Rethinking (IMINT) - Image Intelligence Strategy from Space

SIAINDIA An association for space industry

SATSURE

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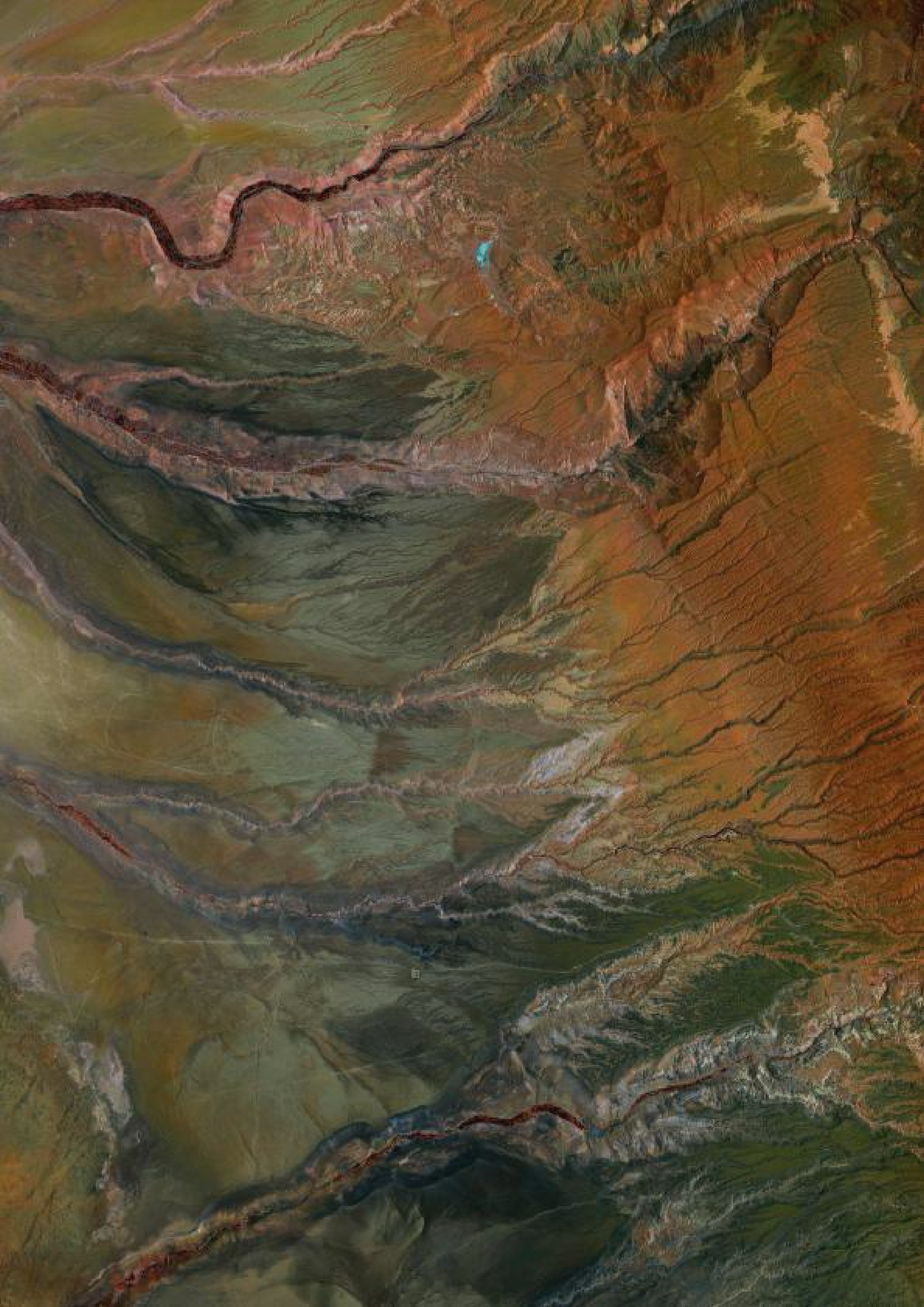
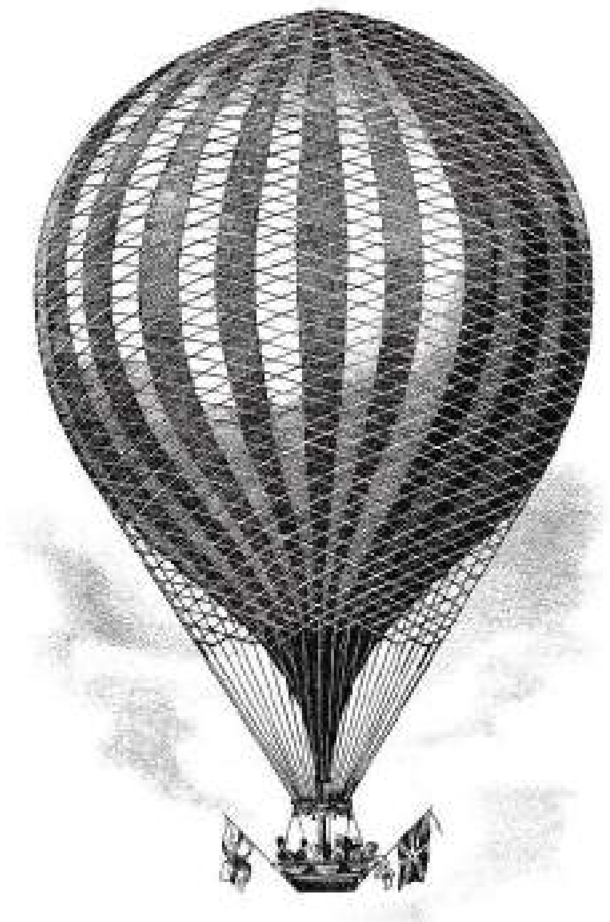


