UYS-2(V) - Archived 07/2002

Outlook

- No further production expected

- Spares and support activity only

- This report will be archived next year, 2002

10 Year Unit Production Forecast
2001 - 2010

Units

NO PRODUCTION FORECAST

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
⊠	0	0	0	0	0	0	0	0	0	0

Years
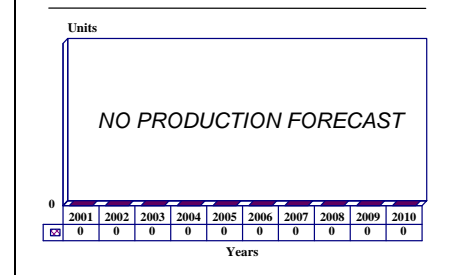
Orientation

Description. The UYS-2(V) is the US Navy's Enhanced Modular Signal Processor (EMSP) for acoustic systems.

Sponsor

US Navy
  Naval Sea Systems Command (NAVSEA)
  PMS-412
  Washington, DC
  USA

Contractors

Lucent Technologies Federal Government Solutions
  (formerly AT&T Federal Systems Advanced Technologies)
  9305 Gerwig Lane
  Columbia, Maryland (MD) 21046
  USA
  Tel: +1 410 290 3915
  Web site: http://www.lucent.com/gov
  (Prime: Development/production)

Secondary Contractors

Raytheon Co
  (acquired Hughes Electronics Corp which acquired
  Alliant Techsystems Inc Marine Systems)
  4040 23rd Avenue W
  Seattle, Washington (WA) 98199-1209
  USA
  Tel: +1 425 356 3000

  Web site: http://www.raytheon.com
  (UYS-2 VHSIC supplier)

TRW Inc
  Systems Integration Group
  One Federal Road
  Fairfax, Virginia (VA) 22033
  USA
  Tel: +1 703 968 1000
  Web site: http://www.trw.com
  (Engineering and integration support)

Status. In operational service. Both the limited production SEM-B version and the full SEM-E version production runs have been completed.

Total Produced. An estimated 280 (all variants) units have been produced. (Estimated production breakdown is: UYS-2(V) SEM-B, 35 units; UYS-2(V) SEM-E, 241 units; and UYS-2A(V) SEM-E, 4 units for Spain.)

Application. The UYS-2(V) EMSP is a modular, state-of-the-art, distributed parallel signal processor to provide increased performance capability for multiplatform ASW weapon systems, specifically including SQQ-89 Surface Ship Combat System, BSY-2 Submarine Combat System, Surveillance Towed Array Sensor System (SURTASS), and the Airborne Low Frequency Sonar (ALFS).

Price Range. Based on 1992 program plans from the US Navy for 150 units of the UYS-2A(V) SEM-E, the average per-unit price was estimated at US$1,766,666.

Technical Data

Design Specifications. As a second-generation Navy Standard Militarized Digital Signal Processor, the UYS-2(V) uses a unique dynamic data flow architecture that allows easy growth and technology insertion. The EMSP hardware set consists of eight functional elements:

- Scheduler (assigns processing tasks to available processing resources);

- Global Memory (stores data and processing instructions);

- Data Transfer Network (transfers data between functional elements);

- Command Program Processor (control processor providing operating system, graph management, system control and built-in test);

- Arithmetic Processor (performs the control, arithmetic and memory functions necessary to execute preprogrammed primitives);

- Input/Output Processor (provides digital interface to external devices);

- Input Signal Conditioner (translates analog signals into the digital language of EMSP and digital signals to analog); and

- Data Processor (executes user programs in Ada, can perform its own input/output).

Each functional element (FE) consists of a group of Standard Electronic Modules (SEMs), with some FEs using many of the same SEMs. Its modular configuration allows a mix of arithmetic processors, global memories, and input/output processors, etc.

SEM-B. Two versions of the SEMs have been produced. The first model known as the Standard Electronic Module Format B (SEM-B). The SEM-B was earmarked for surface ship and submarine applications. Performance specifications for the SEM-B are as follows: Raw Throughput, 84 million floating point operations per second (MFLOPS); Sonobuoy Capability (DIFAR), 35; Reliability (predicted MTBF), 1,650 hrs; Computing Precision, 16-bit or 32-bit floating point arithmetic; Programmability, CMS-2 and flow graphs; Technology, Medium/Large-scale ICs, VHSIC 1 megabit memory ICs; Unique Card Types, 47; and Power Requirements, 3,700 watts. The SEM-B is capable of 120 MFLOPS. A SEM-B SURTASS machine sized at nine arithmetic processors is capable of 756 MFLOPS.

