Space Surveillance Network Sensor Development, Modification, and Sustainment Programs

Richard F. Colarco

L-3 Communications

HQ AFSPC/A5CS

Abstract

The paper and presentation cover status of and plans for sensor development, modification, and sustainment programs supporting the Space Surveillance Network, including:

- Space Based Space Surveillance
- Space Surveillance Telescope
- FPS-85 radar service life extension program
- GEODSS service life extension program
- Haystack Ultra-Wideband Satellite Imaging Radar
- Space Fence
- GLOBUS II
- Self-Awareness SSA

Overview

The Space Surveillance Network (SSN) is made up of sensors, communications links, processing centers, and data distribution channels. The sensors are a conglomeration of capabilities mostly derived from and shared by other missions. Few of the sensors were developed for the express purpose of conducting space surveillance.

The Air Force has recognized that providing warfighters with effective Space Situational Awareness (SSA) requires a coordinated architecture-based approach to establishing and maintaining sensor capabilities. Air Force Space Command (AFSPC) has established programs to acquire new capabilities such as Space Based Space Surveillance (SBSS) and Space Fence, has partnered with other agencies to acquire the first Space Surveillance Telescope (SST), and has begun to modernize legacy capabilities such as the Eglin FPS-85 radar, the Haystack radar, the GLOBUS II radar, and the Ground-based Electro-Optical Deep Space Surveillance (GEODSS) system.

The Air Force has also recognized that protection of space systems must become a priority, and has established a program to do this through Self Awareness Space Situational Awareness (SASSA).

Space Based Space Surveillance

The first SBSS satellite is expected to launch into a sun-synchronous low-Earth orbit in October 2009. The satellite was built by a team made up of Boeing (prime) and Ball Aerospace (space vehicle). The development and production contract provides for satellite design, fabrication, delivery, and launch, as well as ground station delivery and post-launch support.

Launch will be on a Minotaur IV from Vandenberg AFB. The satellite is ready for launch.

The mission of SBSS is timely detection, identification, and tracking of resident space objects (RSOs). SBSS will track objects primarily in deep space (orbital period greater than 225 minutes). However, SBSS will also have the capability to track objects with shorter periods, illumination permitting. SBSS will provide position, maneuver setection, and space object identification data to the Joint Space Operations Center (JSpOC) and the Alternate Space Control Center (ASCC).

The SBSS payload consists of a visible sensor assembly, a gimbal, and payload deck electronics.

The visible sensor assembly consists of:

- Optical bench
- Telescope
- CCD focal plane array
- Cryoradiator
- Video Interface Box
- Elevation electronics box
- Filter wheel mechanism
- Focus mechanism
- Aperture door mechanism
- Electrical harness

The gimbal consists of:

- Beryllium yoke
- Azimuth and elevation drives
- Azimuth launch lock
- Electrical harness for interface with payload electronics

The payload deck electronics package consists of:

- Payload electronics box
- Gimbal amplifier segment
- Solid state recorder
- On-board mission data processor
- Electrical harness for interface with visible sensor assembly, gimbal, and bus

Space Surveillance Telescope

SST is a ground-based system using the latest in optical technology to increase SSA capability. The SST program is a DARPA technology demonstration providing a 3.5 meter f/1.0 telescope. SST has the potential to become an Air Force Space Command (AFSPC) dedicated sensor pending successful outcome of a demonstration in 2011 - 2012.

MIT Lincoln Laboratory is providing program management, integration, supervision of facility construction, and the telescope camera. L-3 Integrated Optical Systems is building the telescope.

The SST will detect small objects in deep space, and provide a rapid, wide-area search capability, significantly increasing optical surveillance capacity. The telescope is designed to find, fix, track, and characterize faint objects. It will be more sensitive than GEODSS.

SST will be the first large telescope to employ a curved CCD focal plane array. It is the most dynamically agile telescope of its size ever built. It provides the first major technology push for deep space surveillance in over three decades.

The SST facility at White Sands Missile Range NM is complete. The telescope is still under construction. SST will see first light in late 2010. DARPA testing will occur in 2010 and 2011. AFSPC will evaluate the telescope’s performance in actual operations in 2011 and 2012. During this evaluation period, SST will operate as a contributing sensor to the SSN. At the end of the evaluation period, assuming SST performance is acceptable, it will become a dedicated SSN sensor.

The potential exists to acquire and deploy additional SST installations in the post-2012 time frame. AFSPC will publish an architecture that includes SSTs in late 2009.

