hard power. While media and legal means have been resorted to quite extensively, its grey zone tactics in the maritime domain have increasingly seen the usage of physical assets like its Coast Guard ships, maritime militia vessels, special purpose ships and the distant-water fishing fleet. This article highlights the indispensability of wide-area ocean reconnaissance electronic intelligence (ELINT) satellite clusters as part of a viable maritime domain awareness (MDA) architecture, to detect radio frequency emissions, vis-à-vis these Chinese assets. Since India does not possess such satellite clusters yet, it must leverage the capabilities available with the QUAD partners under the IPMDA framework. In addition to the collaborative approach, certain technologies which have been indigenously introduced in the Indian civilian maritime sector may also be innovatively exploited to watch against Chinese grey zone operations in and around the Indian maritime zones.
Keywords: Chinese Grey Zone operations, DRDO, ELINT, Hawkeye 360, Indian Navy, Indo-Pacific, IOR, IPMDA, ISRO, Maritime Domain Awareness, Nabh-Mitra, QUAD, Sagar-Mitra, Sindhunetra, South China Sea, Wide Area Ocean Reconaissance Satellites, Yaogan

The Chinese grey zone activities generally involve the deliberate pursual of political objectives through carefully designed operations. The tenets of such grey zone missions call for not seeking decisive results quickly; ensuring that such missions do not escalate into open conflict; and use of all resources at the disposal of nation-States, including non-military and non-kinetic means. In terms of its application in the maritime domain, Peter Layton has posited that grey zone activities can be best understood through an interplay of two important variables. These are, whether violent or non-violent actions are resorted to; and whether military instruments are used or not.[1] Such interplay would result in four possible outcomes, as shown in the four quadrants depicted in Figure 1. While none of these four outcomes can be considered as exclusive to the others, a wide range of encompassed possibilities are nevertheless, covered.

Since 'Playing by the rules China' is a highly optimistic scenario, whose probability of occurrence seems to be pretty unlikely in the context of current geopolitical environment; it would not be totally out of place to discount this scenario altogether. At the other extreme, 'Do as you are told China' would lie at the limits of grey zone activities with serious risk of escalation into a conflict; and is hence not being considered within the scope of this article.

Figure 1: Chinese Grey Zone Possibilities encompassing Maritime Domain



Source: Peter Layton

That leaves two plausible scenarios. The first one is the 'Whatever it takes China', where non-military means and assets are used in a volatile fashion day-in-and-day-out, to harass the adversary and keep him in constant state of frustration and tenterhooks. The second situation relates to 'Pushing the envelope China' where greater and more visible use of the Chinese naval assets would made in a non-violent but assertive way — with the threat of 'use of force' being inherently implied by virtue of their mere presence.

Chinese Maritime Grey Zone Operations in the South China Sea (SCS)

The World has been watching the last two scenarios being constantly played out in the South China Sea, with due concern. A combination of the grey zone tactics from this playbook are being aggressively pursued against Vietnam and Philippines, in particular. The Scarborough Shoal has virtually been made inaccessible to the Pilipino fishermen and law enforcement authorities since 2012. At the same time, the Second Thomas Shoal has become a veritable battleground of sorts, with the Chinese Coast Guard ships and maritime militia vessels physically obstructing the Coast Guard ships and logistics resupply vessels of the Philippines. They have even gone to the extent of engaging in wilful collision on multiple occasions over the past year — the latest being on 05 March 2024.[2]

A milder intensity of these activities has been witnessed vis-à-vis Malaysia and Brunei, which have comparatively limited disputes and are located a little farther. Indonesia is probably being lulled into false sense of security by the oft repeated and disarming Chinese promises with respect to its Natuna group of islands. The mildest manifestation of these

grey zone tactics was witnessed when the Chinese Ministry of Natural Resources released a new map of China on 28 August 2023, depicting 10 dash lines in the south China Sea — with the tenth dash extending due east of Taiwan.[3]

Possible Contours of China's Maritime Grey Zone Operations in the Indian Ocean Region (IOR)

While the Chinese maritime grey zone operations in the SCS have been growing increasingly aggressive by the day; the nature of their maritime grey zone operations can be said to be a little more nuanced in the IOR. The vast region in terms of area — about 73.6 million square km — affords ample sea space to the Chinese maritime assets to engage in grey zone missions. These missions can possibly play out through two specific lines of effort, namely: the deployment and activities of Chinese 'special purpose' ships; and their distant water fishing fleets engaging in illegal or unlawful acts, as per their capabilities and mandates.