EVOLUTION OF DEFENCE AND WARFARE STRATEGIES

The development of warfare strategies depends on two factors: access to timely information and the nature and quality of that information. Information can be obtained in two formats: audio and visual.

Ground intel and/or COMINT information contains essential data but lacks parameters such as the nature of the surroundings and the coordinates of variables in the real world. The conversion of such data into actionable information depends on fusion with spatial information along with human intelligence and analysis.



On the other hand, visual-based data provides the receiver with a holistic view of the real-world scenario. This is because the image data comes with several parameters, such as the coordinates of the features of interest and the nature of the variables. These parameters are perceived as intelligence data, which is then turned into actionable data with minimal human intervention, leading to an enhanced decision-making process.

Over time, the medium of recording and communicating imagery intelligence has changed with respect to the area coverage and the ability to process acquired images into actionable information. The first instance of recording imagery was done through a hot-air balloon, leading to the aerial photography era.

DEGREE AND TIMELINESS OF INFORMATION ACCESS

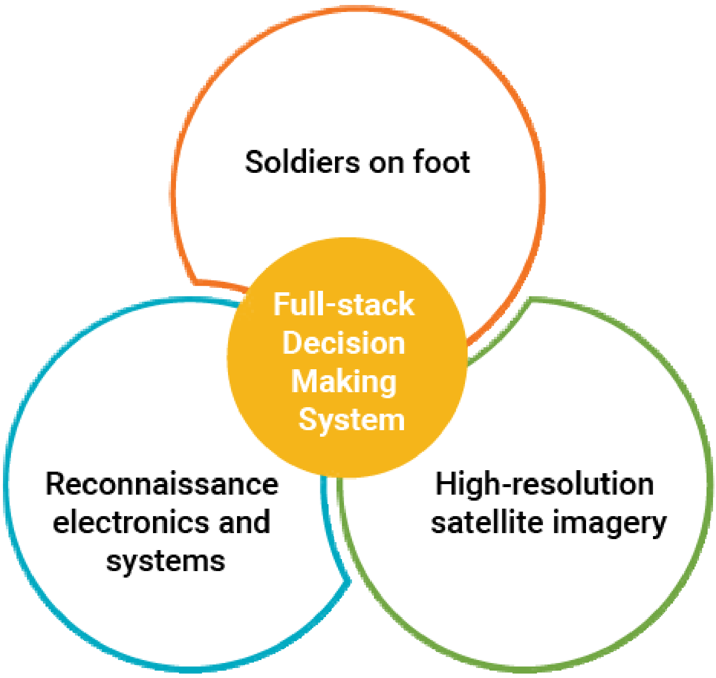
The advent of aerial photography during World War I made reconnaissance the most widely used application. It allowed forces to gather and interpret information about their enemies and locations. However, despite the availability of information, the conversion of data into actionable insight remained a significant obstacle, which hindered the decision-making process.

During World War II, scientists addressed this issue by providing Defence forces with radar, sonar, and infrared detection systems to track their enemies better. These systems provided more comprehensive information, including more characteristics and parameters of enemies and objects.

Since then, there have been two critical developments in imaging from space. First, the development of sensors and cameras that provide high-resolution images. Second, improving image processing capabilities allows the extraction of multiple parameters.

While satellite imagery is a valuable tool for Defence forces, it does not tell you the ground story. It must be integrated with an existing communication system to enable faster decision-making processes and effective Defence resource management.

In India, one of the most critical tasks for the Defence force is to maintain and monitor suspicious activities along the 15,200 km of land border and 7,500 km of coastline. Integrating a communication system with imagery intelligence in this space can enable forces to operate more efficiently and effectively. By combining satellite imagery with real-time communication, Defence forces can quickly respond to threats and take appropriate action.

