The Importance of Space Situational Awareness and the Potential Role for Japan to Contribute

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What is SSA?

- 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

What's in orbit now?

Active Satellites

Satellite Quick Facts			
Total number of operating satellites: 1167			
LEO: 605	MEO: 77	Elliptical: 38	GEO: 447
United States: 502	Russia: 118	China: 116	
Total number of U.S. Satellites: 502			
Civil: 20	Commercial: 210	Government: 120	Military: 152

includes launches through 1/31/2014

Union of Concerned Scientists Satellite Database

Space Debris

Larger than 10 cm	~22,000	Sources of new debris
Between 1 and 10 cm	~500,000	Can cause major damage
Smaller than 1 cm	Lots	Can cause minor damage

David Wright, Scientificamerican.com

Significant recent events

- 2007 Chinese anti-satellite test
  - Destroyed one of their own weather satellites at 850 km altitude, created > 3,000 pieces of debris larger than 10cm
- 2008 Destruction of USA 193
  - Modified SM-3 missile defense interceptor fired from U.S. Aegis cruiser b/c satellite posed a "threat" to people on the ground
- 2009 Iridium-Cosmos satellite collision
  - U.S. Iridium 33 satellite collided with Russian Cosmos 2251 at 800 km altitude, destroyed both & created > 2,000 pieces of debris
- 2010 Galaxy 15 "Zombiesat"
  - Commercial communication satellite in GEO stopped responding to ground commands, drifted through belt with payload still active
- 2013 Test of new Chinese ASAT booster that could reach "nearly to GEO"

Elements of SSA

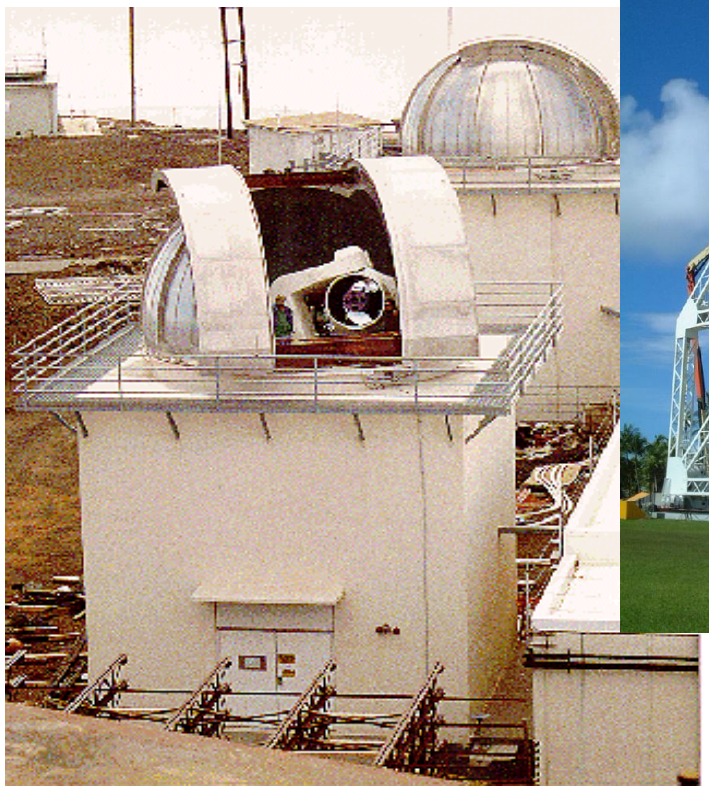
"Civilian"

- Metric Data (Catalog)
  - Data on space objects' orbits and trajectories that allows for predictions of 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
- Space Object Status
  - Health, telemetry, planned maneuvers (usually provided by owner/operator)

"Military"

- Intelligence
  - Characterization of objects in orbit (shape, design, capabilities, weaknesses)
  - Assessment of behavior, intentions, and potential threats

