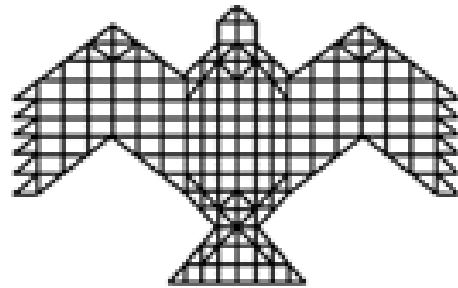


Space Situational Awareness: Indian Perspective

Mrunalini Deshpande

Senior Research Fellow

International Strategic and Security Studies Programme



National Institute of Advanced Studies




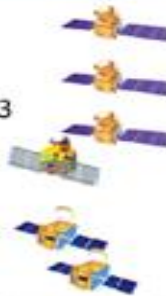







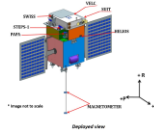
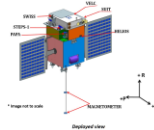





Need for SSA

- Space assets play an important role in enhancing national power and prestige
- More than 70 nations have invested in space and this number is likely to increase to more than 80 in the coming decade.
- The advent of private players and the growing importance of the commercial sector has rapidly transformed the use of space.
- The number of objects in space is increasing exponentially. Currently there are a total number of 19,432 objects on orbit of which only 2216 are active satellites
- LEO and GEO - crowded – SpaceX, OneWeb

India's assets in space

- Currently India has a total of 93 satellites on-orbit out of which 58 are active.
 - Communication Satellites (INSAT, GSAT)
 - Earth Observation Satellites (Cartosat, RISAT, IRS)
 - Navigation Satellites (GAGAN, IRNSS)
 - Small Satellites (Microsat, YOUTHSAT)
- Indian assets are mostly concentrated in LEO and GSO

SPACE MISSIONS 2016-2020

MISSIONS	2016-17	2017-18	2018-19	2019-20
EARTH OBSERVATION SATELLITES	CARTOSAT-2 Series1 CARTOSAT-2 Series2 SCATSAT-1 RESOURCESAT-2A INSAT-3DR 	CARTOSAT-2 Series3 CARTOSAT-2 Series4 MICROSAT 	CARTOSAT-3 OCEANSAT-3 RISAT-1A RISAT-2 Series 	RESOURCESAT-3S OCEANSAT-3A RESOURCESAT-3 CARTOSAT-3 Series HRSAT(3) GISAT-1 GISAT-Series 
COMMUNICATION & NAVIGATION SATELLITES <div style="border: 1px solid black; padding: 2px; display: inline-block;">Procured Launch Service</div>	IRNSS-1G  GSAT-18 	IRNSS-1H IRNSS-1I South Asia Satellite GSAT-6A GSAT-19 GSAT-17 	GSAT-29  GSAT-7 Series  GSAT-11 	GSAT-22 
SPACE SCIENCE & PLANETARY EXPLORATION SATELLITES			Chandrayaan-2 	ADITYA -L1 
TECHNOLOGY DEVELOPMENT LAUNCH VEHICLES  PSLV GSLV GSLV-MkIII	 RLV-TD SCRAMJET 5 Missions 1 Mission	 4 Missions 2 Missions 1 Mission	Includes one Commercial  5 Missions 2 Missions 1 Mission	Includes one Commercial  6 Missions 2 Missions 1 Mission

Threats to Space Assets

Natural

Space Weather

Impact of meteorites
and asteroids

Accidental

Collision (Satellites &
Debris)

Intentional

Jamming- GPS, radar &
communication satellites

Low and high altitude
ASAT weapons

Maneuverable Satellites

Directed Energy Weapons

Current SSA Requirements

- Debris tracking
- Collision avoidance
- Prediction of threats from asteroids and meteorites
- Monitoring threats from Space Weather and prediction of space weather conditions
- Satellite anomaly detection, attribution

Components of SSA

1

Data Collection

2

Data fusion

3

Analytics

4

Decision-making tools

Current SSA Capability

Collision Avoidance Analysis (COLA)

Performed prior to each Launch- identify possible threats during the ascent and orbital phase

Space Object Proximity Analysis (SOPA)

Collision probability computation

Space Debris Modelling

Re-entry predictions

India uses TLEs from NORAD to perform these functions

Space Debris Mitigation

India is an active member of the Inter- Agency Debris Coordination Committee (IADC)

- Re-entry test campaigns
- Orbital lifetime prediction
- Space debris modelling

Multi Object Tracking Radar



- Capable of tracking 10 objects up to a maximum range of 1000km – object size 0.25m²
- The radar operates in the L band between 1.3- 1.4 GHz and uses a phased array antenna. The antenna is physically stationary, while the beam is electronically steered.
- The radar can track different stages of launch vehicles simultaneously during nominal and non-nominal missions and can compute instantaneous impact points (IIPs) of the descending objects.
- Currently used for:
 - Space Debris Proximity analysis in powered and orbital phases during satellite launch
 - Re-entry prediction of debris
 - TLE Catalogue building

