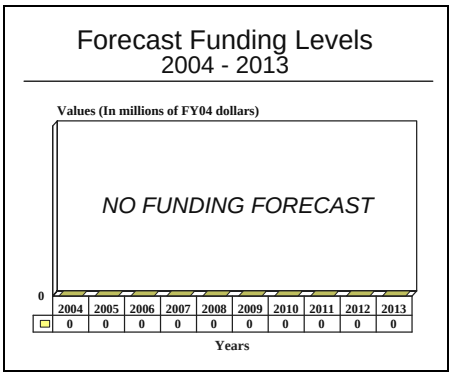
SOSUS - Archived 12/2005

Outlook

- SOSUS continues on standby status
- Can be reactivated at any time
- This report will be archived December 2005



Orientation

Description. The Sound Surveillance System (SOSUS) is a United States undersea surveillance system composed of hydrophones in ocean-floor-mounted cables connected to shore-based computer data processors.

Sponsor

U.S. Navy
Space & Naval Warfare Command
Arlington, VA, USA

Naval Command, Control & Ocean Surveillance Center
RDT&E Division
San Diego, CA, USA

Naval Research Laboratory
Washington, DC, USA

Naval Civil Engineering Laboratory
Port Hueneme, CA, USA

Status. In standby operational service (data available but not continuously monitored). Some elements of the system are being used by the U.S. National Oceanic and Atmospheric Administration (NOAA) and scientists for various ocean and marine monitoring projects.

Total Produced. No information is available on the number of units produced because of the highly sensitive nature of the operation.

Platform. The hydrophones are located on seabeds, and the processing centers are at land-based sites.

Application. Originally used for underwater surveillance, classification, and detection of hostile submarines. Currently, the primary mission of SOSUS is to provide undersea global maritime surveillance in areas of interest to national security. Other uses include detection of coastal intrusions from foreign navies, terrorists, drug smugglers, and fish poachers.

Price Range. It is estimated that US$16 billion has been invested in SOSUS over the program's lifetime.

Contractors

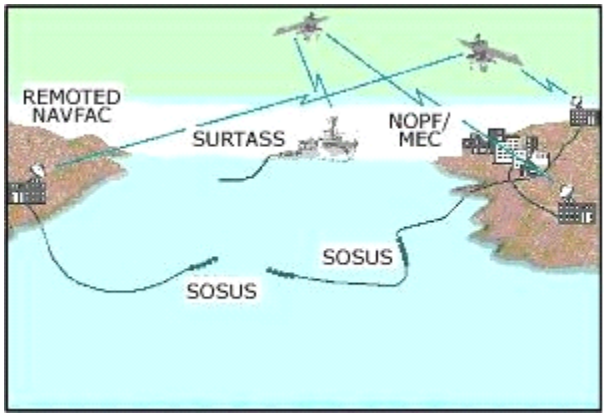
General Dynamics Advanced Technologies System, http://www.gdats.com, 5440 Millstream Rd, I-84 And Mt Hope Church Rd, McLeansville, NC 27301 United States, Tel: 1 (703) 271-7300, Prime-FSS

Lockheed Martin Maritime Systems & Sensors - Manassas, http://www.lockheedmartin.com/wms, 9500 Godwin Drive, Manassas, VA 22110-4157 United States, Tel: 1 (703) 367-2121, Fax: 1 (703) 367-6091, Prime-Phase II

Orincon Corp, http://www.orincon.com, 4770 Eastgate Mall, San Diego, CA 92121-1970 United States, Tel: 1 (858) 455-5530, Fax: 1 (858) 452-0271, Prime-Phase III

Technical Data

Design Features. SOSUS is a series of underwater, ocean-floor-mounted hydrophones connected to shore-based processing equipment. The system detects the movement of submarines off the coasts of the United States and in choke-point areas in the North Atlantic, including the Greenland-Iceland-United Kingdom (GIUK) Gap, the Norwegian Sea, and near the Azores. Similar systems cover major portions of the North Pacific. The hydrophones act as microphones that pick up ocean sounds and submarine noises. The raw acoustic data are in turn relayed to land-based processing centers that filter the data to determine if an actual submarine contact has been made. Upon a positive contact, a land-based long-range maritime patrol aircraft, such as the P-3C, is sent to locate and track the contact, using sonobuoys to determine speed and direction.



U.S. Navy SOSUS as used by the U.S. NOAA

Variants/Upgrades

Many of the improvements to the SOSUS are classified. Contracts for SOSUS are usually identified only as oceanographic research or oceanographic systems. Similar systems used by the U.S. Navy and based on the same technology used for SOSUS include the Fixed Distribution System (FDS), the Fixed Surveillance System (FSS), the Advanced Deployable System (ADS), the Integrated Undersea Surveillance System (IUSS), and the Surveillance Towed Array Sensor System (SURTASS).