Typical ground-based SSA sensors



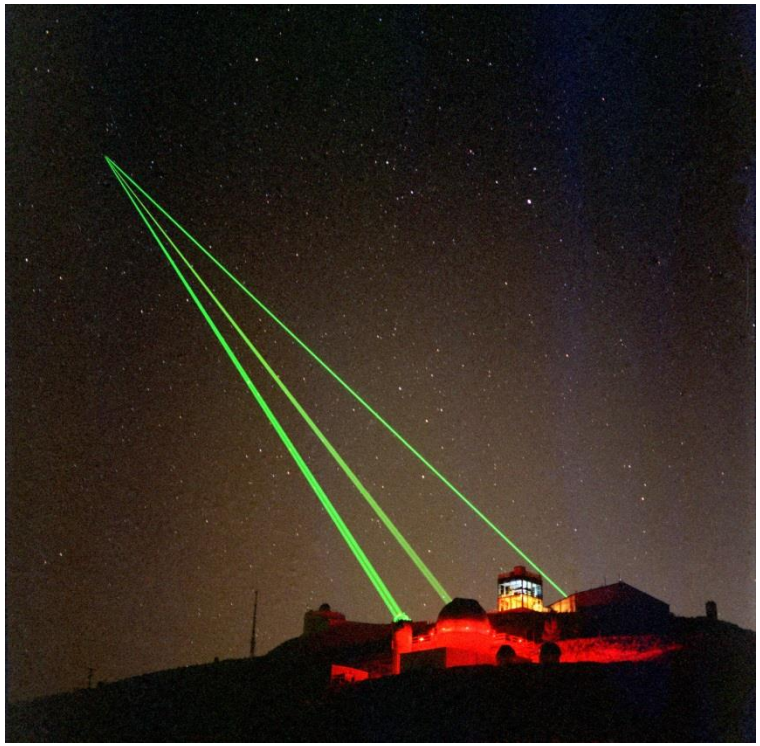
GEODSS

ALTAIR

RAF Fylingdales

Lasers for SSA

- Ground-based lasers used to get precise ranging of space objects
  - International Satellite Laser Ranging Service
  - EOS Space Systems in Australia
- Ground-based lasers used for adaptive optics
  - Laser "guide star" used to remove atmospheric distortion
  - Used by many observatories



