Space Situational Awareness Fact Sheet

Updated May 2017

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Introduction

Space situational awareness (SSA) is the ability to accurately characterize the space environment and activities in space. Civil SSA combines positional information on the trajectory of objects in orbit (mainly using optical telescopes and radars) with information on space weather. Military and national security SSA applications also include characterizing objects in space, their capabilities and limitations, and potential threats.

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

Types of SSA Sensors

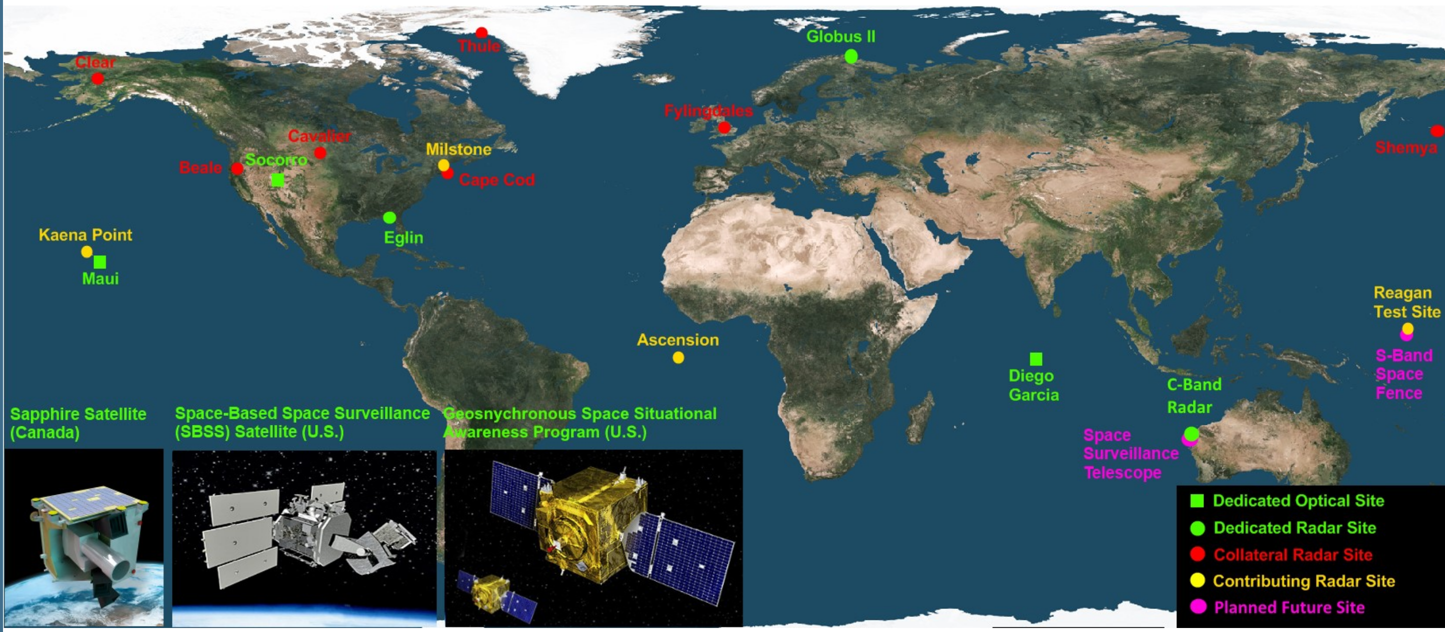
Ground-based radars have historically been the backbone of SSA. Radar consists of at least one transmitter and receiver. The transmitter emits radio waves at a specific frequency, some of which reflect off the target and are measured by the receiver, which can then calculate the location of the target in relation to the radar. The primary advantages of radars are that they can actively measure the distance to a target and some types of radars can accurately track many objects at once. Some radars can also detect the motion of an object and construct a representation of its shape. The main disadvantages of radars are their cost, size, and complexity.

Optical telescopes are also widely used for SSA. Telescopes collect light or other electromagnetic (EM) radiation emitted or reflected by an object and focused into an image using lenses, mirrors, or a combination of the two. The main advantages of using optical telescopes for SSA is their ability to cover large areas quickly and, in particular, to track objects above 5,000 km (3,100 mi) altitude. Some telescopes can create high resolution images of space objects. The main disadvantage of optical telescopes is that they require specific lighting conditions and clear skies to see an object, although space-based optical telescopes eliminate some of these limitations.

Other types of sensors can be used for SSA, including sensors that detect radio frequency (RF) or other types of signals from satellites, lasers that measure the distance or range to a satellite very accurately, and infrared sensors that detect heat. Combining data from many different types of sensors, both ground- and space-based, that are also distributed around the globe provides a much more complete picture of the space environment and of activities in space.