China has been deploying an array of 'special purpose' ships in the IOR over the past two decades. These ships are equipped with advanced technological hardware and capabilities for data collection, collation, theme-based segregation, analysis and distribution in different domains. The Chinese survey ships have also been deployed for underwater survey tasks on request from India's neighbouring countries like Pakistan, Sri Lanka and Maldives.[4] Some such ships which require special mention are mentioned below:

- Intelligence collection ships (Dong Diao class, Type 815)
- Deep-sea Research vessels with/without submersibles (Xiangyanghong series)
- Hydrographic survey vessels (Shiyan-6/7 types)
- 'Yuan Wang' series of space tracking and telemetry ships

Similarly, some probable grey zone activities of Chinese 'distant water' fishing fleet — whether acting unilaterally, or within the fleet or in combination with either 'special purpose' ships or even in conjunction with the People's Liberation Army (PLA) naval ships — are mentioned below:

- Effect rendezvous (R/V) with the PLA Navy ships and act on their orders
- Operate in collusion with 'special purpose' ships
- Cyber activities inconsistent with fishing
- Underwater data collection by employing probes, buoys or UUVs
- Illegal, unreported, and unregulated (IUU) Fishing in Indian Maritime Zones

Maritime Domain Awareness (MDA): Pre-requisite for Countering China's Maritime Grey Zone Operations

In order to counter the Chinese grey zone operations in the maritime domain, particularly in the Indian Ocean, it is imperative that the countries invest in building a comprehensive

MDA architecture. This architecture should be built around many sources and technologies; must be reliable, accurate, user-friendly, agile, easy to access; and also amenable to dissemination in shortest possible timeframe. Some such sources are as follows:

- Space-based surveillance technologies
- Maritime reconnaissance (MR) and airborne early warning (AEW) aircraft
- Long range UAVs, both, shipborne and shore-based
- Joint and single service identification systems to discern between 'friend and foe'
- Effective cyber-space monitoring capability to safeguard own information
- Sub-surface surveillance including mobile and static systems, deployable either from ships, submarines or aircraft
- Robust networking infrastructure to provide high-speed large-bandwidth connectivity for multi-media data sharing

The space-based surveillance technologies — out of those mentioned above — are progressively becoming the most important means of building of a comprehensive MDA picture. India, on its part, has taken some stellar initiatives towards erecting the MDA effort in the IOR, particularly against non-traditional threats.

Information Fusion Centre for IOR (IFC-IOR). One such initiative is the establishment of IFC-IOR, which was established at Gurgaon on 22 December 2018. The Centre functions under operational control of the Indian Navy; and aims to strengthen maritime security in the IOR and beyond, by building a common maritime situation picture. It also act as a maritime security information-sharing hub for the region. IFC-IOR gets its data for collation, analysis and fusion from various sources, as mentioned below:

- Information of vessels at Sea from National Automatic Identification System (AIS) Chains
- Space-based AIS Data from Resource-sat series of satellites
- Data from Coastal Radars
- Long Range information and Tracking (LRIT) data
- Information from 'White Shipping Agreement' Partners
- Maritime Security Information System (MSIS)
- Information from International Maritime Organisation (IMO) departments and organisations
- Information from Indian Ports association with respect to International Ship and Port Facility (ISPS) code

International Collaboration of IFC-IOR towards Comprehensive MDA. Since its inception, IFC-IOR has established working level linkages with more than 25 nations and 45 multinational organisations/maritime security centres. To achieve better correlation, compressed information processing cycles and timely input distribution across the region, IFC-IOR also hosts International Liaison Officers (ILOs) from 13 partner nations. These include the uniformed representatives from Australia, France, Italy, Japan, Maldives,

