



*Promoting Cooperative Solutions for Space Sustainability*

# **The Importance of Space Situational Awareness (SSA) For ADR and OOS**

Brian Weeden

Technical Advisor

Secure World Foundation

- Space situational awareness (SSA) is information about the space environment and activities in space that can be used to:
  - Operate safely and efficiently
  - Avoid physical and electromagnetic interference
  - Detect, characterize and protect against threats
  - Understand the evolution of the space environment
  - Provide awareness and transparency of space operations

# SSA in the context of ADR and OOS

- Entities performing ADR or OOS activities will need a high degree of SSA to be successful
  - Determining which debris objects to remove and precise tracking to enable interaction (docking, lasing, etc)
  - Finding and locating servicing clients, rendezvous operations
- However, SSA requirements go beyond that needed for actual operations
  - How do you convince other space actors that your ADR/OOS activities are being conducted safely?
  - How do you convince other space actors that your ADR/OOS activities are not hostile or malicious?
- Can current SSA capabilities deliver these needs?



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# SSA NOW

“Civilian”

- Metric Data (Catalog)
  - Locations of objects in space and the ability to predict where objects were in the past and will be in the future
- Space Weather
  - Measurement, warning, and forecasting of the effects of Solar activity on objects in orbit
- Object Status
  - Health, telemetry, planned maneuvers (usually provided by owner/operator)

“Military”

- Intelligence
  - Information about objects in orbit (images, signals, capabilities, behavior) collected on objects in orbit

# Historical context for SSA

- “Space Surveillance” was born during the Cold War as part of protecting the US and USSR from nuclear attacks
  - Nuclear threat progressed from airplanes to ballistic missiles (and satellites)
  - Space used for strategic warning, intelligence, & treaty verification
  - Two super powers controlled virtually all aspects of space
- SSA capabilities reflected these priorities
  - Emphasis on survivability and reliability
    - Everything revolved around possibility of nuclear war
    - Only take data from sources we can absolutely trust
  - Focus on military and national security customers
  - Data “silos” within certain government organizations

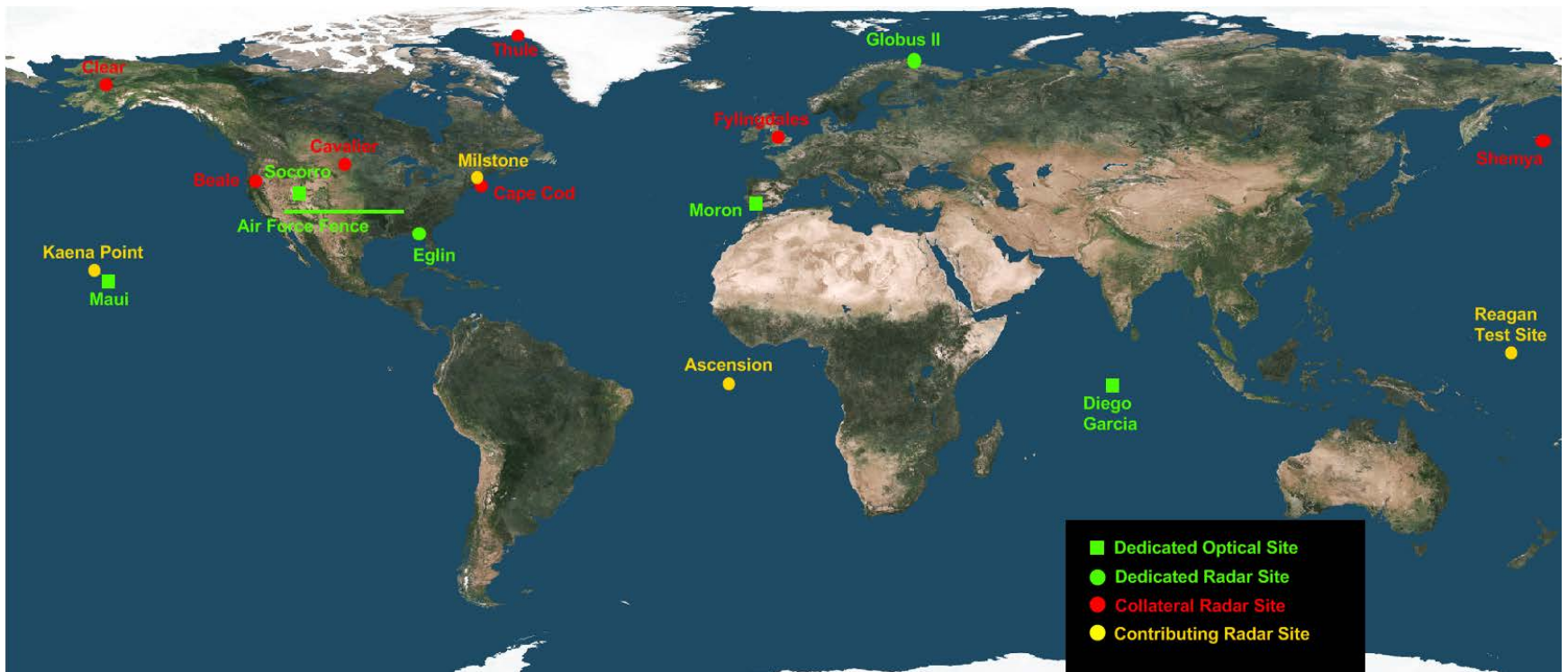
- Today's world is vastly different from 50 years ago
  - 12 countries have demonstrated indigenous space launch capability (Iran, North Korea, and South Korea are the newest)
  - Over 70 entities operate about 1,060 active satellites
  - 15,000+ pieces of tracked space debris (>10cm), 500,000 pieces untracked (1cm to 10 cm)
  - Private sector now makes up significant portion of space activity
- SSA mindset and capabilities have not kept up
  - Still done primarily for military/national security purposes by the military
  - Bureaucracy/security needs have hampered upgrades and modernization, particularly for computer hardware/software and algorithms