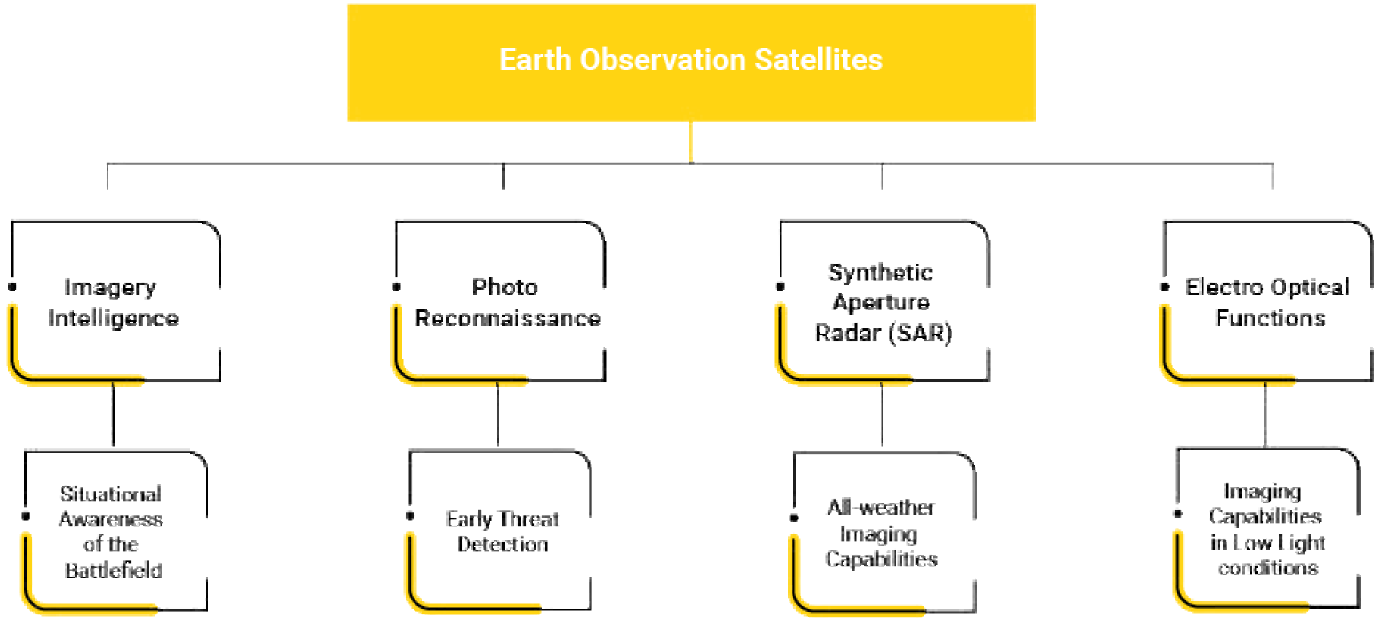


While India boasts a robust communication system on the ground, it needs a strong Earth Observation Satellite fleet and data processing infrastructure simultaneously.

IMPORTANCE AND THE NEED FOR THE EARTH OBSERVATION SATELLITE (EOS) SYSTEM IN ORBIT

Today, access to information has become more integral than ever amid the ongoing Russia-Ukraine war. Where the forces still rely on modern communication channels, satellite communication and imagery have enhanced the forces' capabilities on the ground to be two steps ahead.