Starfire Optical Range, New Mexico

Space-based space surveillance

U.S. Space-Based Space Surveillance (SBSS) Satellite

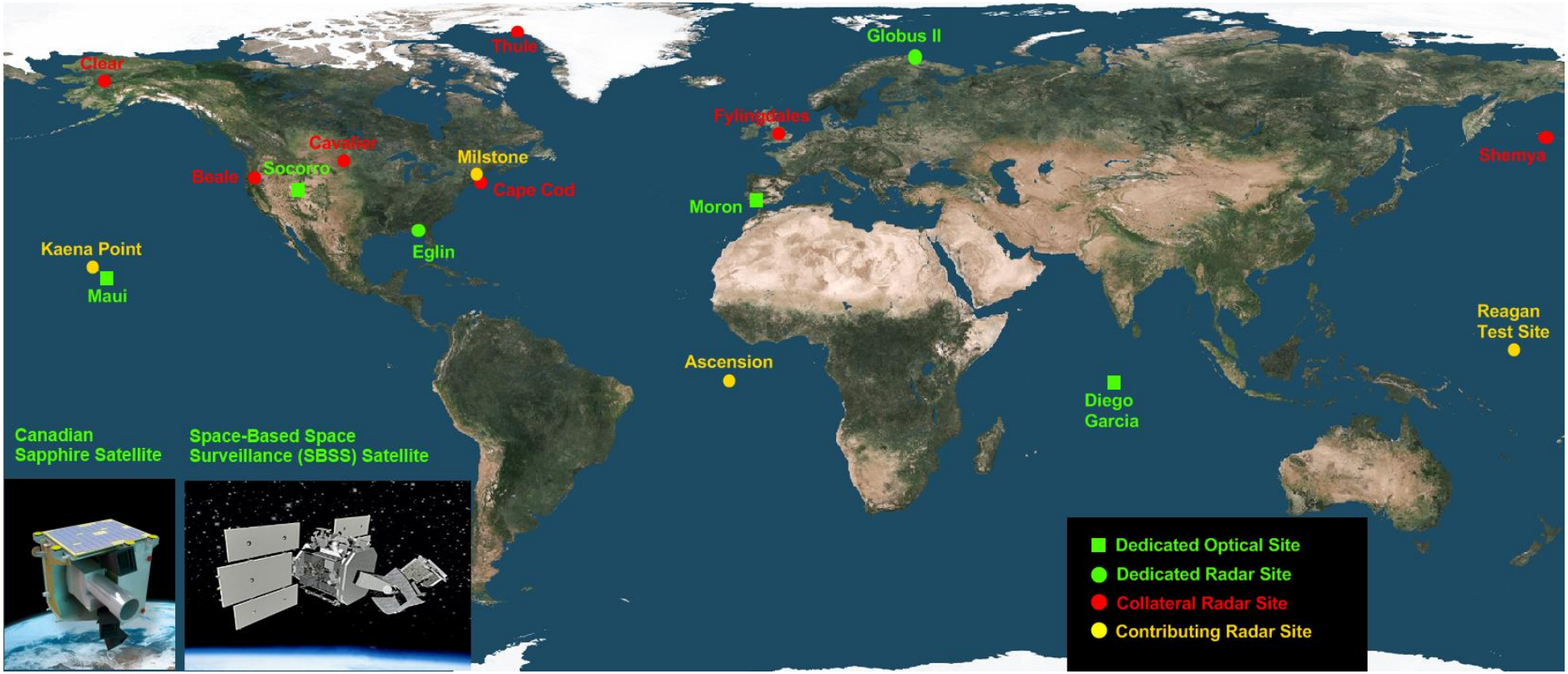
Canadian Sapphire Satellite

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 2 satellites in orbit
  - Maintains the most complete tracking database of 23,000+ space objects bigger than 10 cm
  - 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
  - Outdated hardware and software
  - Very little coverage in the Southern Hemisphere or Asia, Africa, and South America

US Space Surveillance Network



Planned U.S. upgrades to SSA

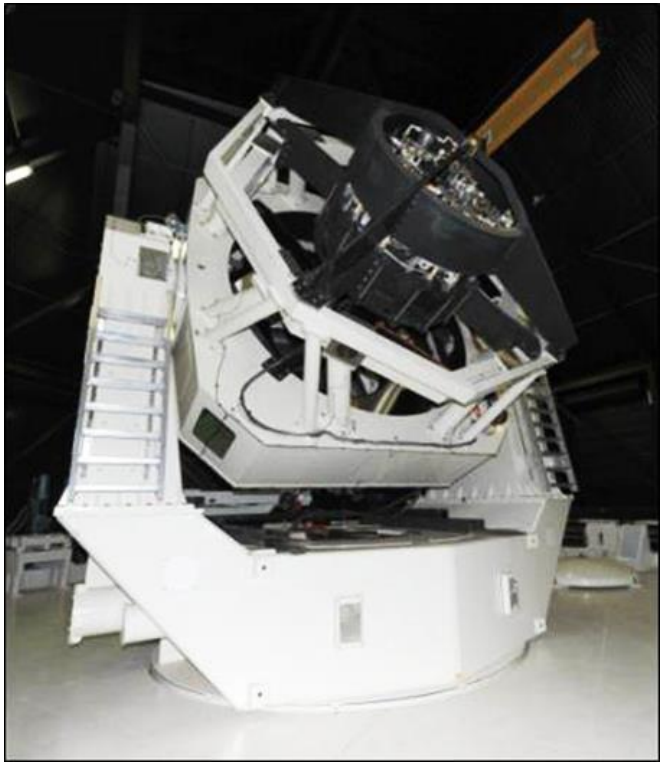
- $1B contract award for S-Band Space Fence
  - Located on Kwajalein Atoll
  - Track objects as small as 5 cm at altitudes of up to 40,000 km
  - Expected to have initial operating capacity in 2019

- Moving two existing sensors to northwestern Australia
  - C-Band radar from Antigua
  - Space Surveillance Telescope (SST) from New Mexico

- Revealed existence of previously classified Geosynchronous SSA (GSSA) program
  - 2 pairs of satellites orbiting near GEO to do close-up inspection of satellites

Sensors being moved to Australia

Antiqua Tracking Radar



Space Surveillance Telescope

Emerging private sector SSA capabilities

- Space Data Association (SDA)
  - Not-for-profit entity created by major commercial satellite operators
  - Membership includes 27 satellite operators controlling 350+ satellites
  - Members provide data on the locations of their own satellites
  - SDA provides members services to support conjunction analysis (CA), collision avoidance (COLA) & radio frequency interference (RFI) detection