# Current capabilities - USA

- United States military has the best set of SSA capabilities, although not ideal
  - Operates global network of 30+ ground based radars and optical telescopes, plus a satellite in orbit
  - Maintains the most complete satellite catalog of 16,000+ space objects
  - Data fed to Joint Space Operations Center (JSpOC) in California
  - Provides a range of data and services for US government, satellite operators, and public
- Limitations
  - Primary customer is US military
  - Antiquated hardware and software
  - No real coverage in Southern Hemisphere



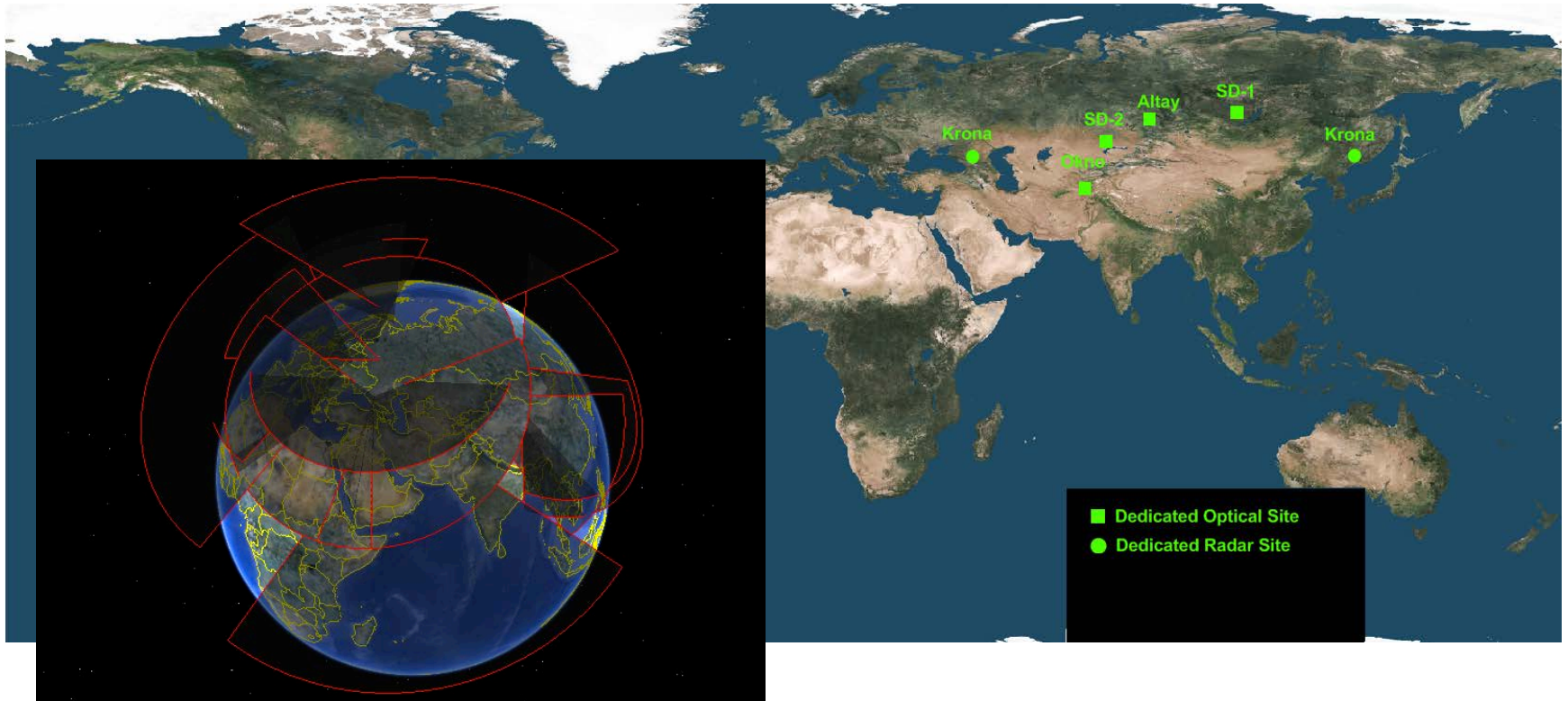
# US Space Surveillance Network



# Current capabilities - Russia

- Russian military has the second best set of SSA capabilities
  - Operates network of ground based radars and optical telescopes across much of former Soviet Union (FSU)
  - Maintains a good catalog of low Earth orbit (LEO) space objects and geosynchronous Earth objects (GEO) space objects over Asia
  - Data largely not made available to those outside the Russian military
  - Roscosmos also has some specialized analysis capabilities to protect human spaceflight
- Limitations
  - Russian military rarely shares data with anyone else
  - Very antiquated hardware and software
  - Limited funds for upgrades
  - No coverage outside of FSU territory

# Russian Space Surveillance System



Missile Warning Radar Coverage  
(Podvig, 2012)