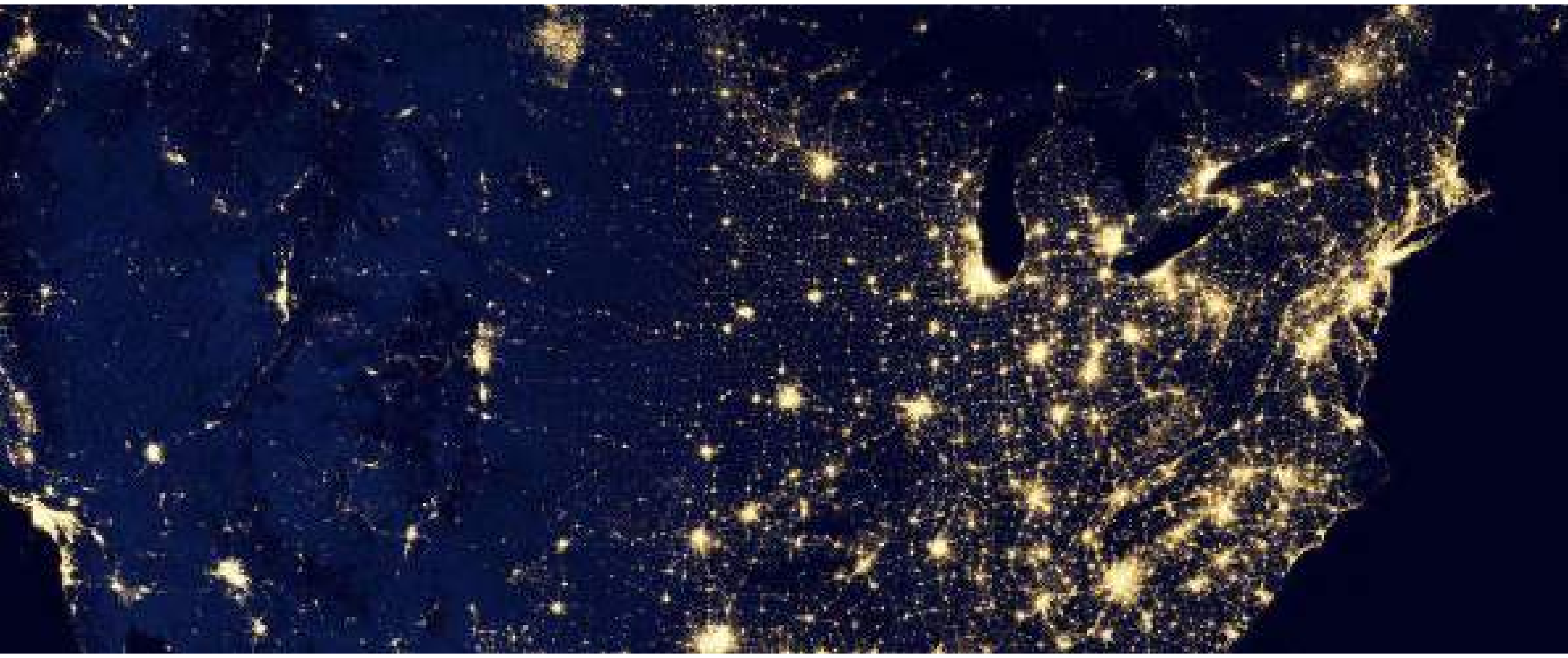
In contrast, specific stakeholders in the West and Asian region have developed and deployed large fleets of EO satellites between 100 - 400[1]. These fleets have given the countries an edge over other states to strengthen their borders and national security.



[1] https://www.pixalytics.com/earth-observation-satellites-2022/

Amid the ongoing conflicts and potential threats from India's adversaries, it is crucial for the Indian Defence forces to address the situation. While reconnaissance drones and aircraft can provide valuable images, their range is limited to small regions and territorial airspaces. Moreover, these systems can easily be detected by the enemy's advanced surveillance satellites in orbit, putting them at risk of being shot down, jammed and more recently being hijacked through cyber attacks.

For example, the Gaofen series, which consists of 32 high-resolution satellites under the China High-resolution Earth Observation System program, gives neighboring nations an edge over India in building and planning military strategies. Therefore, it is essential for India to invest in advanced satellite technologies and Earth Observation Systems to stay ahead of its adversaries and maintain its national security.



INDIAN ASSETS FOR DEFENCE AND ITS CAPABILITIES AND IMPACT.

According to government sources, India currently has a total of 53 operational satellites in space, with 21 of them being communication satellites, eight being navigation satellites, 21 being Earth observation satellites, and three being science satellites. Additionally, some of these satellites are dedicated to assisting the armed forces. Below are a few examples of these assets:

Satellite Name	Launch Year	Type	Capabilities
RISAT-1	2012	SAR Satellite	All-weather, day-and-night imaging capabilities for military and civilian applications. **Resolution**: 1-meters
RESOURCE-SAT-2A	2016	Remote Sensing Satellite	Multispectral images for various applications, including land use, environmental monitoring, and natural resource management. **Resolution**: 56 meters in the visible and near-infrared bands. 23.5 meters in the shortwave infrared band.
RISAT-2B	2019	SAR Satellite	High-Resolution images for various applications, including surveillance and reconnaissance. **Resolution**: 0.5 meters

CARTOSAT-3	2019	Remote Sensing Satellite	High-Resolution images for various applications. **Resolution**: 0.25 meters
EOS-01	2020	Remote Sensing Satellite	Multispectral and Hyperspectral images for various applications, including agriculture, forestry, and disaster management. **Resolution**: 10 meters

Lacking sufficient revisit and agility to image the sensitive zones around the 1500 km border line on the Eastern and Western front, the armed forces rely on external sources to have persistent IMINT capability. It could impact the decision-making process of the Indian Armed Forces, resulting in reduced **situational awareness.**

Extensive fleets of high-resolution satellite imagery not only help the decision makers make accurate decisions and unite the nation's three commands, the Navy, Air Force, and Army. The satellite imagery directed directly to the three commands enables each battalion to understand the position and movement of the enemy across the three zones, land, water, and air.

Accurate EO data is the need of the hour, which is critical for effective military operations, including reconnaissance and surveillance, targeting, and battle damage assessment. Today, the Indian armed forces could use a indigenous solution in bolstering the link among the three commands.

◯ WHAT DO WE NEED

Today, India stands fourth on the global stage when it comes to having best Earth Observation satellites in terms of number of satellites, resolution and application areas. Despite the fact, activities such as infiltration at the borders or stationing enemy arsenals go unnoticed due to limited coverage, seasonal visibility, low resolution, and limited revisit times.