- Analytical Graphics, Inc.'s Commercial Space Operations Center (ComSpOC)
  - Negotiating contracts with dozens of radars, telescopes, & RF sensors around the globe
  - Use proprietary software to create SSA products from the sensor data
  - Plan to offer subscription SSA services

U.S. Security Space Strategy

"Space, a domain that no nation owns but on which all rely, is becoming ***increasingly congested, contested, and competitive***"
– 2011 National Security Space Strategy

Five Pillars:

1. Develop and promote ***norms of responsible behavior*** in space
2. Increase the ***resilience*** of U.S. national security space capabilities
3. ***Partner*** with like-minded nations and private sector entities
4. ***Deter aggression*** against U.S. space systems
5. ***Defeat attacks*** & prepare to ***operate in a degraded environment***

SSA plays a role in all five of these pillars

U.S. policy on space security

- The U.S. is in the middle of a significant shift in policy on its approach to space security
  - Old: unilateral approach with U.S. buying/operating a full spectrum of capabilities and giving allies access (***politically-driven partnerships***)
  - New: cooperative approach with U.S. focusing on core capabilities and getting rest from allies/commercial industry (***capability-driven partnerships***)
- Drivers of this fundamental shift
  - Declining defense budgets and fiscal pressure
  - Inability to protect traditional space architecture against threats
  - Increased focus on national security uses of space by other countries
  - Commoditization of technology leading to explosion of private sector incentives, interest, and innovation

"4-Eyes" space cooperation agreement

- Schriever 2010 war game exercised a Combined Space Operations Center (CSpOC) involving the U.S., allies, & commercial partners
- Negotiations between the "4-Eyes" (U.S., U.K., Canada, and Australia) on developing a real-world version of the concept
- Early 2014 they signed a MOU on Combined Space Operations (CSpO)
  - Each country will operate their own national space operations center
  - Some level of communication/coordination between the national centers
- Second "circle of trust" for CSpO might expand to France, Germany, and Japan in the near future

Options for U.S. Allies to contribute

1. ***Geographic or political specialty***
   - Access to critical geographic locations for basing sensors
   - Political insight into or connections with specific countries or regions of interest to the U.S.
   - Regional leader or coordinator
2. ***Indigenous capability or industrial base expertise*** in a specific area complementary to U.S. capabilities
   - Have developed (or are willing to develop) and operate a capability that adds value to what the U.S. already has, fills in gaps in their capability, or adds resilience
3. Willingness to ***buy into joint space programs*** with the U.S. and other allies
   - Wideband Global Satcom (WGS) model
   - Canadian Radarsat Constellation Mission (RCM)

Current Allied Capabilities

- Australia
  - Geographic location (Southern Hemisphere)
  - Strong economic and diplomatic ties to Asia
  - Existing "special relationship" on intelligence
- Canada
  - Geographic location (North Pole)
  - Niche capabilities in robotics, radar satellites, on-orbit SSA, maritime domain awareness, polar domain awareness (future)
- United Kingdom
  - Geographic location (close to Russia)
  - Existing "special relationship" on intelligence
- France/Germany
  - Niche capabilities in ground-based radar tracking sensors, radar imaging satellites

Options for Japan

- Geographic location
  - Fill in coverage gap (Asia) in existing U.S. SSA capabilities
  - Crucial for monitoring activities of China, North Korea
- Contribute independent Japanese capabilities
  - Is there a specific national capability Japan has or can procure that is complementary to U.S./allied capabilities?
  - Can Japanese industry offer a commercial service or contribute to one?
- Buy into development of U.S./allied capabilities
  - Is the U.S. or its allies procuring a capability that Japan can buy into?
  - Bluestone? (Sapphire follow-on)
- Central "hub" of SSA cooperation for Asia-Pacific
  - Can Japan become the hub for SSA data sharing between Asia-Pacific partners?

Challenges

- Overcoming the civil-military divide and organizational politics
  - Missile Defense vs. Space Surveillance / SSA
  - Balance between transparency/data sharing and protecting national security
  - No country has yet figured this out
- Developing operational expertise and experience
- Acquiring the hardware/software to process and utilize SSA data
  - Buy into the U.S. military's JSpOC Mission System (JMS), purchase a commercial solution, or develop your own?
- Overcoming residual U.S. reluctance to partner on space security issues

Main challenges are organizational/political, not technological

Thank You
Questions?

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