An Unofficial History of
The Surveillance Towed Array Sensor System (SURTASS)
1972 - 2015

Surveillance Towed Array Sensor System (SURTASS)

The History of a Distinguished IUSS Program

Overview

They slip from port on secret missions, destinations unknown". This was the lead-in sentence from an article printed in 1988 in the Washington Post. The "they" in this case are the TAGOS ships outfitted with the SURTASS undersea surveillance equipment.

Briefly, SURTASS consists of a shipboard segment and a shore segment connected by satellite digital communication. The shipboard segment consisted of a long line of acoustic sensors with signal processing computers, navigation and communications equipment. The acoustic data is transmitted to shore facilities via satellite. The SURTASS shore segment consists of communications equipment, data processing and display equipment.

Initially SURTASS acoustic data was analyzed ashore and integrated with other USS data. Later SURTASS evolved into a tactical asset reporting directly to fleet combatants.

SURTASS is a unique program within the Department of the Navy (DON); it had its own navy, 23 TAGOS ships at its peak, with Navy personnel ashore and civilians at sea. The ships were built by NAVSEA, crewed by MSC with the mission equipment operated and maintained by civilian technicians under contract to NAVELEX/SPAWAR (later OT ratings were deployed as operators, with civilians continuing to maintain the equipment).

The program has is own logistic chain, the Integrated Undersea Operational Support Center (IOSC) in Norfolk, Va., with an annex in Pearl Harbor, Ha. IOSC was later expanded to include SOSUS support. To avoid another USS Pueblo incident, pyrotechnics safes were installed to prevent sensitive data from falling into the wrong hands. Although never needed TAGOS ships were frequently harassed by the soviet "fishing boats" and helicopters.

The program had its own installation facility located at the Naval Supply Center at Oakland Ca. TAGOS ships sailed from Builders yard directly to Oakland for mission equipment installation, shakedown and final sea trials. Not to pass up recognition of a program milestone, a ceremony, with a guest speaker, was conducted when the final sea trials were completed and the mission system turned over to the SURTASS contractor operator; and of course a party that evening at a local watering hole caped off the milestone.

Not to be outdone by other DON programs, SURTASS had its coffee cups, tee shirts and ball caps as well as tie clips, beer mugs and golf balls. The program had its annual golf tournament, which, some say, was the social event of the year in the Norfolk area. There were Christmas parties and annual picnics. SURTASS had it own publication, The HEADS UP, put out by IOSC provided technical and logistic updates, helpful hints and notification of social events.

Over the program years there were marriages between team members and unfortunately some break ups. People who signed up with the program stayed with the program. At the inception of the program when the concept of operations was developed it was estimated that an attrition rate for the SURTASS technicians would be as much as 25% per year because of the 90-day deployments, as it turned out the rate rarely exceed 5%

The SURTASS team believed that working hard and playing hard went hand in hand, and in the right mix would produce the desired results. The results of this approach was a consistently high System Availability, and the high Probability of Detection (Pd) and low False Alarm Rate (FAR) against the most capable of threat submarines. Endorsements and BZ's from Fleet Operational Commanders were a common footnote to a post mission debrief. Then there was the Post article reporting SURTASS as a "Pentagon Success Story"

The Beginning

The Undersea Surveillance System (USS), PME 124 Office was established in 1972. At that time, the concept of towing a long line of hydrophones from a surface ship was proving to be a highly effective method of detecting submarines at long distances. The Navy recognized its value both as a mobile augmentation to the Sound Surveillance System (SOSUS) fixed arrays and as a means of extending sonar coverage for combatant ships. Initially the Navy was considering developing a single-towed array design that could be used universally for both tactical and surveillance applications.

The surveillance application, SURTASS, had its roots in two programs: the AN/SQR-14A Interim Towed Array Surveillance System (ITASS), installed on a few KNOX-class frigates in the 70's, and the Large Aperture Marine Basic Data Array (LAMBDA) system being sea tested by the Naval Undersea Center (NUC). The tactical application was based on the NAVSEA AN/SQR-18 program.