The Indian armed forces need a high-resolution satellite constellation that can assist in monitoring the borders and Indian coastlines. To address this requirement, India currently relies on various foreign satellite operators to fill the gap and purchase satellite imagery for military and intelligence purposes with limited indigenous provision.

However, this approach does not address the issue thoroughly, as it places the onus on India to demand images to nullify suspicions about potential activities at the borders. It is then, the images are procured and then processed to identify and investigate suspicious activity. During this not so timely process, the theatre of war may not hold steady, hence reducing the efficacy of the intelligence.

Therefore, India must develop a platform to process high-quality EO satellite data and seamlessly communicate with the armed forces in actionable intelligence. This requires integration and data analysis, which is essential to exploit the potential of space capabilities fully. Today, advanced 'AI on Edge technology allows for the automated processing of images in orbit through AI, processing images into actionable intelligence to a great degree.

The high-quality EO satellite data is similar to crude oil, which needs further stages of processing and refining to be valuable. Developing such capabilities is critical to strengthening India's border and national security.

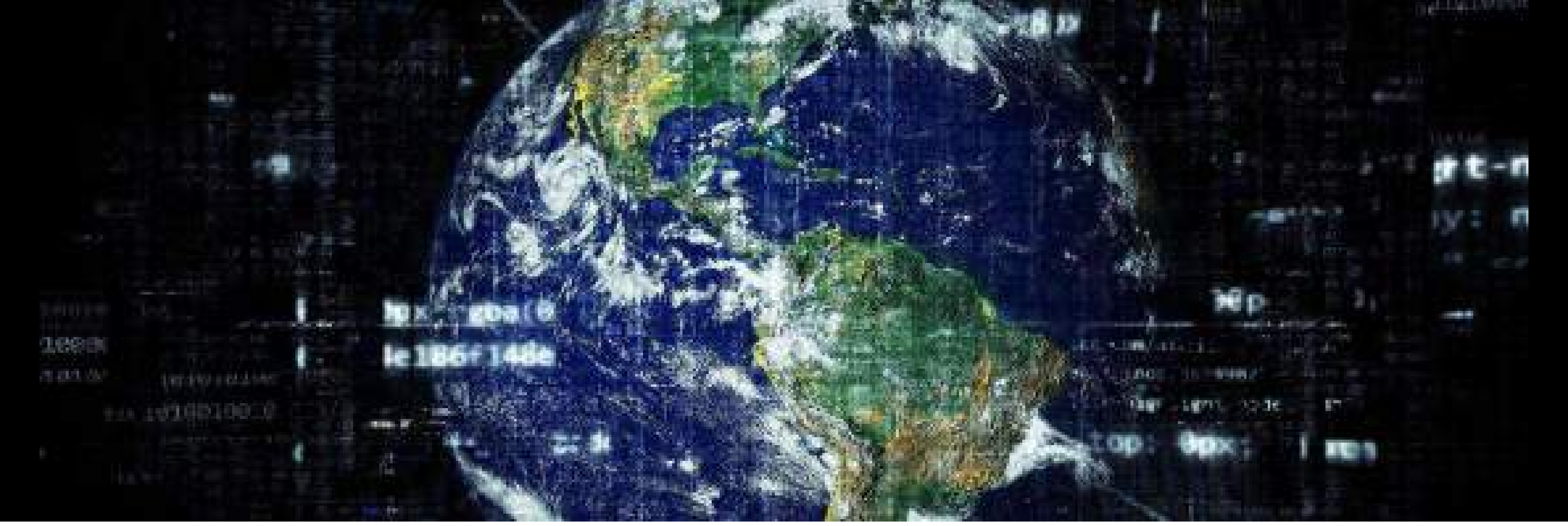
In the pursuit of developing indigenous capabilities, India can also look at its pool of stakeholders in the space sector. While the state agencies work round the clock for national security, the private sector can not only assist the agencies but also compliment their overall efforts. This can be done through innovative solution and technology, human capital, and new methodologies to approach a certain problem.

To enable this approach, it has to begin with creating domain awareness, where the needs and requirements would be mentioned clearly.

○ POLICY AND FINANCING

The procurements and policies in India have taken a massive turn towards supporting the private ecosystem, further evolution is necessary to keep up with the global pace. The announcement of Indian Space Policy '23 has been a welcome step in this regard. It is prudent to accept that India is resource constrained and its needs are better served through optimization of capabilities and capacities . Presently, the efforts by private entities lack the desired scale and sophistication to serve the IMINT community. While various non-government bodies enter into the sector, it would better supported by a top-down policy clarity and regulatory framework. The deep-seated bureaucratic and technocratic mindset that is suspicious of new commercial activity and sceptical of private entities competence can give way to increased interdependence in capability development and innovation. Owing to the sensitivity of the sector, a path to indigenisation is the key to accessing better technology and achieving scales. As a sensitive sector, it is always wise to steer clear of export challenges and IPR restrictions.