Mauritius, Myanmar, Sri Lanka, Seychelles, Singapore, United Kingdom, and the US; with Bangladesh becoming the latest entrant in December 2023.[5] A combined team of Indian Naval personnel and ILOs, duly assisted by civilian analysts monitors the IOR and adjoining seas; for developing deeper understanding on varied maritime issues including piracy, armed robbery, contraband smuggling, IUU fishing, irregular human migration (IHM); and possible links of these non-traditional threats with maritime terrorism. The IFC-IOR extensively collaborates with other Information Fusion centres operating from Singapore, Madagascar and Seychelles; as also with the Information sharing centres associated with the Djibouti Code of Conduct (DCOC) grouping — Sanaa in Yemen, Mombasa in Kenya, and Dar-es-Salam in Tanzania — For two-way information flow.

Pacific Maritime Domain Awareness (IPMDA) Initiative. In addition, the QUAD group of countries are seriously working to operationalize the IPMDA at a much broader scope and larger scale. IPMDA is a technology and training initiative to bring increased transparency to the critical waterways within the Indo-Pacific region. IPMDA harnesses innovative technology, such as commercial satellite radio frequency (RF) data mining, to provide near-real-time electronic intelligence (ELINT) to its partners across South-east Asia, Indian Ocean, and the Pacific. IPMDA also supports the ability of Indo-Pacific partners to rapidly detect and respond to a wide range of challenges involving illicit maritime activities.[6] The QUAD countries have accordingly launched a series of regional pilot projects, to collate and deliver RF data to maritime agencies in the region.

Wide Area Ocean ELINT Satellites: Vital MDA System for detecting China's Grey Zone Operations

It has been argued earlier that Chinese special purpose ships and its fleet of distant water fishing vessels would presumably be the main players which would engage in grey zone operations in the IOR. While the first set of ships would be obligated to keep their AIS transponders on, and hence may not become 'dark ships; they would certainly generate RF transmissions over a wide spectrum, ranging from mobile satellite phone devices, VHF/UHF communication channels, to navigation and specialised radar systems operating in super-high frequency (SHF) bands.

The distant water fishing fleet vessels, on the other hand, would be the most likely candidates for going 'dark' — by switching off their onboard AIS transponder — when they decide to engage in missions inconsistent with legal and authorised fishing activities. However, even with the AIS transponder turned off, the very nature of communication and marine navigation at sea — whether external or internal — would demand that such vessels radiate in certain RF bands like the VHF, UHF and/or satellite telephony.

The space-based ELINT system should therefore, have the capabilities for detection of emissions over a broad RF spectrum, and across a large sea area. The system should also cater for analysis and relay of this RF information to the earth stations or command and control centres in 'as real-time Basis' as possible. Since the required area of coverage, per-force, has to be quite large, it would suffice if such a system can just confirm the presence or absence of an object of interest through detection of its RF signal, even with

approximation in locational accuracy. Subsequently, other remote sensing satellites with high resolution payloads — electro-optical (EO), synthetic aperture radar (SAR), infra-red (IR) or radar for instance —may be cued on to the indicated area for localising, classifying, identifying and tracking the object with pin-point accuracy. These efforts may also be complemented with other assets like the MR aircraft, UAVs and shore-/ship-based radar and electronic warfare (EW) systems, as required. It must however be noted that the whole ISR chain can commence in most cases, only on the reception of initial input from the wide-area ocean-reconnaissance ELINT satellite cluster.

However, India does not have a wide-area ocean reconnaissance satellite cluster of its own; though the DRDO, in collaboration with ISRO has sent a single Electro-Magnetic Intelligence Satellite (EMISAT) under 'Project KAUTILAYA' in a 748 km sun-synchronous polar orbit on 01 April 2019.[7] On the other hand, China possesses multiple such clusters which form part of a comprehensive network of '*Yaogan'* earth observation system. It comprises a number of remote sensing satellites — having different payloads and in widely differing orbits — in addition to the ELINT clusters.[8]

Since the requirement of wide-area oceanic ELINT coverage is inescapable, India is collaborating with the US under the rubric of QUAD's IPMDA arrangement to build a comprehensive MDA picture for the region. To that end, it is implied that India may be looking for a pilot project with a private US satellite company, the 'Hawkeye 360', which already has seven wide-Ocean-Area ELINT satellite constellations in orbit.[9] The company provides various data and value-added services like the space-based RF signal raw data, detection and geo-location of such RF signals, as also GPS interference detection solutions. Figure 2 below provides the basic technical and operating details of 'Hawkeye 360' ELINT system.[10]