Eventually, it was determined that tactical and surveillance mission requirements were unique and .a single design could not meet both mission needs. The tactical mission was assigned to the Escort Towed Array System (ETAS) and transferred to the Naval Sea Systems Command (NAVSEA). The surveillance mission was assigned to SURTASS and retained in the Naval Electronics System Command (NAVELEX), assigned to PME 124. SURTASS was established as a program by Decision Coordinating Paper-92, and the first formal acquisition milestone (Milestone I) was successfully passed on 17 May 1973.

Following approval of the concept design phase of SURTASS, an engineering study was initiated. The study team, staffed primarily by NUC and TRW, prepared a report that contained the baseline configuration for each system component, with supporting trade-off analysis and rationale.

A basic issue that the study team had to resolve was the allocation of functions to ship and shore. Three options were considered. All processing, analysis and reporting activities would be located (1) ashore, (2) shipboard or (3) a hybrid approach where system functions would be split between ship and shore. The hybrid approach was selected due to limitations in satellite link capacity (option 1) and a desire to avoid a larger vessel (option 2). This approach would place signal processing on the ship with the transmission of beamformed data to shore for display, analysis and reporting.

Full Scale Engineering Development

On 26 November 1974, full-scale engineering development of the hybrid was authorized; however, one condition was attached to this approval: that the program uses the Navy's standard signal processor, the Advanced Signal Processor (ASP) (AN/UYS-1). Thus, SURTASS was to become the first DON system to integrate and use the ASP.

In late 1974, four SURTASS design study contracts were awarded, one each to Hughes Aircraft Company, General Electric, Sperry and Raytheon. These studies culminated in proposals for the Engineering Development Model (EDM). The Hughes proposal was selected for the EDM, and work was started in September 1975.

A key decision that resulted in significant procurement and operating cost savings and a more efficient ship-shore communications process was the decision to combine the ships communications requirements with the SURTASS mission communications requirements. An MOU was executed between MSC and NAVELEX providing for the SURTASS crew handling all ship and mission communications.

The vessel selected as the EDM platform was the R/V MOANA WAVE. She was launched by Halter Marine in 1973 and operated by the University of Hawaii for the Office of Naval Research. In 1976, EDM array at-sea testing began. These tests led to concerns about the reliability of the digital telemetry array, which had been developed as part of the EDM system. An alternate hard-wired analog array was procured from Hydroscience, Inc. and after extensive testing; it was designated as the baseline array.

Technical Evaluation (TECHEVAL) of SURTASS was set for early 1978; however, this accelerated schedule allowed little time for installation, integration and shakedown of the system components. Consequently, this first TECHEVAL was unsuccessful. Subsequently, the program was restructured, and a new completion schedule was initiated for the development, integration, and verification of the system. A series of at-sea tests were conducted (1978-79); and in March 1980, TECHEVAL was successfully completed.

After beginning in May 1980, Operational Evaluation (OPEVAL) was completed successfully in July of that year. A unique aspect of the production program was the ship-acquisition strategy, which encompassed separate contracts for ship construction and SURTASS system installation. This allowed small commercial ship builders to bid on construction contracts. The initial contract for twelve T-AGOS class ships was awarded by NAVSEA to Tacoma Boat Building Company in September 1980.

The first SURTASS ship, the USNS STALWART, was launched in July 1983 and delivered in early 1984. After completing ship self-noise trials, the ship transited to Oakland, California, for SURTASS equipment installation, then to Key West, Florida, where testing, shakedown and certification were conducted. The TAGOS class ship has proven to be a sea-worthy platform with an extremely quiet, self-noise profile. NAVSEA contracted with Halter Marine for a second flight of six T_AGOS class ships, bringing the total number contracted to 18. Initial Operating Capability (IOC) for SURTASS was achieved in November 1984.