The current model of financing relies on various grants and awards through DIO and iDEX. While the seed amounts may appear substantive, the space hardware ecosystem is expensive and even more so from the perspective of a resource strapped startup or MSME. It is only logical to ask for a review of the NCNC procurement policies that are sector specific. The answer could lie among clusterisation of requirements to pool prize money or incentivizing JVs and collaborations to access higher amounts. In the same breath, the L1 procurement needs to be revamped. Constant and recurring engagements to vye for sometimes the only customer, depletes the resources of cash strapped startups. It is therefore a suggestion to look for a longer engagement period with the startup industry as well as (pseudo) assured orders. L1 also forces the companies to cut costs in terms of imports, indirectly benefiting adversaries as we take steps towards reaching on-par technical standing, globally.



THE WAY AHEAD

Putting Data Management and Processing into Perspective

There are two aspects to the decision-making process in Defence: information from satellite imagery and decision intelligence from imagery. While India has plenty of images from different providers, there is a significant gap in data management, analytics, and interpretation.

The gap exists between the provider (satellite) and receiver (armed forces). To address this gap, there is a need for a geospatial data refinery in India for the armed forces, which can be integrated with the existing data management system.

India procures images for Defence from various image providers with different systems and sensors capturing the images. These images fall under the following categories:

The data management refinery can resolve certain things such as:

- High- and moderate-resolution optical
- Very high resolution (VHR) optical
- Synthetic Aperture Radar (SAR)
- Spectral (HSI, TIR, GHG)
- Weather (GNSSRO/R, etc.)

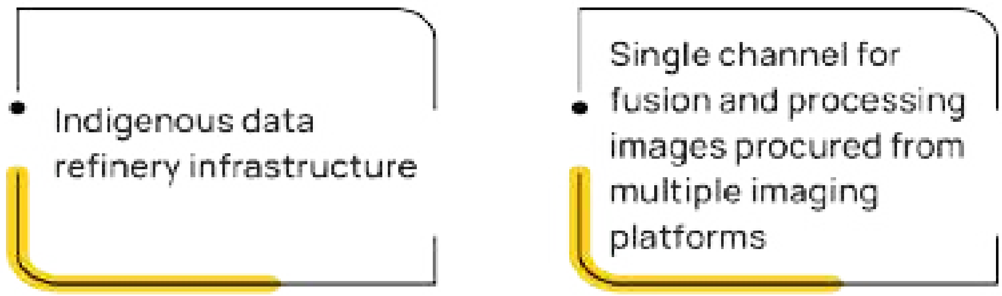
All these images provide two aspects to Defence forces: **topographic information** and **topography characteristics.** Both are derived from the fusion of optical and radar data sets. For instance, optical data imaging provides the actual color of the regions captured, such as vegetation mapping.

Radar data, on the other hand, assists the Defence forces during cloudy and night skies as it can look through the clouds and offer day or night imaging through most atmospheric conditions.

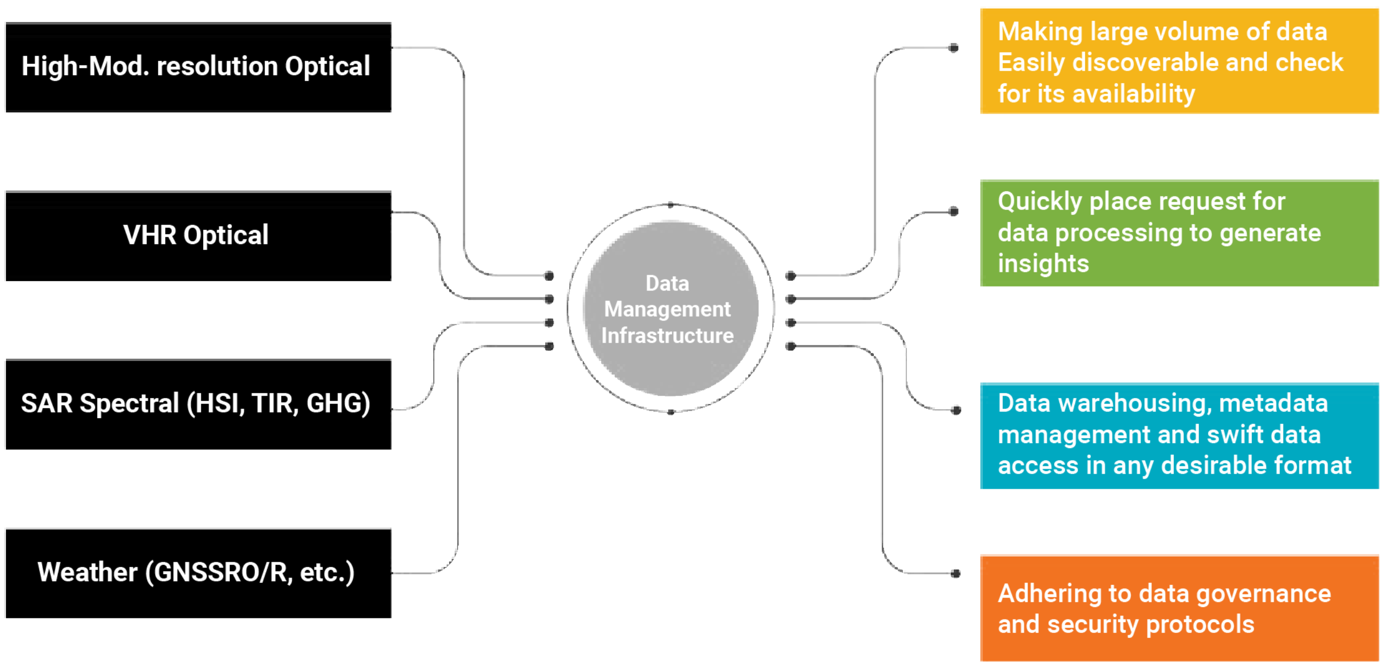
Besides, the capability of radar sensors to respond to surface texture allows for small objects to be detected using lower-resolution datasets with sufficient contrast.
To manage and process such data from different sources and configurations, the data management infrastructure needs a series of AI and ML algorithms to understand and present different data sets in a visualized format.