Eglin FPS-85 Radar Service Life Extension Program (SLEP)

The FPS-85 is the workhorse of the SSN in the near-Earth regime. It provides timely and accurate metric tracking and space object identification data. Although primarily a near-Earth sensor, it is the only dedicated, high-capacity phased array radar with both near-Earth and deep-space capability. It is the primary tracker of low-inclination objects, and of objects that transit the manned-spaceflight regime. It has the capability to track most near-Earth objects once per day.

The FPS-85 routinely tracks 50-60 manned spaceflight objects that are not tracked by any other sensor, and 220-230 manned spaceflight objects that are tracked by at most one other sensor. This makes the operation of the FPS-85 critical to the safety of manned spaceflight.

The SLEP will extend the operation of the radar until 2018, and will provide the ground work for future updates to the radar. The SLEP will replace:

- Computer
- Radar Interface and Control Equipment
- Calibration system
- Signal processor
- Beam steering equipment (tentative)

GEODSS SLEP

GEODSS is the key provider of deep space metric observations. It produces 70% of all geosynchronous tracks and 50% of all deep space tracks. GEODSS tracks over 200 objects not tracked by any other sensor.

The GEODSS SLEP funds replacement of aged and unsustainable Sensor Controller Group and Data Processing Group with modern components. Without the SLEP, GEODSS will soon experience degraded operations, and eventual mission failure.

Haystack Ultra-Wideband Satellite Imaging Radar (HUSIR)

The Haystack radar is a contributing sensor operated by MIT Lincoln Laboratory, and provides imaging of near-Earth and deep space objects. Haystack operates today at X-band, with one GHz of bandwidth.

The upgrade will add the capability to operate at W-band with eight MHz of bandwidth. This will enable finer characterization of satellites, and characterization of smaller satellites than possible today.

Operation at W-band requires replacement of the current Haystack antenna. Because of this, Haystack will be down from operations from May 2010 until August 2011. A smaller antenna, which is being used to test the W-band RF components, is producing images and will be available for limited operations during this time.

Space Fence

The Space Fence program is a new acquisition that will produce three worldwide-dispersed radar sites. The radars will provide the ability to perform un-cued tracking of small objects at low and medium orbital altitudes.

The Space Fence program was begun by the US Navy to replace the current VHF Fence radar system. In 2003, the Navy transferred the program to the Air Force. In the intervening years, the Air Force has refined the requirements for the program to make the resulting radars more capable than a simple VHF Fence replacement.

The program is in concept development, with an expected IOC for the first site of 2015.

GLOBUS II SLEP

The GLOBUS II radar is a dedicated sensor that provides metric tracking and imaging of near-Earth and deep space satellites. It provides the only all-weather, 24/7 space-track capability covering 0-90 degrees east longitude.

The radar is located in Vardo, Norway. It is one of five wide-band imaging radars in the SSN. It provides the most accurate tracking of any space surveillance radar.

Radar development began in 1992. The radar was fielded in Norway in 2003, making it 11 years old at IOC. As a result, the radar’s reliability has been deteriorating since it was fielded. Extended downtimes for emergency maintenance are expected in the 2010 time frame.

AFSPC will begin a SLEP in 2010 to extend the service life of the radar to 2030.

Self-Awareness Space Situational Awareness (SASSA)

US space systems are increasingly susceptible to a wide variety of threats. The US needs to provide effective protection for space systems. The first step in doing this is to provide effective tactical and strategic situational awareness.

The SASSA program will support this first step by providing a common, standards-based solution. This is the most effective and efficient way to integrate a variety of sensors and other instruments on a broad set of satellites. SASSA will begin with a technical demonstration and will proceed with methodical risk reduction activities over the subsequent several years.

SASSA I will be a prototype and technical demonstration activity going through the 2013 time frame. It will produce an integrated set of flight hardware that will be operated on-orbit, providing a test bed to allow continued interface testing with new instruments. The interface specification will be developed to enable future technology investments. Lessons learned will be integrated into SASSA II. SASSA I characteristics are:

- A two-year development, followed by a one year on orbit demonstration on an operational host
- A common interface unit that can handle six instruments such as radar warning receivers
- Low technical risk in components
- Moderate technical risk in software and interfaces
- Define common interface standards for instruments and bus connections
- Leave-behind test bed capability

SASSA I is not intended to address the full spectrum of threats.

SASSA II will be a risk reduction program in the 2010 – 2015 time frame. It will establish policy for future space protection activities. Instruments and interfaces developed in SASSA I will be matured to provide more effective protection. SASSA will end with a finalized business strategy to guide future activities.

An eventual SASSA acquisition program (2014 and beyond) will encompass full-scale production of a standardized protection capability. The goal is integrated on-board awareness and protection capabilities for all US space systems.