Operations

While SURTASS was in initial production there was the deployment of the Quick Reaction Surveillance System (QRSS), a NOSC initiative with a Hydroscience Inc. towed array system. QRSS was a van installation installed on ships of opportunities designed for high ambient environment, specifically in the Mediterranean Sea, in CTF 66 OPAREA. Then there was the High Ambient Variant (HAMV) and the QRSS. Both systems were operated and maintained by Navy enlisted personnel. They provided valuable operational support to the assigned fleet as well as providing important feed back to the SURTASS designers,

Getting back to SURTASS, TAGOS ships were painted white at first to keep them and their surveillance mission from being identified with the gray-ship Navy. After a year of operations, it was determined that the ships were attracting more attention because of their being painted white! They were repainted gray and remain that color today. TAGOS ships remain today non-combatant, single mission vessels.

T-AGOS ships equipped with SURTASS were deployed in the Atlantic, Pacific oceans, Mediterranean and North Sea. Resupply /replenishment ports included Rota Spain, Yokosuka Japan, Norfolk Va, Honolulu Hawaii, and Glasgow, Great Britain.

Acoustic data from these ships were uploaded to Naval Oceanographic Processing Centers (NOPF) for processing , integration with other IUSS data and reported out to fleet follow up forces. NOPF Norfolk, Va. received SURTASS data from TAGOS ships operating in the Atlantic Ocean and Mediterranean Sea, while NOPF, Ford Island ,Hawaii processed data form TAGOS ships operating in the Pacific Ocean areas.

Between 1984 and 1989, SURTASS equipped T-AGOS ships conducted over 300 missions and steamed over 2.8 million nautical miles while maintaining a system availability of over .95, an extraordinary record.

The high-availability achieved for the shipboard system is due to a solid-system design that minimize single points of failure and includes redundancy for critical mission components, an innovative spare-parts system, and a unique waterfront organization that provides life-cycle support. Possibly the most important factor was a stable pool of well trained, capable and highly motivated operator/maintainers. An effective screening program was key to obtaining and retaining quality personnel.

The early "SURTASS Navy" was unique in that civilians go to sea while the sailors remain on shore. During the early days of program developments, there was great concern about sending these ships to sea on sensitive missions without a government or military presence on board. After much deliberation, the decision was made to proceed as planned with an all contractor crew. History has established this as a sound decision.

Over the years, the SURTASS program continued to evolve and improve its capability as a mobile ocean surveillance system.

One example of this evolution was the development of a platform, the Small Waterplane Area Twin Hull (SWATH), with a higher sea-worthiness capability. The high-sea states of the northern latitudes during the winter months had limited operations of T-AGOS monohulls. The need for a platform capable of conducting surveillance operations in these environments for extended periods with fewer limitations drove the decision to pursue a new design for SURTASS ships. In 1981, NAVSEA awarded a contract for the design of a SWATH SURTASS ship.

This new design provides a platform relatively isolated from the effects of high Sea States (SS) up to and including SS-4, Buoyancy provided by twin hulls located well below the waterline allows the ship to remain stable in high-sea states. A contract for four 3500-ton SWATH ships (the third flight) was awarded to McDermott, Inc. in 1986. The first ship, USNS VICTORIOUS, was delivered in August 1991. Subsequently, sea testing has demonstrated that this class ship provides a highly stable platform under even the most adverse weather conditions(while providing a low self noise profile).

During the mid 1980's, it became apparent that the Soviets would soon be deploying a quieter submarine force, also that third world countries were acquiring and deploying quiet, diesel-electric submarines. In order to counter this trend the SURTASS began to upgrade its ocean surveillance capability. These upgrades included:

- Low frequency active systems
- Development of a new digital receive array for use with both active and passive systems
- Initiation of a block upgrade passive improvement program

Low Frequency Active Systems

In 1986, the Navy initiated the Low Frequency Active (LFA) program and authorized an Advanced Technology Demonstration (ATD). In August 1987, the North American Shipbuilding Company delivered the R/V CORY CHOUEST, originally a North-Sea Pipecarrier ship, to Johns Hopkins/Applied Physics Laboratory for use as the LFA ATD platform. The vessel underwent extensive modifications to accommodate LFA systems: Hydro-Acoustics, Inc. developed the active sources, Hydroscience, Inc. provided the array, and Hughes Aircraft Company developed and integrated the ATD on-board-processing system. This ATD first went to sea on board the CORY CHOUEST in 1989. As a subsequent result of these successful at-sea tests, the SURTASS/LFA program was approved to proceed to Full Scale Engineering Development, Milestone II.

