

Fact Sheet

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Summary

Space situational awareness (SSA) is broadly defined as characterizing the space environment and its effects on activities in space. SSA combines positional information on the locations of objects in Earth orbit using optical telescopes and radars, commonly known as space surveillance, with information on space weather. Military and intelligence SSA applications also includes characterization of objects in space and their capabilities, limitations, and intent.

SSA is an inherently international and cooperative venture: it requires a network of globally distributed sensors and data sharing between satellite owner-operators and sensor networks. SSA also forms the foundation of space sustainability as it enables safe and efficient decision making and operations, and promotes stability by reducing mishaps, misperceptions, mistrust.

Types of SSA Sensors

Radars form the backbone of an SSA system. Radar consists of at least one transmitter and receiver. The transmitter emits radio waves at a specific frequency; some of these waves reflect off the target and are measured by the receiver, which is then able to calculate location of the target in relation to the radar. The primary advantages of radars are that they can actively measure the range and range rate to a target, and that some types of radars can accurately track many objects at once. The main disadvantages of radars are their cost, size, and complexity.

Optical telescopes form the second major type of sensor used to track space objects. They operate in the same fashion as telescopes used for astronomy applications: electromagnetic (EM) radiation emitted by an object is gathered and focused to form an image using lenses, mirrors, or a combination of the two. Although telescopes can be designed for many different parts of the EM spectrum, the visible portion is most often used for SSA. The main advantage of optical telescopes for SSA is their range and ability to cover large areas quickly. Above 5,000 km (3,100 miles) altitude, it becomes very time consuming and difficult for radars to search for objects. Optical telescopes can perform this function much faster and easier. The main disadvantage of optical telescopes is that they require specific lighting conditions and clear skies.

Other types of sensors can be used for SSA, including sensors that detect electronic signals from satellites, lasers to measure distance very accurately, infrared sensors that detect heat, telescopes which take pictures of satellites, and specialized radars that can create three-dimensional maps of space objects.

Space weather is primarily caused by the interaction of charged particles emitted by the Sun and the Earth's magnetic field.¹ Spacecraft located in orbit between the Earth and Sun can provide early warning of solar storms and charged particles heading for the Earth.²