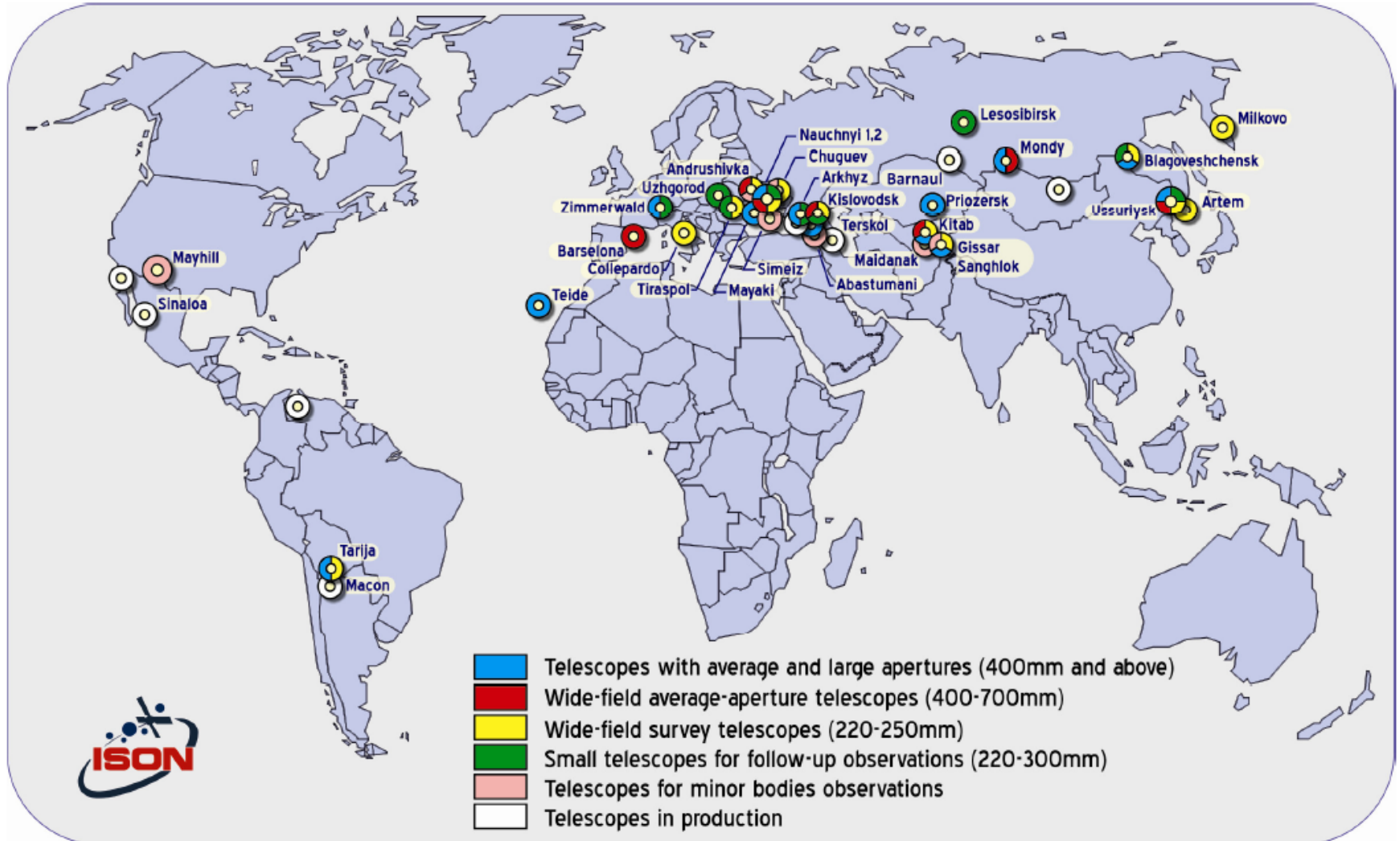
# Current capabilities - Europe

- Europe doesn't currently have an SSA system, but several countries have their own limited capabilities
  - France, Germany, UK, Italy, Switzerland each have a few ground-based radars or optical telescopes
  - Some bilateral data sharing agreements between European countries and/or the US and Russia
  - Maintain catalog that is a combination the public US catalog with other sources
- Limitations
  - Coverage only over Europe and limited sensor throughput
  - Face significant policy challenges in increasing data sharing
  - Limited funding at the European level

# Current capabilities – non-state

- Space Data Association (SDA)
  - Not-for-profit entity created by major commercial satellite operators
  - Purpose: “facilitate the controlled, reliable, and efficient sharing of SSA data to improve the safety of satellite operations”
  - Provides members services to support conjunction analysis (CA), collision avoidance (COLA) & radio frequency interference (RFI) detection
- International Scientific Optical Network (ISON)
  - Collection of international scientific telescopes to provide data for scientific analysis, coordinated by the Russian Academy of Sciences
  - 30 telescopes, 20 observatories, 10 countries
  - Excellent deep space catalog
- “Amateur” Observers

# ISON Current Status





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# Not so “amateur”





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# THE FUTURE OF SSA



# SSA is inherently international

- “Good” SSA requires a *geographically distributed* network of both radar and optical sensors and *combining sensor observations with owner-operator data*
- Theoretically, building the sensor network can be done unilaterally
  - Large economic cost
  - Need “friends in the right places”, basing agreements
  - Long logistical tails
- Every space actor needs a certain level of SSA for safe and efficient space activities, but few have the resources to build a complete network
  - Many actors can make partial contributions

