Space Situational Awareness

FACTSHEET

SECURE WORLD FOUNDATION

Promoting Cooperative Solutions for Space Security

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Overview

The United States Air Force Space Surveillance Network (SSN) is a critical foundation of US space operations. It is a network of sensors scattered across the globe which provide both tracking and identification data on objects in Earth orbit.

Mission

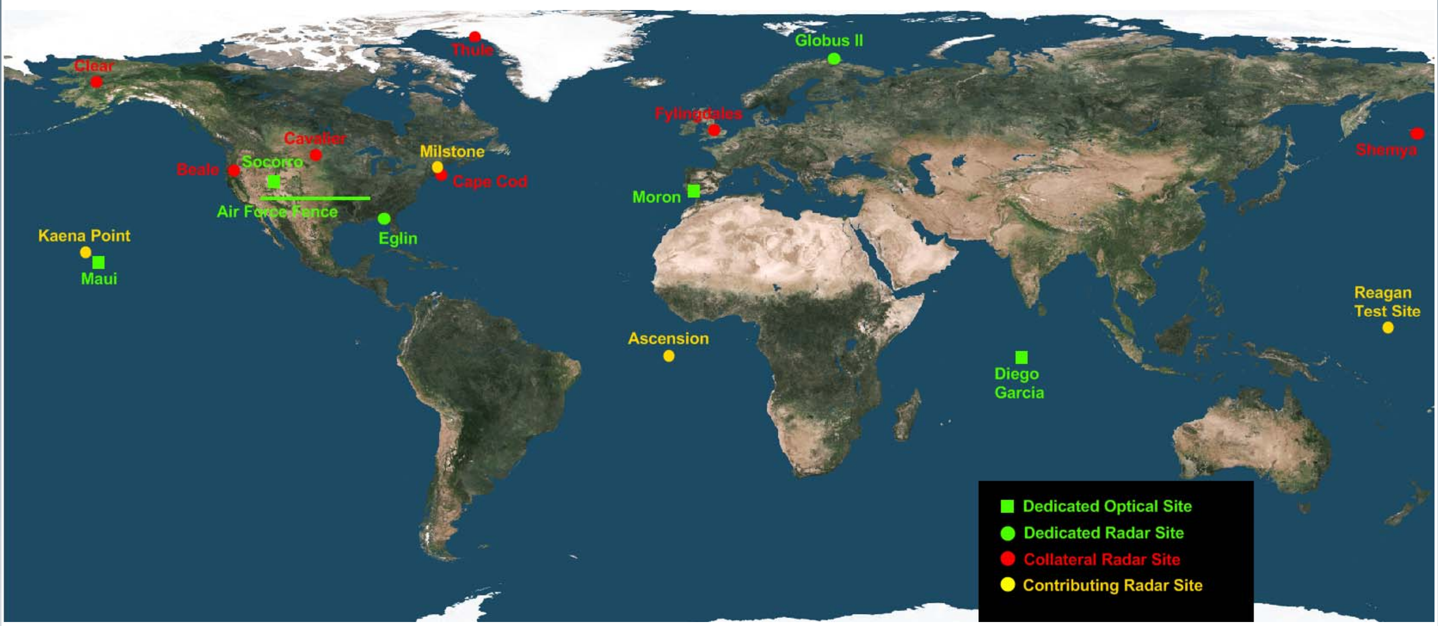
The SSN provides the information to the Joint Space Operations Center (JSPOC), which has the mission to detect, track, identify, and catalog all man-made objects in Earth orbit. Air Force Space Command (AFSPC) provides the personnel, training, maintenance, and long-term acquisitions for most of the SSN sites. Surveillance data from the sensors is routed to the JSpOC, located at Vandenberg, Air Force Base, California.

The JSpOC is part of United States Strategic Command (USSTRATCOM) and has operational command and control of the SSN. The JSpOC fuses the SSN data with other sources to provide Space Situational Awareness (SSA) for the US military and other customers. This SSA data is used to maintain the satellite catalog, predict atmospheric re-entry of space objects, catalog new launches, detect satellite maneuvers, and safeguard important satellites such as the International Space Station and Shuttle.

Components

The SSN is comprised of both radar and optical sensor sites spread across the Northern Hemisphere. These sensors are grouped into three main categories which signify mission and ownership.

- **Dedicated** - These are sensors whose primary mission is space surveillance and are owned by Air Force Space Command. Generally they are purpose-built for the space surveillance mission.
- **Collateral** - These are sensors whose primary mission is not space surveillance but still are an important part of the SSN and owned by Air Force Space Command. Most of these sensors were initially designed, located and primarily used for missile warning. However, with the end of the Cold War many spend the vast majority of their time performing the space surveillance mission.
- **Contributing** - These are sensors which provide data as part of the SSN but are not owned or operated by Air Force Space Command. Generally they are owned by either private contractors or other branches of the US government and they are under contract to provide a certain amount of space surveillance data.



Current configuration of the United States Space Surveillance Network (SSN). **Source: USAF.**

Operation

The JSPOC functions as the central command and control node for the SSN. Each day the JSpOC will send every sensor site a tasking list which contains all the objects that particular sensor is assigned to track during that day. The capacity to track every object all the time does not exist – objects are only tracked as necessary to maintain accurate positional data and as the mission requires.