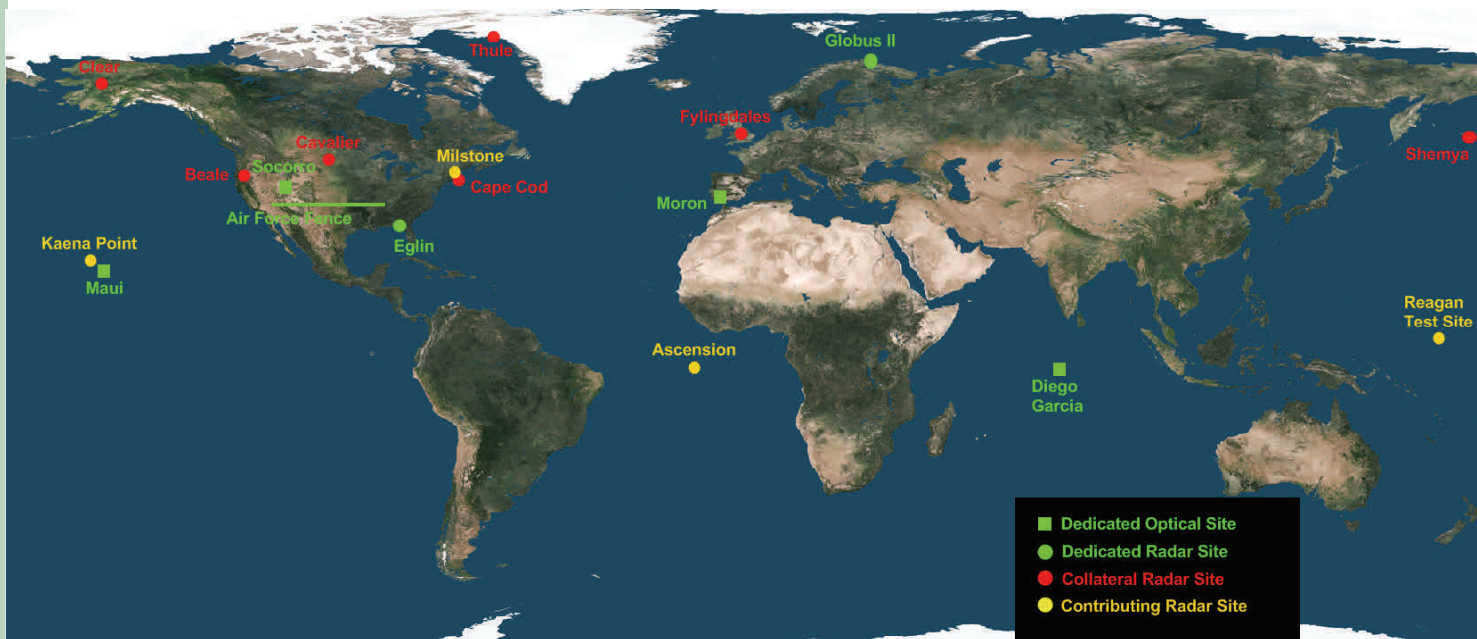


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Global SSA Capabilities

The United States operates the largest network of sensors and maintains the most complete catalog of space objects, although there are gaps in its coverage and catalog. The U.S. system is known as the Space Surveillance Network (SSN) and is managed by the military.³ It consists primarily of phased array radars primarily used for missile warning and optical telescopes, along with a few mechanical tracking radars and a large space fence located along the southern United States. The U.S. military also operates a space-based tracking telescope onboard the Space-Based Space Surveillance (SBSS) satellite.⁴ The SSN has little to no coverage in the Southern Hemisphere or in South America, Africa, and Asia.



The U.S. Space Surveillance Network

Observations of space objects from SSN sensors flow to the central command and control center called the Joint Space Operations Center (JSpOC), located Vandenberg Air Force Base in California.⁵ Operators combine these observations to produce an element set for each tracked space object which describes its position in space. The JSpOC maintains a satellite catalog of all the known element sets and uses this to perform a variety of analyses to support commercial and civil spaceflight safety along with military and intelligence applications.

Russia operates the second largest network of sensors and also maintains a good catalog space objects. The Russian system is known as the Space Surveillance System (SSS) and also consists mostly of phased array radars used primarily for missile warning, along with some dedicated radars and optical telescopes.⁶ Several of the SSS sensors are located in former Soviet republics and are operated by Russia under a series of bilateral agreements with the host countries.⁶