The Hawkeye 360 satellite clusters can, in addition, detect the global positioning system (GPS) jamming signals and also geo-locate their sources. The indispensability of GPS as

Figure 2: 'Hawkeye 360' ELINT system – Basic technical and operating details

Hawkeye-360 – Basic Details

- 7 constellations of 3 satellites in different orbits (Total of 11 clusters planned)
- About 600 KM Altitude
- Revisit Frequency – Nearly 1 per hour [Up to 24 inputs per day]
- Different RF receiver payloads covering entire radio communication and Marine Navigation Radar frequency bands
- 150 MHz to 10,000 MHz [VHF, UHF, L1 BAND GPS, S BAND AND X BAND]
- Coverage around any one spot – About 3500 KM Diameter
- Can cue any two sensors at a time on demand
- Offers geo-location of emitters or raw data as desired, in specified sector of interest
- Processed data with classification also provided for specific objects

Source: Various Hawkeye 360 Catalogues

the lifeline for safe navigation of ships, aircraft — and even vehicles on land — all across the world is universally recognised. However, the low strength of GPS signals renders them quite susceptible to accidental or intentional interference. In recent years, certain countries and even non-state actors have shown the capabilities to jam or spoof the GPS signals in order to downgrade the operational activities of targeted country or group; and thus, gain asymmetric advantage. 'Hawkeye 360' can tune the satellites' GNSS antennas to detect and geolocate signals in the GPS L1 wideband frequency range. Mapping of interfering emitter locations by 'Hawkeye 360', will then enable the affected party to deploy suitable countermeasures.

It is however, nobody's case that the RF signals detected and geo-located by Hawkeye 360's Wide-area Ocean ELINT satellite clusters will alone, provide the whole solution to the vexed ISR challenges in the Oceanic domain. Rather, a holistic MDA picture can only be built when different means of space-based data collection — like AIS, EO and SAR — are used in a synergistic fashion to plug data gaps, with each system complementing the other. Similarly, AIS data alone can be an incomplete and unreliable source for monitoring maritime activity, since it is contingent upon the subject vessels voluntarily transmitting their position and identification information via their AIS transponders. In a situation where a vessel either turns off its AIS transponder or falsifies (spoofs) its AIS signal, RF data from ELINT satellites becomes quite invaluable in its subsequently tracking. The fusing of such RF data with other modes of data collection therefore, helps 'connect the dots', thus enabling 'dark ship' detection with greater certainty. Consequently, this integrated architecture provides a robust approach to ISR and positive identification in the vast maritime domain.

Innovative Exploitation of Indigenous Space-based Technologies to detect China's Grey Zone operations in IOR

While bilateral and multilateral collaborations towards usage of space-based MDA in mitigating Chinese grey zone operations in the IOR are parts of one approach; India is concurrently augmenting its own capabilities by using the innovative skill sets of new generation, with adequate handholding from DRDO and ISRO. One such endeavour is the '*Sindhu-Netra*' micro-satellite with AIS payload, which is dedicated solely for meeting maritime requirements. It is an Indian technology demonstration satellite funded by DRDO, and built by the students of Hyderabad based PES University. It was launched in February 2021 to track merchant navy ships in the IOR. It is claimed that the satellite, if required, can also receive AIS signals in specific areas such as the South China Sea, or the piracy-prone areas near the Gulf of Aden and the African coast.[11]

In addition, some innovative exploitation of ISRO developed safety applications for fishermen's safety can also be explored to geolocate vessels of interest, which may be observed to be operating in the Indian maritime zones by the Indian fishermen. '*Nabh mitra*'[12] and '*Sagar Mitra'* are two such applications which are capable of sending distress messages from fishermen at sea via a two-way SMS service from their Android phones.[13]

The fishermen have to just report the vessels of interest, if encountered at sea, over SMS. Same action can be followed for reporting the Chinese distant-water fishing vessels if they are observed to be engaged in activities other than fishing. An institutionalised system of interaction between the maritime security agencies, the concerned State governments and the fishing community — Something on the lines of erstwhile 'war watching' organisation — will of course, have to be built and sustained, for this initiative to become an effective tool of surveillance.