# A potential goldmine of SSA sensors



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## SEARCH FOR SSA SENSORS

215 SENSORS FOUND

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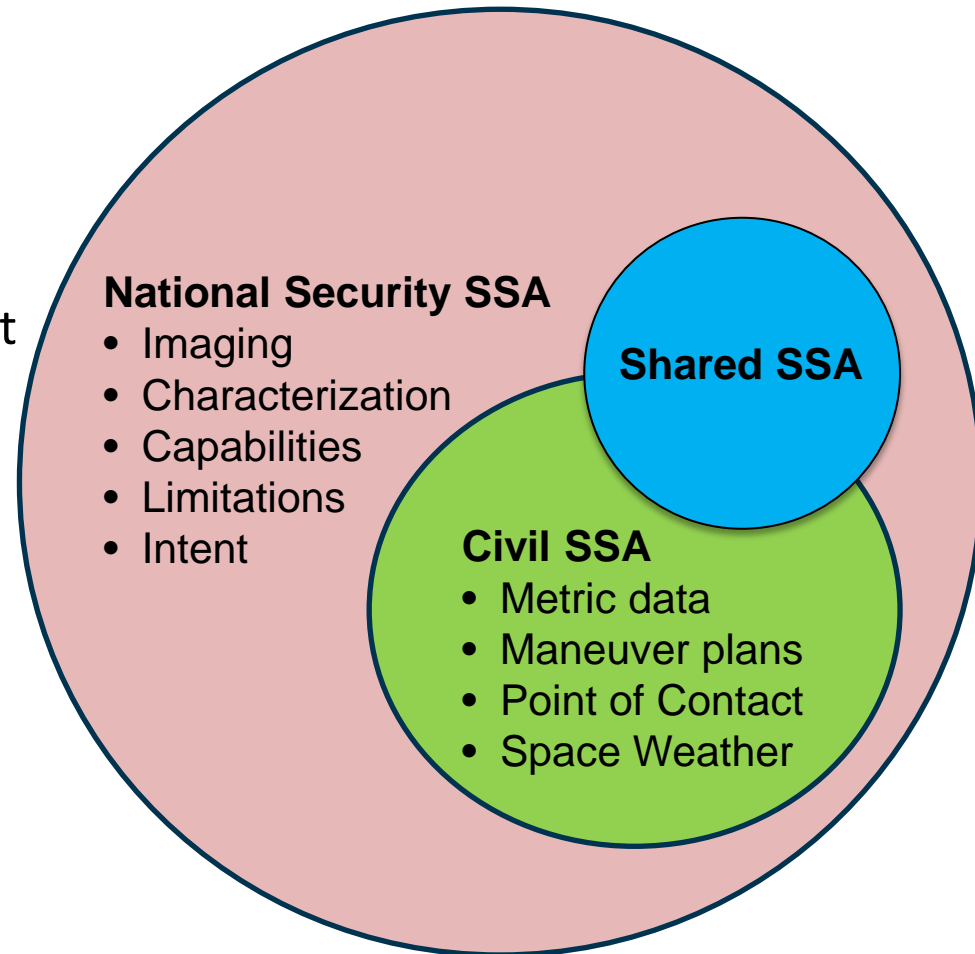