*Russian missile warning radars*⁶



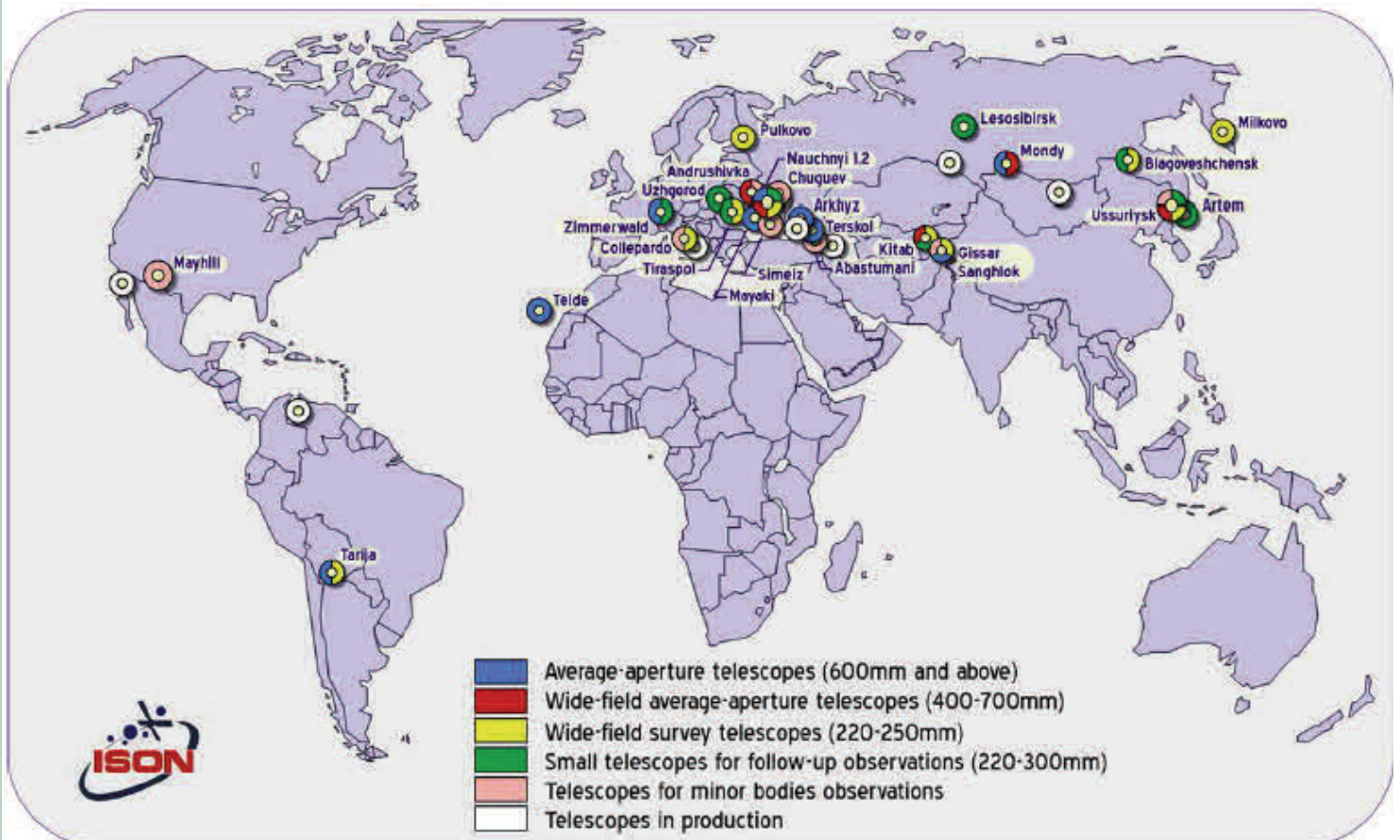
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Europe does not currently possess an integrated SSA network, although several individual countries in Europe operate some significant individual sensors. The United Kingdom, France, Germany, and Norway operate tracking radars, and several countries operate optical telescopes of varying capabilities.

In 2008, Europe initiated an SSA Preparatory Programme to begin the process of creating a future European SSN system.⁷ The Preparatory Programme will develop plans, architectures, and policies to provide space surveillance of Earth orbit, space weather prediction and warning, and tracking and identification of hazardous Near-Earth Objects such as asteroids. Future initiatives will develop plans for imaging capabilities.

The International Scientific Optical Network (ISON) is a partnership of scientific and academic institutions around the world organized by the Russian Academy of Sciences in Moscow. ISON consists of 23 observatories in 11 countries which operate more than 30 telescopes that are used for space surveillance.⁸ ISON is a heterogeneous mix of telescopes of various sizes and capabilities, but as a network it can track a wide range of object sizes throughout deep space and provide a significant number of observations.



There are also many **amateur satellite observers** around the globe that use telescopes, binoculars, and other equipment to track satellites. Some have the capability to image satellites or detect radiofrequency transmissions.⁹ Although they are only loosely organized through the Internet, the amateur observing community presents a non-trivial SSA capability. In particular, they have demonstrated the ability to routinely track classified national security payloads from several countries, including the American X-37B.¹⁰



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The Space Data Association

In October 2009, three of the leading commercial satellite operators formed the Space Data Association (SDA), a not-for-profit entity based in the Isle of Man.¹¹ The purpose of the SDA is to collate data provided by participating satellite operators on the locations of their satellites with other external sources and to provide warning of potential collisions or radiofrequency interference (RFI).