Program Review

Background. The SOSUS program (along with the Fixed Distribution System program) forms part of the Navy's Integrated Underseas Surveillance System (IUSS). Another element of IUSS is the Surveillance Towed Array Sensor System (SURTASS). The sensors of the SOSUS system date back to the 1960s and are no longer as effective in performing their mission as they once were. The later-generation Soviet submarines are very quiet compared to earlier classes. The SOSUS system is apparently unable to reliably detect these submarines. Although the system is constantly being improved, the improvements are limited. Thus, the Navy decided to field a new-generation replacement for SOSUS called the Fixed Distribution System (FDS). It differs from SOSUS in that it features more sensors and the ability to beam-form. The latter entails selective turning on of a row of sensors at a time. These rows face in different directions, resulting in a three-dimensional acoustic picture and the option of many listening variations. This enhanced surveillance capability means that submarine direction of travel, speed, and class can all be identified. SOSUS, a fixed system, is limited in that it cannot direct its acoustic beam.

The SOSUS program began with a research contract to Western Electric in 1950 for Project Caesar, a long-range seabed hydrophone array. By 1953, cables and hydrophones had been planted on the continental shelf off New England, and by 1960, hydrophones covered much of the North Atlantic. By the mid-1960s, similar arrays covered most of the North Pacific, and the hydrophone network could distinguish a target submarine signature from ambient noise. In the late 1960s, the improved Caesar system and stations became known as SOSUS.

While most of the efforts undertaken in the SOSUS program in the 1980s are classified, the Navy was known to have used state-of-the-art computer and display technology to develop signal and data processing subsystems. In FY85 the service obtained approval to produce an adaptive beam-former subsystem. It also completed testing of the integrated acoustic display (IAD) and the wideband acoustic recall (WBAR) systems. IAD upgrades were begun, including an interface for a WBAR long-term storage system and a hybrid resolution analysis display. The Navy also completed a training curriculum for the target data processor (TDP), interarray processor II (IAP II), and IAD subsystems.

The Navy finished testing the IAD and WBAR upgrades in FY86. A Battle Group Quick Reaction Surveillance System was added to the program, and at-sea tests were begun. The service also funded efforts in real-time signal processing and the distribution and transfer of information from collection to processing subsystems. In FY87, the Navy initiated development of hardware and software to support planned automation functions. These were tested for personnel reductions in distributed sensor field operations. The IAD/WBAR system finished development to meet follow-on test and evaluation requirements. The Navy continued subsystem software development as well. A contract was awarded to AT&T for a shipboard processing and display system. FY94 and FY95 marked a lower level of procurement funding for SOSUS as the Navy acquired the necessary hardware to complete the consolidation and modernization of the program.

After the consolidation and upgrade was completed in 1995, SOSUS was placed on operational standby (data available but not continuously monitored), with SURTASS and other systems in the IUSS picking up the slack. (Technically, SOSUS remains an active system that can be called into action very quickly.)

In 1997, the U.S. government granted permission for companies to begin marketing SOSUS technology internationally for the creation of systems similar to SOSUS. Industry sources once reported that several Middle Eastern countries were interested in establishing their own similar systems; however, this interest seems to have faded into the past like the system itself.

SOSUS Status. The demise of the Cold War has left SOSUS a bit out in the cold – an unemployed spy. Consolidations, shutdowns, and outright closings have plagued SOSUS and similar older systems in recent years. As part of the IUSS consolidation effort, which provides the U.S. Navy with its primary means of nuclear and diesel submarine detection, the U.S. Navy selectively left productive SOSUS arrays active or in standby mode while shutting down arrays that were no longer productive. This consolidation allowed the option to reactivate arrays as strategic needs change. Sensor sites have been remoted to permit acoustic data transmission via satellite to a shore receiving site.

With the end of the Cold War, the program underwent a major transition. Emphasis shifted from maintaining a large, dispersed surveillance force with many SOSUS sites to smaller, mobile undersea surveillance systems that have proven just as effective against modern diesel submarines.

Fortunately, all has not been doom and gloom for SOSUS, as many people came up with ways to keep the US$16 billion investment from being discarded. Several U.S. government agencies and scientists have used SOSUS. In 1992, the Navy, Coast Guard, and National Marine Fisheries Service used the system to track fishing vessels, and investigated SOSUS as a way to enforce the international ban on drift-net fishing. In addition, marine and biological scientists used SOSUS to track the migrations of whales, including a single blue whale as it swam from Cape Cod, Massachusetts, to Bermuda, to Florida, then back to Bermuda, a trip of some 1,700 miles.