In 1990, Hughes Aircraft Company started development of the EDM receive system, and in 1991 Lockheed Sanders began development of the active-source vertical array. LFA successfully completed TECH and OPEVAL in 1994. LFA operates both mono-static and bi-static modes. (Mono-static is a single platform for both transmitting and receiving while bi-static consists of a single platform for transmitting with other ships being the receiving platforms).

Testing of LFA at sea prompted concerns as to the effect of LFA high power transmissions on the ocean's whale population resulted in the engaging of the scientific and environmental community to investigate the issue. These concerns took several years and significant program resources to resolve. Resolution of the issue included establishing operating limitations in areas where whales were known to migrate, and the setting in place mitigation procedures prior to and during LFA operations.

New Array for Both Active and Passive Systems

In December 1989 AT&T was awarded a contract for development of the SURTASS Reduced Diameter Array (RDA). The array is designed to be used for both active and passive operations. It is smaller in construction than its predecessor (2.3"D vs. 3.5"D); acoustic signals are converted to optical signals and transmitted to the towed ship by fiber-optic cable. An electro-mechanical coupler that connects each array module greatly reduces at-sea maintenance time and increases reliability. Two RDA pre-production arrays were procured. After initial cost and schedule problems the arrays went to sea and performed exceptionally well.

Block Upgrade Passive

The SURTASS Block Upgrade processing system development was initiated in the mid 90's to provide improved signal and data processing capability. When combined with the RDA, the SURTASS Block Upgrade system provided greatly enhanced performance over the current passive system. In a repeat of history, the use of the next generation Navy standard signal processor, Enhanced Modular Signal Processor (EMSP), AN/UYS-2, was mandated for use in the Block Upgrade system. As with the ASP, this was the first integration and use of the EMSP in a Navy system. However, at the time of the introduction of EMSP the idea of using COTS hardware for non-combat applications was gaining support. Consequently, SURTASS LFA quickly picked up on the initiative and transitioned to COTS for signal and data processing applications. The Block Upgrade system was installed on the second SWATH ship, USNS ABLE, and at-sea testing began in February 1993. TECHEVAL/OPEVAL for SURTASSS Block Upgrade system was successfully completed in 1994.

International Expansion

In 1989, a Memorandum of Understanding (MOU) was established with Japan for Japan to provide two Japanese Maritime Self Defense Force (JMSDF) ship and ashore facility to support the US undersea mission, and to fund SURTASS ship and shore mission equipment. This Japanese entry into the undersea surveillance mission was to mitigate the effect of their giving the Soviets plans for manufacturing quiet submarine propellers. "JAOS" systems were successfully installed, tested and installed on JDS HIBIKI, JDS HARIMA and at the JMSDF shore facility. Under the agreement JAOS ship and shore equipment was upgraded along with SURTASS.

Cold War End/Emergence of Littoral Warfare

Since the early 1980s SURTASS has been a highly effective counter to the Soviet nuclear threat. However with the demise of the Soviet Union, that threat has been sharply reduced and, while still a concern, the requirement for long-range detections in deep oceans has been overshadowed by the requirement for detection ranges of tactical significance in shallow, high surface-noise environments against the quiet diesel/electric submarine, which is proliferating within the third world.