The SDA chose Analytical Graphics, Inc. (AGI) as its lead contractor in April 2010.¹² AGI established initial operating capability in August 2010 and achieved full operations capability in September 2011.¹³ These plans include establishing three data centers, one each in North America, Europe, and Asia, to provide backup and redundancy. The SDA is also in negotiation with the U.S. government and other SSA providers on potential data sharing agreements.

The Importance of SSA

SSA is critical to space activities and the long-term sustainability of space. It provides knowledge about what is happening in space, and in particular Earth orbit. This knowledge provides understanding of the space environment, including space debris and space weather, which could damage satellites or disrupt satellite services. SSA helps owner-operators protect their satellites, including human-crewed spacecraft, from these and other threats.

SSA also provides awareness of the potential negative impacts of certain activities in space, such as explosions and collisions, and their potential to degrade the long-term utility of space. This awareness can be used to develop best practices and procedures to help avoid accidents or unintentional activities that can harm the space environment.

At the national level, SSA is used by many States to help protect satellites and space capabilities that are critical to national security, including space-based reconnaissance, imagery, weather, early warning, communications, and precision navigation and timing. SSA can also be used for offensive activities in space, including the targeting of satellites with anti-satellite (ASAT) weapons and using temporary, reversible means such as jamming.

SSA also contributes to international security and stability. It can provide assurance that all space actors are operating in space in accordance with established norms and guidelines, and can also serve as the foundation for verification regimes for agreements. SSA provides a level of transparency about activities in space and can help prevent mishaps, misperceptions, and mistrust that could lead to conflict in space or on Earth.

Footnotes

1. "A Primer on Space Weather", National Oceanic and Atmospheric Administration website: <http://www.swpc.noaa.gov/primer/primer.html>
2. "SOHO's Orbit", Solar and Heliospheric Observatory Homepage: <http://sohowww.nascom.nasa.gov/about/orbit.html>
3. "Space Surveillance", Air University, United States Air Force: <http://www.au.af.mil/au/awc/awcgate/usspc-fs/space.htm>
4. Justin Ray, "Space Surveillance Project Successfully Blasts Off", Spaceflight Now, Sept 26, 2010: <http://spaceflightnow.com/minotaur/sbss/>
5. "14th Air Force", U.S. Air Force Fact Sheet: http://www.vandenberg.af.mil/library/factsheets/factsheet_print.asp?fsID=4684&page=1
6. Pavel Podvig, "Reducing the Risk of an Accidental Launch", *Science and Global Security*, Vol 14, pp. 75-115, 2006.
7. "SSA Preparatory Programme", European Space Agency website, 5 December, 2008: http://www.esa.int/esaMI/Operations/SEMDPU322OF_0.html
8. Igor Molotov, "Optical Tracking of Space Debris: Overview of ISON's Capabilities and Future Plans", Igor Molotov, presentation at the 2011 Beijing Space Sustainability Conference, Beijing, China, 13-14 October, 2011.
9. John Schwartz, "Satellite Spotters Glimpse Secrets, and Tell Them", New York Times, February 5, 2008: <http://www.nytimes.com/2008/02/05/science/space/05spotters.html>
10. William Broad, "Surveillance Suspected as Spacecraft's Main Role", New York Times, May 22, 2010: <http://www.nytimes.com/2010/05/23/science/space/23secret.html>
11. Peter de Selding, "Satellite Operators Solicit Bids to Create Orbital Database", Space News, November 18, 2009: http://www.spacenews.com/satellite_telecom/091118-satellite-firms-moving-ahead-orbital-database.html
12. "Space Data Association Selects Analytical Graphics, Inc. to Design and Operate its Space Data Center", Satellite Spotlight, April 14, 2010: <http://satellite.tmcnet.com/news/2010/04/13/4725646.htm>
13. "Space Data Center Attains Full Operational Capability Status", Space Data Association Press Release, September 20, 2011.