The U.S. Navy had been rather reluctant about footing the bill for maintaining 30,000 miles of undersea cable. It was unlikely that a civilian agency could afford to, or would be willing to, step forward and assume responsibility for SOSUS. An internal document from the U.S. National Oceanic and Atmospheric Administration, which also uses the system for scientific research, said, “NOAA is not prepared to pay for, or contribute to, the support of the systems and archives.” Without proper upkeep, the system and its miles of cable will last only another several years.

SOSUS has retained the most critical part of its deep-water coverage and has eliminated coverage in areas no longer of interest. Processing sites have been reduced, and display equipment modernized to lower life-cycle costs and enable consolidation of the system. To reduce manpower requirements, the U.S. Navy directed that the SOSUS system be placed on standby status as of 1995. The underwater system and shore processing equipment will be maintained, but no manpower will be allocated

to monitor SOSUS data. Overall, roughly 80 percent of SOSUS has been dismantled or mothballed. Of the 18 shore stations that gathered SOSUS information during the 1980s, all but four have been closed. The remaining four are pretty much on standby status, where data are collected and available but not constantly monitored or manned.

NOAA VENTS Program. In October 1990, the U.S. Navy granted approval to NOAA/PMEL (Pacific Marine Environmental Laboratory) to access the SOSUS arrays in the North Pacific to assess their value in ocean environmental monitoring, as part of the U.S. government's dual-use initiative. PMEL carries out interdisciplinary scientific investigations in oceanography and atmospheric science. Current PMEL programs focus on open ocean observations in support of long-term monitoring and prediction of the ocean environment on time scales from hours to decades.

The data collection systems developed by NOAA's VENTS Program have been in place since August 29, 1991. VENTS conducts research on the impacts and consequences of submarine volcanoes and hydrothermal venting on the global ocean. Acoustic signals from the North Pacific Ocean are monitored and recorded at the Newport, Oregon, facility of NOAA/PMEL. This is the primary tool for both continuous monitoring of low-level seismicity around the northeast Pacific Ocean and real-time detection of volcanic activity along the northeast Pacific spreading centers in support of the VENTS research program in ocean hydrothermal systems. Real-time ridge-crest monitoring potentially permits the timely on-site investigation of hydrothermal and magmatic emissions.

Data acquisition is accomplished by combining portions of the Navy's processing facilities with NOAA-designed systems installed at the U.S. Naval Ocean Processing Facility at Whidbey Island, Washington. Analog outputs from each hydrophone element are available either through direct cabling or remote data linkage. U.S. Navy systems perform adaptive beam-forming on digitized hydrophone signals, with the outputs converted back to analog electrical signals. These analog hydrophone and beam-former outputs are accessed by the NOAA-supplied systems, where the signals are low-pass filtered, digitized, and temporarily buffered on hard disk. The digital data are provided to a wide-area network based on NFS (Network File System) protocol, linking the acquisition computer by encrypted, dedicated telephone line to an analysis system located at NOAA laboratories in Newport, Oregon.

On October 12, 2000, changes in the U.S. Navy's electronics configuration resulted in the loss of beam-formed outputs to dual users. At that time, the two NOAA/PMEL data acquisition systems were combined into a single system (WHIDBEY) that collects multiple hydrophone elements at 256 Hz sampling rate. The data are transferred, digitally beam-formed, and displayed at PMEL in Newport. The new configuration allows complete flexibility in beam-forming. In performing this upgrade, PMEL and University of Washington Applied Physics Laboratory engineers made accommodations to allow future dual users to easily assess all hydrophone elements from all systems.

Seismic Monitoring. "T-wave" refers to a relatively high-frequency waterborne seismic phase generated by submarine earthquakes. (T corresponds to tertiary, since these waterborne phases travel slower than solid-earth P- [primary] and S- [secondary] waves, and therefore arrive third on seismograph records.) Waterborne T-waves propagate more efficiently than solid-earth body waves because of the presence in most of the global ocean of an acoustic wave guide, commonly referred to as the sound fixing and ranging (SOFAR) channel. Relative to solid-earth seismic waves that propagate spherically, acoustic waves within the oceanic SOFAR channel propagate cylindrically, and can therefore travel great distances with little reduction.

Marine Mammal Monitoring. The same systems used for seismic monitoring are capable of detecting vocalizations from large marine mammals at long ranges in the open ocean, an environment where very little is known about their behavior, distribution, and habitat. In the case of large blue whales, accurate locations can be derived for individual animals at ranges of several hundred kilometers by applying mathematical matched filters to the acoustic signals. Other species under study include fin whales, humpback whales, Minke whales, and potentially other large whales such as Bryde's whales and sperm whales.

Acoustic Thermometer. In support of the seismic program, a low-power acoustic beacon was installed on Axial Seamount in August 1993. This known acoustic source projects twice per day to allow calibration of ocean sound speed models. The travel time is routinely derived for each SOSUS array at ranges of up to 3,600 kilometers. The resulting time series provide a means of monitoring acoustic travel times within the oceanic sound channel over thousands of kilometers.