The output of such images and processes enables the Defence forces in the following areas:

In short, to turn the existing data sets available with the armed forces into actionable intelligence, India needs two things:



The proposed data management infrastructure will enable the armed forces to derive actionable insights from various image sources within a stipulated time frame. Additionally, the infrastructure would require minimal human intervention and enable efficient data consumption and utilization, leading to a quicker time-bound decision-making process.



DEPLOYING ON-BOARD PROCESSING IN ORBIT

The Western and Asian counterparts of India is far ahead in terms of their Earth Observation (EO) satellite fleets compared to India. These fleets of satellites enable sovereign states to enhance national security and protect their interests and assets across the globe.

However, despite India's adversaries having huge fleets of satellites, India does not necessarily need many satellites to protect its borders and enhance its national security. The number of space assets should align with the national interest, which is clear and laid out for India, that is, to secure its status of sovereignty.

India needs to combine the two aspects of the decision-making process: **large swath-high-resolution image capturing with image processing and analytics in orbit.** This system will fill two gaps and assist India in building future space capabilities simultaneously.

India needs a two-step approach to progress toward building and maintaining assets in space.

In-orbit data processing assets - Update (or) retro fitment of the existing fleet of satellites

This system would be able to process images of different resolutions and characteristics through a single processing channel, which would help reduce the burden on the ground-based dataprocessing systems and infrastructure.

Additionally, such a system would enable faster delivery of processed images to the command centers, improving the decision-making process and enhancing national security.

However, it is important to note that developing such a system would require significant investments and resources and must be carefully planned and executed to ensure its success.