SENSOR(S) DETAILS

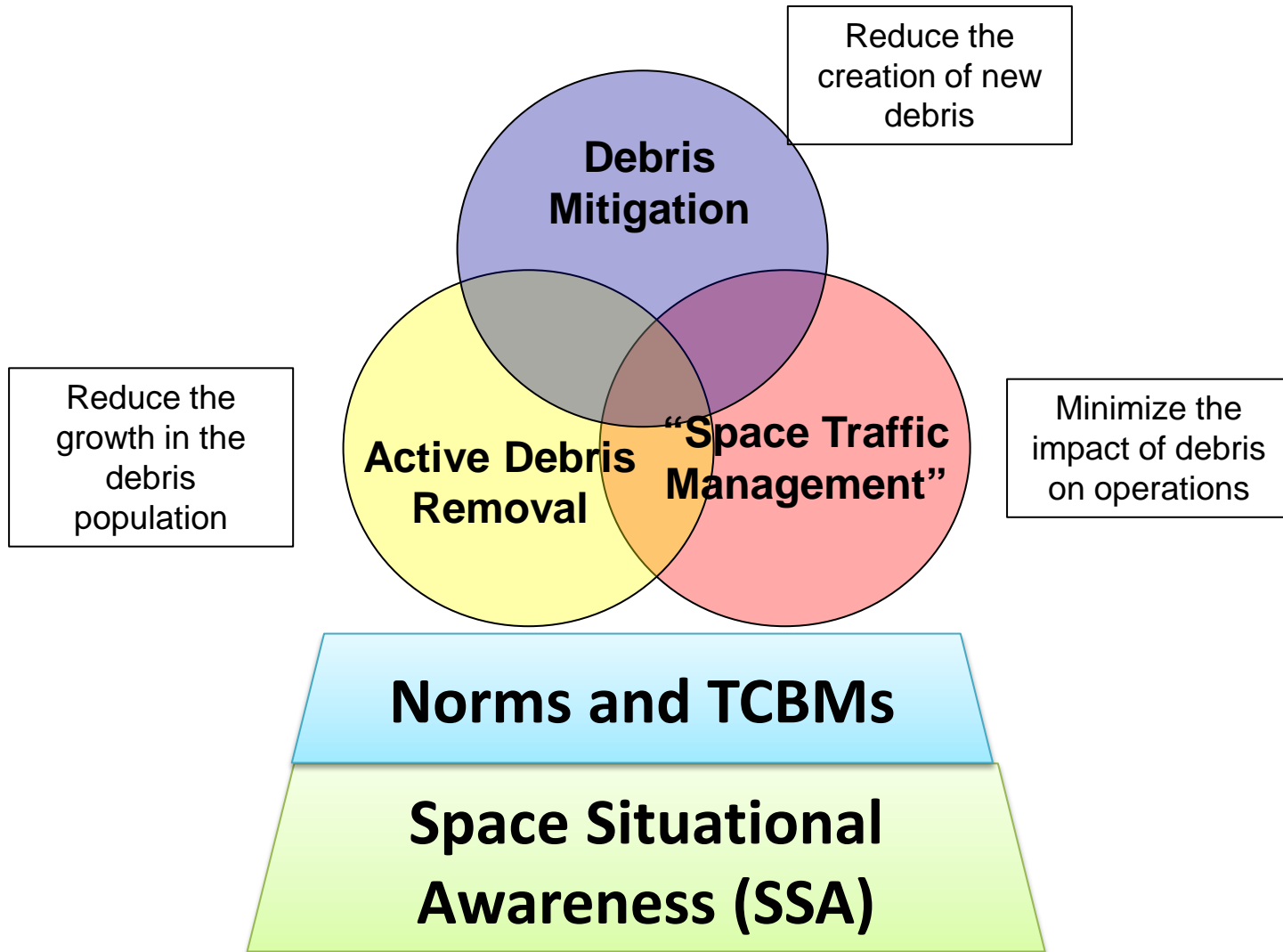
CLICK ON A SENSOR FROM THE MAP ABOVE TO VIEW ITS DETAILS

- It is impractical for a single actor to achieve “good” SSA by themselves
- Fundamentally, SSA requires data sharing and cooperation between different actors
  - Networks of telescopes and radars distributed around the globe to track debris
  - Satellite owner/operators with telemetry, health, and planned maneuvers
- Multiple independent sources of SSA data are good
  - Greater accuracy and redundancy
  - Independent monitoring and validation

- Core set of SSA services to support all users
  - Maintain catalog of space objects
  - Conjunction assessment warnings
- Specialized capabilities to support national security
  - Threat assessment
  - Determining object capabilities
- Sharing on multiple levels
  - Sharing between allies
  - Sharing between gov'ts and commercial
  - Sharing publicly



# Space sustainability realized





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# Thank You Questions?

[bweeden@swfound.org](mailto:bweeden@swfound.org)