Because of the reduced Soviet submarine threat of the Cold War period the SURTASS program started downsizing in the mid 1990s. The TAGOS fleet of 23 ships was gradually reduced in number its current level of 4 SWATH/TAGOS platforms deployed in the Pacific Theater. Concurrently with this downsizing the program began a number of initiatives designed to meet the requirements dictated by the evolution of the diesel/electric threat. These initiatives included LFA bi-static processing, shallow water LFA, twin-line arrays, adaptive beam forming, Full Spectrum Processing, non-traditional acoustic signal processing and automation

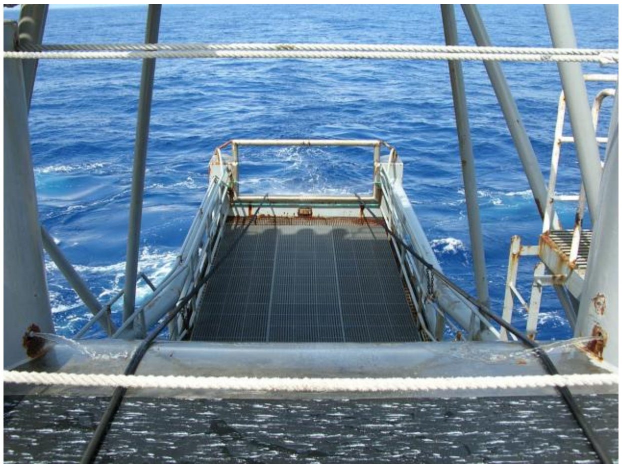
Technology Insertion

LFA Bi-static greatly expands LFA coverage by using other TAGOS ships as LFA receivers. Bi-static allows for the large LFA ships to remain in deep water while smaller ships can operate in shallow restricted littoral water.

Shallow water LFA is a higher frequency system than LFA, which requires smaller and lighter transducers modules and shorter receive arrays. This configuration allows for operations in shallow water and deployment on smaller ships.

Untraditional signals emitted from submarines, e.g. hull contractions and expansions are being exploited as are those signals emitted from the diesel/electric propulsion system.

Twin line arrays which consists of two parallel arrays that resolve bearing ambiguity without the need for ship maneuvering as is necessary with single line arrays. These arrays are shorter and more suitable for smaller ships. Twin lines are being provided to the Japanese SURTASS ships.



Array repair facilities and logistic support facilities located at Norfolk, Virginia and Pearl Harbor, Hawaii were consolidated into a single facility at Norfolk. Fewer operational T_AGOS ship days requires operating out of remote ports nearer OPAREAS, thereby reducing transit time and costs associated with returning to homeports. Array modules and critical spare parts are located at these ports to ensure rapid response to maintenance requirements.

As in most programs with longevity, SURTASS has its share of folklore.

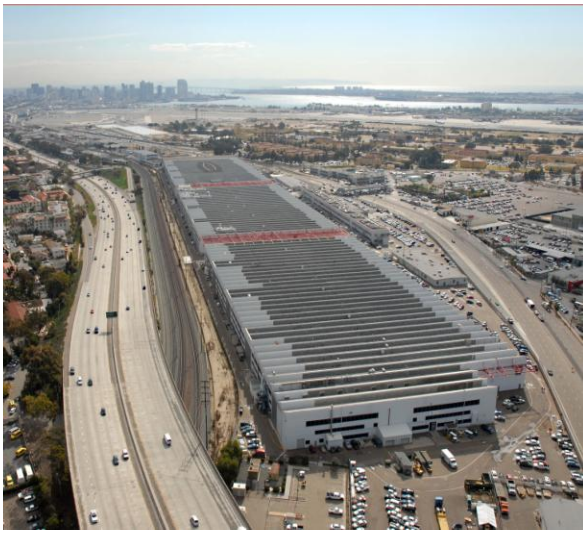
According to “certain SURTASS sources,” the first time that power was applied to the shore system at NH-95 in Norfolk, Virginia, there was an “explosion”! It is reported that smoke filled the room and the imaginations ran wild in the confusion that followed! The “explosion” turned out to be the result of a reverse voltage diode shorting out. After the smoke cleared and the diode was replaced, the system was successfully powered up and…so were the stories.

Another favorite SURTASS tale is the one about the first message sent via satellite from the MOANA WAVE moored at Fort Lauderdale to the shore system in Virginia at NH-95. The message was, “What has Roland wrought?” In this message, “Roland” referred to CDR Roland Evans, the Program Manager at the time, and the phrase was taken from Thomas Edison’s famous first telephone message.