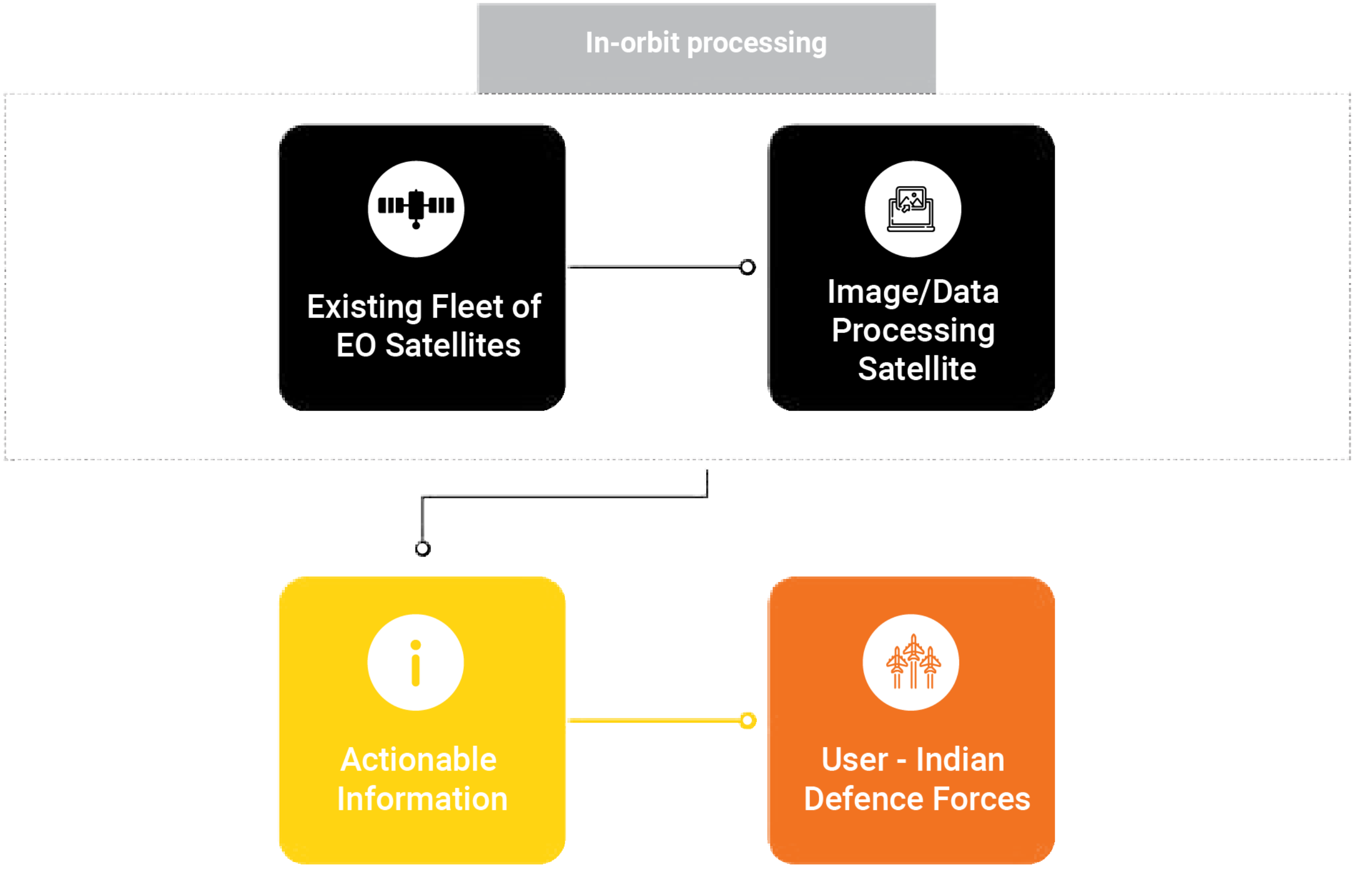
Building large-swath high-resolution with AI-on-edge processing satellites.

Complementing the existing fleet of satellites, India can develop a fleet of satellites with extensive swath capabilities beyond 50 km and the ability to capture images with a resolution of 2m.

Additionally, an onboard image processing unit would fast-track the decision-making process for the Indian armed forces. With a single image, the parameters and degree of information available would significantly help the armed forces manage international border security.

Moreover, these satellites can complement India's existing and upcoming fleet of satellites through the "**Tip and Cue**" method.

In case of any unusual activity is detected by a satellite, it can inform the government, which can deploy other satellites to position themselves on the specific coordinates to monitor the activity and inform the command center to take appropriate action.


In-orbit processing
Existing Fleet of EO Satellites
Image/Data Processing Satellite
Actionable Information
User - Indian Defence Forces

A SECURE FUTURE WITH UNCONVENTIONAL STRATEGIES

National security management and innovations:

A sovereign nation like India must understand the state and position of adversaries' technology. This enables the state to manage human capital and technology deployment and development.

Today, India has no shortage of technology or human capital. It needs indigenous support to turn the existing set of infinite information into actionable insight. With the proposed solution above, the Indian Defence forces could access quantified data sets and visual data sets, with critical parameters, from topographical conditions to the deployment and movement of adversaries across the border.

Furthermore, an active border alert system can be implemented by merging the visual data sets and active assets in the orbits that complement India's existing and upcoming assets. Any unusual activities within a certain distance of our border will be instantly recognized, and the command center will be informed. This system can also maintain internal and maritime security for the Indian armed forces.

○ GLOBAL IMPLICATIONS

India is applauded worldwide for diplomatic exercises and initiatives, such as providing aid to the earthquake that hit Turkey or providing vaccines to the world amid the pandemic. Besides, India also extends its Defence capabilities regarding innovation and troops to nations for national security. Countries have also shown trust in purchasing indigenous Defence solutions built by India.

This only paves the way for establishing that India has the potential to support states in their time of need. Now, with the innovation in space technology for the armed forces, India can leverage it to other nations if and when needed. The application can range from assisting countries in analyzing the damages aftermath of natural disasters like earthquakes, floods, or landslides.

With India's EO satellite fleet of large swaths and high-resolution, nations can fastrack and plan evacuation processes for any potential natural disaster or plan their resources well.

○ ABOUT SATSURE

SatSure is a deep tech decision intelligence company that uses satellite imagery-based data analytics to solve problems at the nexus of agriculture, infrastructure, and climate action by using advances in satellite remote sensing, machine learning, and big data analytics.

The company operates on a B2B and B2G model. It enables institutions to implement projects and processes for solving socio-economic and large-scale decision problems by providing organizations with a robust data infrastructure that enables transparency and symmetry, which is critical to handling large-scale operations.