Production versions of the SEM-B, as well as the follow-on SEM-E, feature VHSIC chips which enable the UYS-2(V) to perform 32-bit floating point arithmetic, providing 46 percent more throughput than the less-versatile 16-bit fixed-point arithmetic processor originally developed for the SEM-B.

SEM-E. Performance specifications for the SEM-E are as follows: each Arithmetic Processor features 120 MFLOPS, 32-bit floating-point arithmetic, 4 pipe single instruction multiple data architecture, 1 multiply and 2 adds per pipe per cycle. Each Global Memory has a 16 million 16-bit word capacity, 20 million words per second direct memory access rate, and self-contained queue management. The Input Signal Conditioner provides 64 digital/analog input channels (max), 12-bit A/D conversion, high A/D conversion, and 12 analog outputs (max).

The Command Program Processor, the Input/Output Processor and the Data Processor each feature up to 15 standard input/output channels, user programmable in Ada, and up to 24 megabytes of non-volatile memory. The Data Transfer Network includes the Electronic Crossbar switch; 4, 8, or 16 full access, non-blocking two-way paths; and 20 million 32-bit words per second per two-way path. The Scheduler has a 64,000 executing node capacity and greater than 10,000 nodes per second.

The SEM-E version offers improved performance over the SEM-B to include Arithmetic Processors and Global Memory that are 1.42 percent faster, faster Input Signal Conditioner, and a superior non-volatile memory which reduces program loading from minutes to seconds. The SEM-E variant repackages the SEMs onto larger circuit cards using high-density gate arrays and memory devices, about 3,800 devices total, with half devoted to memory. In comparison, a SEM-B card has 25,000 devices with 30 percent devoted to the memory function. The SEM-E improves error reporting and processing to include on-line fault localization support, better error recovery, and concise error messages; off-line fault localization load image size is significantly reduced. Repackaging of the UYS-2(V) to SEM-E reduces weight, power, volume, and cost.

Operational Characteristics. The UYS-2(V) employs a unique application software that is divided into two categories: application and command programs. The application programs represent the implementation of a signal processing application, while the command programs control the starting and stopping of individual signal processing applications.

Each signal processing application is broken down into a series of primitive processing steps such as FIR filters, Fast Fourier Transforms, and complex vector operations. The EMSP Primitive Library contains over 300 microcoded primitives representing a large set of general and special purpose signal processing algorithms which can be downloaded to each Arithmetic Processor (AP) element during system initialization. Primitive availability covers signal processing to include temporal and spatial filtering, spectral analysis, correlation, noise estimation, angle of arrival and tracking. Other primitives cover matrix operations, data comparison and data conversion. Application specific primitives can be easily added.

These primitive processing steps are represented in an EMSP signal processing application as graph nodes connected by data queues which represent the input and output data streams of the particular nodes. Each graph node represents a signal processing primitive that performs a particular processing step. Each queue has stored in the Global Memory (GM) a set of descriptive parameters such as the size of the queue, the type of queue data, and data threshold of the queue. In the EMSP data flow machine, a node is executed when all its input data queues are over their assigned thresholds, its output query is empty, and a processing functional element is available to execute the node.

The EMSP signal processing graphs are implemented using a very high order signal processing language called the Signal Processing Graph Notation (SPGN). The SPGN language consists of descriptions of each node found in a graph along with its associated input and output queues and control parameters. Using SPGN, the application designer has only to be concerned with the actual processing steps and not the processing algorithms. One line of SPGN source code is equal to 20 lines of assembly language object code.

The Command Program controls which application graph will be executed within the EMSP and what input and output data streams will be. The Command Program resides in a special functional element, the Command Program Processor (CPP), and is written in Ada. An additional function of the Command Program is to act as the interface with the operators who can control graph execution parameters. The Command Program can also be designed to reconfigure an EMSP system to continue processing in a degraded mode.