Global SSA Capabilities and Initiatives

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.[1] 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. There are also two space-based tracking telescopes as part of the SSN, the U.S. Space-Based Space Surveillance (SBSS) satellite[2] and the Canadian Sapphire satellite.[3] The SSN historically has little to no coverage in the Southern Hemisphere or in South America, Africa, and Asia, but that is improving. In 2015, the U.S. military began moving an existing C-Band radar[4] and the Space Surveillance Telescope[5] to Australia to compensate for some of this gap. The U.S. military also began building a new S-Band Space Fence in the Marshall Islands, expected to be completed by 2019, to track much smaller objects than the existing SSN currently can.[6]



The U.S. Space Surveillance Network

Data from the SSN flows to the central command and control center called the Joint Space Operations Center (JSpOC), located at Vandenberg Air Force Base in California.[1] There, the 18th Space Control Squadron maintains a database of the orbital trajectories of more than 23,000 space objects, which is used to perform a variety of analyses to support commercial and civil spaceflight safety along with military and intelligence applications.[7] These services include providing conjunction assessment (CA) warnings to all satellite operators as part of the SSA Sharing Program.[8] The U.S. has negotiated a significant number of bilateral data sharing agreements with more than 50 individual satellite operators, eleven countries, and two international intergovernmental organizations.[9]

Russia operates the second-largest network of sensors and also maintains a relatively complete catalog of space objects. The Russian system is known as the Space Surveillance System (SSS), which also consists of phased array radars used primarily for missile warning, along with some dedicated radars and optical telescopes.[10] 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. Russia is also in the process of upgrading and modernizing its SSA capabilities with the Automated Space Danger Warning System (ASPOS) to track space debris and support national security.[11]

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 28 observatories in 16 countries that operate more than 90 telescopes used for space surveillance.[11] 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. In recent years, ISON has developed closer relationships with the Russian government, and currently provides conjunction analysis services for Roscosmos (the Russian space agency) and catalog services for the Vympel Corporation.[11]

Several individual **European countries** operate significant individual sensors. The United Kingdom, France, Germany, and Norway operate tracking radars, and several countries operate optical telescopes of varying capabilities. In 2008, the European Space Agency initiated an SSA Preparatory Programme to begin the process of creating a future European SSA system that combines data from multiple national sensors.[12] The programme includes three segments: space surveillance and tracking (SST), space weather monitoring and forecasting (SWE), and tracking and identification of hazardous near-Earth objects, such as asteroids (NEO). In early 2014, the European Union approved €70 million in funding for an operational SST effort to network existing European space surveillance assets with a central database.[13] ESA is continuing to work on developing concepts for future sensors through its own SST effort.

There are also many **amateur satellite observers** around the globe that use telescopes, binoculars, and other equipment to track satellites. Some amateurs have the capability to image satellites or detect radiofrequency transmissions.[14] 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 U.S. military's secretive X-37B.[15] The Defense Advanced Research Projects Agency (DARPA) has experimented with combining data from some amateur observers, along with academic and civil institutions, to improve existing SSA capabilities.[16]

LeoLab radar in Midland, TX.
ImageCredit: Techcrunch

Over the last few years, **the private sector** has begun developing its own SSA capabilities. The Space Data Association (SDA), a not-for-profit created by commercial satellite operators, uses data provided by members to provide enhanced conjunction assessment and radiofrequency interference (RFI) services.[17] Several commercial companies, such as ExoAnalytics and LeoLabs, are now offering commercial SSA data services from their own radars and telescopes,[18] and others such as Analytical Graphics, Inc. (AGI) and Applied Defense Solutions (ADS) have created their own operations centers to fuse data from multiple sources and provide commercial SSA services. These and other private sector SSA capabilities are improving rapidly and are likely to surpass those of the governments in the near future. Studies conducted in 2015 and 2016 examined the possibility of commercial companies providing SSA data and services to the U.S. government, including civil agencies.[19] In 2016, the U.S. Air Force awarded two small contracts for pilot commercial SSA programs.[20]

Role of SSA in Improving Space Sustainability and Security

SSA also plays a role in the ongoing political initiatives aimed at tackling space sustainability and security. Information exchange on space activities was cited by the recent **United Nations Group of Governmental Experts (GGE)** as an important transparency and confidence-building measure (TCBM) for space activities in their 2013 report.[21] The United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) is discussing improved SSA data sharing as part of its agenda item on Long-Term Sustainability of Outer Space Activities.[22] There is also a growing discussion at the national and international level about a related issue, space traffic management (STM).[23] Although there is no consensus definition, STM typically refers to operational, policy, and regulatory measures taken to minimize the impact of space debris and on-orbit congestion on space activities. Improved global SSA capabilities are a prerequisite to a future STM system, and verification of agreements, whatever form they take.

Endnotes

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