In the early 1980s, SMURF meetings were established between SPAWAR, NAVSEA and MSC to discuss and resolve ship and mission equipment-related issues before they impacted cost, schedule, or performance. You might expect “SMURFs” to be a program-related acronym, but actually it related to football and the Washington Redskins. During the 1982, the Washington Redskin’s wide receivers, named themselves the SMURFs, and supported each other with ‘high fives” in the end zone after each touchdown. (The NFL later prohibited this) The Redskin SMURFs exemplified the idea of teamwork, so… the SURTASS group adopted the name and initiated “SMURF Meetings” to show the camaraderie and the spirit of teamwork that existed among the three commands!

Base Realignment and Consolidation (BRAC)

In 1997 the BRAC directed move of SPAWAR to San Diego was completed and SURTASS took up its new home along with other IUSS programs in the World War II era B-26 aircraft production hangers on Pacific Coast Highway.



The hangers were an interesting place full of history and the layout of the IUSS programs stretched from one end to the other, a measured distance of 100 yards. A skate board was provided to the PD80 Director but he refused to use it. The commute for most was shorter and an agreement with the USMC Recruit Depot across the highway allowed SPAWAR employees use of their physical fitness facilities

1997-200 Period

SURTASS continued to down size its mono hull fleet while adding TAGOS 23 Large SWATH to the fleet. TAGOS 23 was designed and built for LFA installation. Environmental issues with LFA active continued to be addressed with various organizations. The NAVSEA submarine ARCI acoustic processing and display software transition to SURTASS application was initiated. Operational focus was shifting to the Pacific theater as was maintenance and support. Twin line arrays were being built at the Support Center at Norfolk for the JAOS program. Then there was the Y2K mitigation effort to ensure that Y2K would not negatively impact SURTASS. This was a major effort and a successful one!

SURTASS 2010

At this point we fast forward from September 2000 when SURTASS was still part of PD 80/PMW182 to the year 2010. IUSS programs transitioned from SPAWAR PD80 to NAVSEA Maritime Surveillance Systems Program Office (PMS425), with the Directorate financial and program management functions relocated to Washington, D.C.

Four SWATH ships continued to be deployed in the Pacific with an additional vessel under construction. The submarine TB-29 Twin Line array became the standard array for SURTASS and the JAOS programs. Several improvements were developed and implemented to improve twin line array availability in the harsh environment of Littoral waters, these included an improved Y joint where the array meets the tow cable to reduce entanglement; Heading and Roll Control to provide better stability; tow cable tension meters and finally an Array Knowledge Board display to increase awarement of the array status.

Compact LFA is currently undergoing it shakedown on small a SWATH and should become an operational asset in late 2011.

In summary, SURTASS continues to provide an effective mobile wide area undersea surveillance in support of fleet tactical missions as well as our nation's strategic mission objectives. The program continues to focus on system availability, technology insertion to counter to emergent threats, personnel training and retention, and commonality across platforms to reduce costs and improve operational effect.

SURTASS was a product of the Cold War, designed, developed and deployed to counter the Soviet deep ocean nuclear submarine threat. Today the threat and threat environment has changed and so SURTASS has changed. Implementation of design changes provides SURTASS the capability to counter both the new threat and adapt to the littoral environment. Hence, SURTASS will remain an effective undersea surveillance asset well beyond the period covered by this "History of SURTASS".

SURTASS 2115

Again we fast forward to 2015, Compact LFA is operational and installed on small SWATH ships TAGOS 19, 20 and 21. TAGOS 22 is a passive system only. TAGOS 23 continues as a LFA ship. Currently all ships are forward deployed out o f the U. S. Fleet Activities Sasebo, Japan.

The next generation TAGOS ships are in the Navy's Ship Construction Plan that the Navy provides to Congress , but is beyond the FYDP

Foot Note:
The History of SURTASS is a collection of documents produced over the years defining the program, of inputs from past and present SURTASS team members , and remembrances from my 25 years as a SURTASS project engineer, deputy program manager and program manager