Future Systems. In April 1999, Lockheed Martin was awarded a US$107 million contract for Phase II work on a deep water undersea surveillance system. The system is designed for long-life passive acoustic surveillance that can be configured for multiple mission applications and provide long-term barrier and field acoustic surveillance in open ocean areas, as well as areas of high ambient noise. Much of the development

of this system is based upon successful lessons learned during SOSUS' long operation.

Related Reports. For market intelligence on systems similar to SOSUS, please see "Distributed Surveillance Systems" in Tab A. This report covers the Fixed Distribution System and the Advanced Deployable System.

Funding

Operational expenses for SOSUS originally were funded as part of Project X076 IUSS Detection/Classification System. Current expenses are shared by the U.S. Navy, U.S. NOAA, and various scientific groups using the system.

Recent Contracts

No recent contracts directly related to SOSUS itself and valued over US$5 million have been identified.

Contractor	Award (US$ millions)	Date/Description
Lockheed Martin	107.3	Apr 1999 – An FFP contract for Phase II of a deep water, undersea surveillance system. This system is a long-life, passive acoustic surveillance system that can be configured for multiple mission applications. It has the capability to provide long-term barrier and field acoustic surveillance and long-range acoustic surveillance coverage of open ocean areas, as well as acoustic surveillance in areas with high ambient noise. Contains one option, which, if exercised, will bring the total cumulative value of this contract to US$153.2 million. Contract is expected to be completed by September 2005. (N00039-99-C-2202)
Lockheed Martin	6.5	Mar 2001 – A CPFF award term contract for engineering services for Fixed Surveillance Systems. The purpose of this contract is to provide SPAWAR PMW-181 with the technical and engineering services to support U.S. Navy and Department of Defense (DoD) for the Fixed Surveillance Systems of the Integrated Undersea Surveillance System (IUSS) program. Support for these systems will be performed at various sites and platforms in the U.S. and at overseas locations. The scope of the work will include technical and engineering services to support design, development, integration, testing, installation, logistics, life cycle support, training, and documentation of Fixed Surveillance Systems sensors. Contract includes options that would, if exercised, bring the cumulative value of this contract to US$72 million. This contract is made under an "award term" provision. Those provisions will award or remove options based on performance criteria. Performance will be evaluated semi-annually, and excellent performance could extend the potential period of performance by up to 10 years. The total amount possible if all award terms are exercised is US$270.1 million. Contract is expected to be completed by September 2005. (N00039-01-C-2231)

Timetable

Month	Year	Major Development
	1956	Concept formulation

Month	Year	Major Development
Early	1960s	East Coast partially operational
	1964	Installation of upward-looking sonars
1964	1965	Pacific Coast partially operational
	FY70	Sea Spider installed off Hawaii
	1974	SOSUS improvement program begins
Apr	1985	Active Adjunct conceptual studies
Oct	1985	FDS testbed deployment IOC
Jan	1986	Active Adjunct system specification
Dec	1987	IAP II Acoustic Display Console test
Feb	1989	FDS O&M course material delivery
Oct	1990	Active Adjunct sea trial and data analysis
Sep	1991	Active Adjunct system EDM specification
	FY93	Deactivation or remote of selective SOSUS sites begins
Dec	1995	Consolidation and modernization complete, SOSUS system placed on standby operational status
Jan	1997	U.S. government grants permission for SOSUS technology to be exported

Worldwide Distribution

This is a **U.S. Navy** program, but the information gathered has been known to be provided to various U.S. allies. In 1997, the U.S. government granted anti-submarine warfare companies permission to begin marketing SOSUS technology internationally. Additionally, the marine scientific community uses SOSUS for various marine environmental studies through the management of the **U.S. National Oceanic and Atmospheric Administration (NOAA)**.

Forecast Rationale

Although it is still considered a valuable asset, the U.S. Navy's Sound Surveillance System (SOSUS) program officially continues to remain on standby status, meaning the system remains operational and data available, but is not continuously monitored. It is doubtful the U.S. Navy will totally abandon a system that has served so well in the past and can still perform adequately if and when called upon. As part of the "swords to ploughshares" principle, and to help offset maintenance costs, the Navy now allows the scientific community the use of SOSUS for oceanographic research. The U.S. National Oceanic and Atmospheric Administration (NOAA) is one of the main civilian users of SOSUS.

Barring a sudden surge of activity, this report will be archived next year, December 2005. Once archived, should events warrant it, the report will be updated and reissued as soon as possible.

Ten-Year Outlook

No significant funding or production (other than for maintenance and repair) is expected. Therefore, the forecast chart has been omitted. Barring a change of status, this report will be archived next year in December 2005.

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