Optical Telescopes

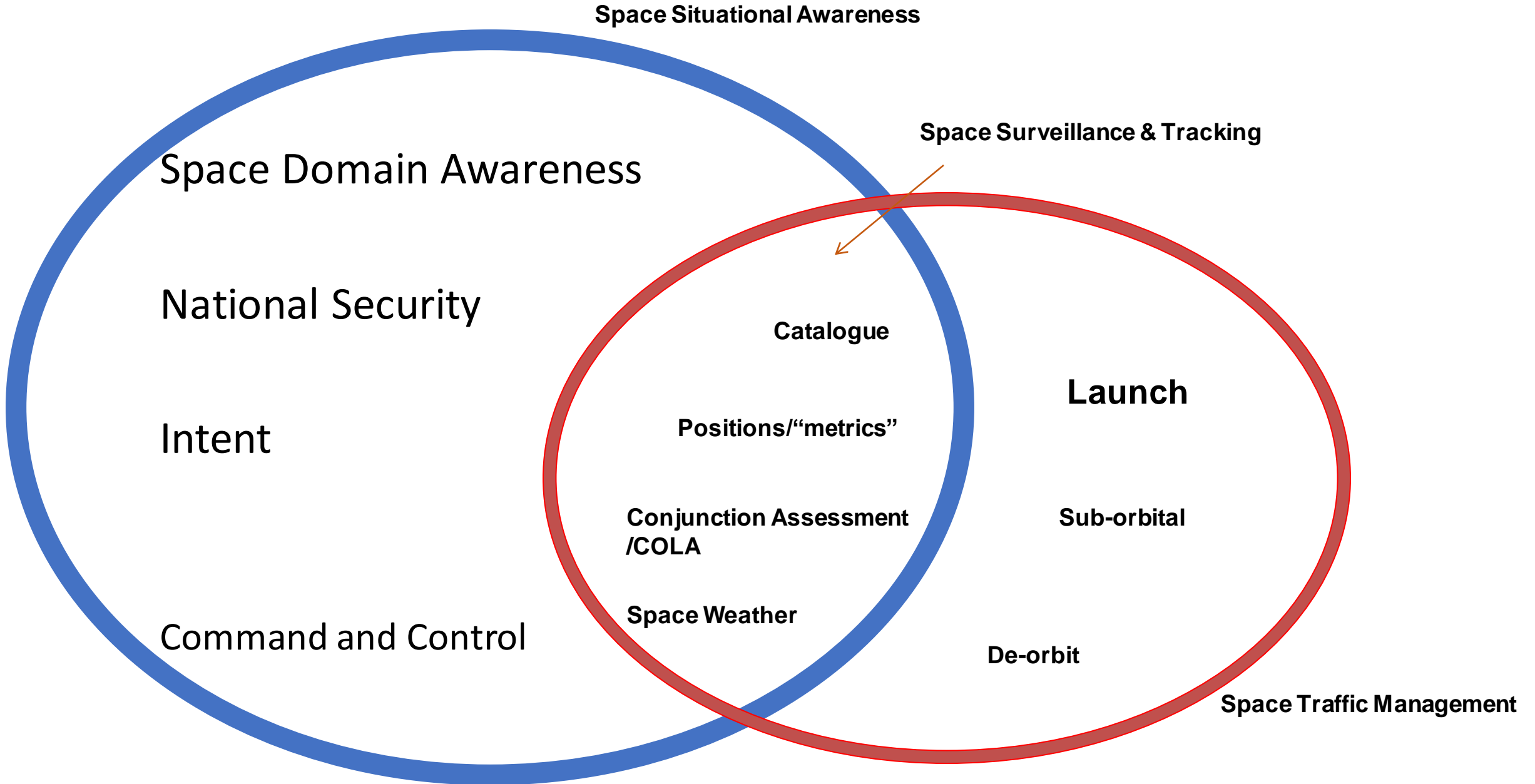
The Indian mainland hosts the following optical- infrared observatories:

- Vainu Bappu Observatory, Kavalur, IIA, Bangalore
- Girawali Observatory, IUCAA, Pune
- Gurushikhar Observatory, Mt Abu, PRL
- Nainital and Devasthal Observatories, ARIES (2450 m)
- Indian Astronomical Observatory, Hanle, IIA (4500 m)
- Global Relay of Observatories Watching Transients Happen (GROWTH)

- 
- A few of the telescopes from these observatories have been used to track satellites.
 - The Himalayan Chandra Telescope (Hanle) has been used for tracking navigation satellites of India.
 - The 1.3 m telescope at ARIES Devasthal Observatory and the 1.3m telescope at the Vainu Bappu Observatory were used to successfully track and image the GSAT- 6A Indian satellite.

Space Weather

- The Aditya L1 mission to be launched in 2019 will help in understanding the impact of space weather and assessing near-earth space conditions
 - Comprehensive solar observatory in space located at Lagrange point L1
- There is no coordinated effort to look at Space Weather alongside SSA at present



Need

Combination of dedicated ground based and space based sensors

Harnessing the capabilities of Amateur Astronomer community in India for catalogue building

Augment Current SSA capabilities through co-operation and collaboration

- Formal Data Sharing Agreements with U.S, Russia
- Network of sensors in Southern Hemisphere- Japan-Australia-India