Variants/Upgrades

UYS-2(V) SEM-B. The first model, known as the Standard Electronic Module Format B (SEM-B), was earmarked for surface ship and submarine applications.

UYS-2(V) SEM-E. The modular construction of the UYS-2(V) allows for various mixes of functional elements to form versions to meet unique user requirements. The SEM-E version is packaged in five different configurations for the following ASW programs: BSY-2, ALFS, SURTASS, and SQQ-89. The BSY-2 configuration is liquid cooled while the other four are air cooled.

UYS-2A(V) SEM-E. Variant sold to Spain.

Program Review

Background. In August 1982, AT&T was selected as the prime for development of the EMSP/UYS-2(V) as the next-generation replacement for the service's IBM UYS-1(V) signal processor designed in the mid-1970s. AT&T won out against several contenders to include the team of IBM/Raytheon/Westinghouse, the Control Data/General Electric/Gould team, the Magnavox/GTE Sylvania team, and Hughes Aircraft, which bid alone. The initial contract award was for US$66.2 million.

The original procurement strategy called for 500 to 700 UYS-2(V) SEM-B systems for application to the improved version of the SQQ-89 surface ship ASW combat system. The SQQ-89 would be fitted to AEGIS cruisers/destroyers and the FFG-7. Other SEM-B applications included the planned upgrade for the Surveillance Towed Array Sensor System (SURTASS), towed by T-AGOS class ASW ships, the Submarine Advanced Combat Systems (SUBACS) – the BSY-2 to be deployed on the SSN-21 Seawolf class attack submarines, and the Fixed Distribution System of seabed-anchored sonar receivers.

A lightweight version was to be spun off for aircraft applications such as the planned P-3C Update IV. Subsequent aircraft applications have been expanded to include the P-7A LRAACA, the SH-60F CV Helo/ Airborne Low Frequency Sonar (ALFS) and the

SH-60B LAMPS Mk III Block II upgrade. The first airborne SEM was delivered to the Navy's P-3C Update IV program in late April 1990.

By late 1988, the UYS-2(V) program was suffering from lack of support from some of the ASW programs, with which UYS-2(V) was slated to integrate. The SQQ-89(V)10 was to receive the largest percentage of UYS-2(V) SEM-B users, but conflicting priorities over various congressionally mandated ASW equipment priorities (UYS-2(V) and the Acoustic Video Processor) pushed the SQQ-89(V) integration out to a point where it would coincide with availability of the more advanced SEM-E, slated for the mid-1990s. At the same time, SURTASS program managers requested that their program be exempted from the UYS-2(V), but the Secretary of the Navy shot down this request. Not wanting to be left out of a possible coup, IBM recommended an improved version of its UYS-1(V) signal processor as a lower-cost alternative to some of the UYS-2(V)'s applications.

During 1989, a total of 16 UYS-2(V)s, in 12 enclosures, were delivered to the Navy. In addition, three Signal Conditioners (which interface sonobuoy receivers with the UYS-2(V)) were delivered for the P-3C Update IV program. According to AT&T, as of December 31, 1989, the SEM-B units in place in major programs (P-3C Update IV, SURTASS, BSY-2, SQQ-89, and FDS) had logged over 118,000 hours of operation. The SEM-B was scheduled to be deployed on two programs, the BSY-2 and SURTASS.

Delays in getting the SEM-B into production brought it to the point where it would be quickly superseded by availability of the SEM-E, a more powerful and compact version. As such, procurement projections for the SEM-B dropped from some 600 units to less than 50 (including developmental units). In 1990, Navy UYS-2(V) procurement requirements were put at 625 systems, of which half were for airborne applications.

The Navy went ahead with a limited procurement of the EMSP SEM-B to satisfy initial SURTASS and BSY-2 requirements and maintain the production base for the UYS-2(V). A total of 24 SEM-B production systems have been procured for SURTASS and BSY-2, in addition to some 16-20 engineering models that have already been delivered to the Navy. Production of the SEM-B units began in FY90.

EMSP program accomplishments in FY93 included: competing DT-IID testing and operational assessment; conducting risk mitigation IV & V testing and Beta Level Application Testing; and supporting software development, integration, testing, critical engineering design support for Development and Operational Testing (DT/OT) for user systems (SEM-E). During FY94, the program activity centered on the following: continuing DT-III Testing (Reliability Demonstration), as well as continuing ASIP which included acceptance testing; supporting software development; and continuing Beta Level testing. The agenda for FY95 called for continuing the previous year's work schedule.