'MapMyIndiaNavIC' (sic) is yet another ISRO developed application (app) for facilitating the safety of fishermen, which may be used for same purpose. The app provides the following specific features:[14]

- Live location of the fisherman on the map
- Current position of the fisherman from the international maritime boundary
- Audio-visual alert when the fisherman is about to cross the boundary
- Location for potential fishing zones - tuna or normal
- Way point navigation from current location to selected potential fishing zone
- App works completely offline
- Provision to receive emergency messages - high tide wave, cyclone, etc.

The most important feature of this app is that it has the Indian maritime boundaries digitally marked in the background; and alerts the fisherman when he is about to cross that boundary. This feature will enable the fisherman to ascertain whether the Chinese fishing vessel or a special purpose ship which he encounters at sea, lies inside the Indian maritime boundary or in its proximity. This feature, if utilised correctly, can be a game changer, as it will provide digitally verifiable evidence about the suspect vessels which may be engaging in grey zone operations within the Indian maritime zones.

Conclusion

The Indian Ocean comprises vast oceanic expanse encompassing more than 73 million square km. Even the Arabian Sea — a smaller portion of the Indian Ocean — spanning about 3.8 million square km covers a large area. The challenge of ensuring effective surveillance of such vast seascapes — whether by terrestrial resources or space-based systems or a combination thereof — requires no reiteration. This challenge gets further amplified if one were to specifically look out for objects which may ultimately threaten the maritime security of India either in-, from- or through sea. India, having developed a credible space programme over the last half-century — encompassing all space-related technology domains including manufacturing of satellites and carrier rockets as well as their launching — is a recognised space power in its own right.

However, the entire Indian space programme lies in the non-military domain and is under control of civilian administration. Thus, the Defence Forces' requirement of satellite-based applications, per-force, becomes one of the many national level requirements — most of which are for civilian purposes. In such existing circumstances, it was quite

difficult for the defence forces till the recent past, to pitch for creation of exclusive space-based infrastructure, assets and processing facilities solely for their dedicated usage. The rapidly changing regional geopolitical landscape — particularly over the last decade and half — has however, forced the national policy makers to acknowledge the consequential threat to the national security, and the utmost need to exploit the space-based assets towards mitigation of such threats.

In the maritime domain, the communication satellite *Rukmini* was the first asset provided for dedicated use of the Indian Navy. Similarly, military requirements have progressively found increasing priority and precedence in many remote sensing satellites and their payloads. While these developments have certainly improved the level of regional MDA, the insignificant area actually covered on the ground — given inadequate number of satellites and their limited swathes — vis-à-vis the vastness of the Indian Ocean, renders the challenge quite insurmountable. This is where the indispensability of wide-area ocean reconnaissance ELINT satellites cluster(s) to kickstart the entire ISR process, by facilitating the first line detection of all relevant vessels in the Indian areas of maritime interest — including the possible Chinese 'grey zone' protagonists — comes in. Hence, critical requirement of this space-based system, which is directly linked to India's maritime security, needs no further emphasis.

Finally, it is posited that generation of Comprehensive Space-based MDA is only a means to monitor and localise the possible proponents of Chinese 'grey zone' activities in the region, and as such, is only the first step in the mitigation of such threats. The next and more important step would be to erect comprehensive infrastructure and build capabilities to counter this threat. Most importantly, due considerations must be accorded while planning of relevant countermeasures, to ensure that own actions do not inadvertently escalate the situation to a point that it degenerates into open conflict.

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Note on contributor:

Captain Kamlesh K Agnihotri, IN (Retd.) is a Senior Fellow at the National Maritime Foundation (NMF), New Delhi. His research concentrates upon maritime facets of hard security vis-à-vis China, Pakistan, Russia, and Turkey. He also delves into maritime security-challenges in the Indo-Pacific Region and their associated geopolitical dynamics. Views expressed in this article are personal. He can be reached at kkumaragni@gmail.com