As a tasked object passes overhead, the sensor will record multiple observations. An observation is not a picture – it is a string of mathematical data that gives the object's position and velocity in reference to the sensor at a precise moment in time. The number of observations taken for a given pass is dictated by the tasking instructions from the JSpOC.

The sensor sites electronically transmit the observations back to the JSpOC. Approximately 500,000 individual observations are collected each day by the SSN. The JSpOC uses these observations to update and refine the element set for each object. The element set is the mathematical equation that gives an objects position in orbit and allows that position to be propagated forward or backward in time. The element sets for all tracked objects in Earth orbit comprise the satellite catalog, currently containing over 17,000 objects. The catalog is available publicly at http://space-track.org.

As the element sets are updated they are transmitted back to the sensor sites so that they have the most accurate position for the next time they are tasked to track that object. This cycle of collecting observations, correcting element sets, and transmitting updated elements and new tasking operates continuously.
A key component of space surveillance is geographic separation. As more sensors observe the same object in different parts of its orbit, accuracy of that orbit is increased over just one sensor observing it in the same location each orbit. One weakness of the SSN is that there are no sensors located in the Southern Hemisphere and thus it cannot observe a significant portion of LEO.

Radars

Radar provides surveillance data by bouncing a radio signal off an object in orbit. The timing of the signal return can be used to calculate the precise position of the satellite in reference to the radar station.

Three different types of radars are used in the SSN. The most common is phased-array radar, which looks like a large, angular concrete building with one or more large, flat sloping faces. These faces of the building are covered in radar elements. The advantage of the phased array radar is that it can divide the radio energy from each face into many individual electronically-steered beams. This allows the phased array to track many objects at the same time by steering a separate beam at each one. The disadvantage is that they generally have limited range, usually only a few thousand kilometers.

The AN/FPS-85 phased array radar at Eglin AFB, Florida, is an element of the Space Surveillance Network (SSN) that detects, acquires, correlates, and tracks space objects. **Source: Federation of American Scientists.**

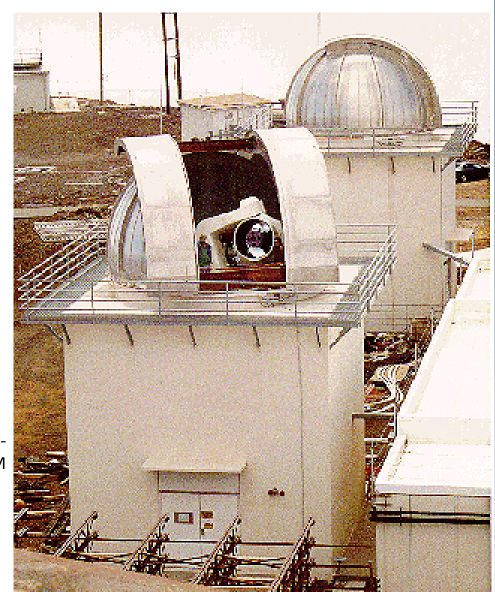
The second type of radar is conventional (or dish) radar. This type uses a large parabolic dish to focus the radar energy into one narrow but very powerful beam. This type of radar can track basketball-sized objects out to the geostationary belt (40,000 km). However, it can only track one object at a time and the entire dish needs to be moved to align on an object.

The third type of radar is a fence. Instead of emitting radio energy only the track certain objects, the fence emits radio waves continuously. The only sensor of this type in the SSN, the Air Force Space Surveillance Fence, uses a series of sites located in a Great Circle across the United States between California and Georgia. The advantage of the Fence is that it tracks everything that passes through it out to its limit of around 30,000 km and does not need to be tasked. It also provides extremely precise timing. However, multiple objects passing through at the same time can create confusing echoes and potentially degrade the positional accuracy.

The ALTAIR (Advanced Research Project Agency (ARPA) Long Range Tracking and Identification Radar) is an Army operated radar located on the island of Kwajalein in the western Pacific. It has two missions, Anti-Ballistic Missile (ABM) testing in support of the Western Space and Missile Center (WSMC) and space surveillance. **Source: Federation of American Scientists.**

Optical

Optical telescopes operate in a passive mode, whereby they do not transmit any energy at an object. Instead they operate in the same way as telescopes for astronomy – they collect sunlight reflected off the object in orbit. The advantage is that they can oftentimes track objects out to a very far distance (sometimes hundreds of thousands of kilometers). The disadvantage is that they cannot track in daylight or with cloudy skies.



Right: The ground-based electro-optical deep space surveillance system (GEODSS) is an optical system that uses a low-light-level TV camera, computers, and large telescopes. GEODSS tracks objects in deep space, or from about 3,000 NM out to beyond geosynchronous altitudes. GEODSS requires nighttime and clear weather tracking because of the inherent limitations of an optical system. There are currently three operational GEODSS sites with coverage areas as follows: Socorro, New Mexico (165W-050W); Maui, Hawaii (140E-010W); and Diego Garcia, Indian Ocean (010E-130E). Each site has three telescopes, allowing GEODSS to track three objects simultaneously. **Source: Federation of American Scientists.**

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