Demonstration testing (i.e., reliability demonstration) was conducted in FY96. Additional work focused on supporting software development, integration, testing, and critical engineering design support for Development and Operational Testing for ALFS, SURTASS, SQQ-89, P-3C, BSY-2, and destroyer DDG-993 class systems. Efforts during FY97 continued along with much of the work from FY96, including risk mitigation IV&V testing.

Plans for FY98 called for supporting software changes for integration, testing and critical engineering design support for development and operational testing for ALFS, AN/SQQ-89, P-3C, AN/BSY-2, and DDG 993 systems. FY99 continued the work from FY98. All work involving the UYS-2(V) has been completed. Any future activity for this specific system will focus on joint program integration as the remaining efforts within the EMSP program are concentrating on integrating commercial-off-the-shelf (COTS) hardware and software with the US Navy's SQQ-89.

Note: The UYS-2(V) EMSP is also involved in other projects, such as SURTASS (Surveillance Towed Array Sensor System) which underwent a major conversion from EMSP SEM-B to SEM-E signal processors. A detailed report on this system can be found under the title **SURTASS**, in the *Anti-Submarine Warfare* and *Land & Sea-Based Electronics* books.

Funding

The UYS-2(V) is also included in the funding of other programs and systems. Primary development funding comes from PE#0604507N Enhanced Modular Signal Processor (formerly PE#0604507N Navy Standard Signal Processors).

US FUNDING

| | FY00 | | FY01 | | FY02 | | FY03 | |
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (US Navy) PE#0604507N Enhanced Modular Signal Processor Project V1440								
EMSP/UYS-2	–	0.9	–	0.8	–	1.1	–	1.2

| | FY04 | | FY05 | | FY06 | | FY07 | |
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (US Navy) PE#0604507N Enhanced Modular Signal Processor Project V1440								
EMSP/UYS-2	–	1.3	–	1.4	–	N/A	–	N/A

All US$ are in millions

RDT&E Source: US Department of Defense FY2001 RDT&E R-2 Budget Item Justification

Recent Contracts

Contractor	Award ($ millions)	Date/Description
AT&T	26.0	Mar 1992 – CPFF incrementally funded modification for additional UYS-2(V) SEM-B & SEM-E integrated program support. (N00024-92-C-5200)
AT&T	45.6	Mar 1992 – Letter contract for UYS-2A(V) production units. The definitized contract is expected to be a firm fixed price, Multi-year contract, with economic ordering quantities of materials authorized. Approximately 150 production units are expected to be procured over five program years at an estimated value of US$265 million. Completed March 1998. (N00024-92-C-5211)
AT&T	26.6	Sep 1992 – CPAF letter contract for the system engineering, design, analyses, testing and related engineering efforts and services to convert the SQQ-89 signal processing software form the UYS-1 to the UYS-2(V) EMSP SEM-E. Completed August 1995. (N00024-92-C-6316)
AT&T	6.2	Apr 1994 – Contract for integrated program support for the UYS-2(V) EMSP. Completed April 1996. (N00024-94-C-6363)
AT&T	35.6	Jan 1995 – FFP contract for 126 units of the UYS-2A(V) SEM-E production units and kits. Completed April 1997. (N00024-92-C-5211)
AT&T	26.1	Jan 1996 – Modification to previously awarded contract for Fifth-Program Year requirement of the multi-year contract to provide the UYS-2A(V) production units and kits for the US Navy's next-generation standard signal

Contractor	Award ($ millions)	Date/Description
		processor. Completed April 1997. (N00024-92-C-5211)
Lucent	43.0	Aug 1997 – CPFF contract for integration program support for the UYS-2(V) EMSP program. Contract is expected to be completed by May 2002. (N00024-97-C-6361)
Lucent	10.5	May 1998 – Modification to previously awarded contract for four (4) UYS-2A(V) SEM-E production units for the Government of Spain under the Foreign Military Sales (FMS) program. The UYS-2A(V) SEM-E provides signal processing solutions which perform computational intensive processing of sensor signals for major air surface and subsurface acoustic systems. Contract completed September 1998. (N00024-92-C-5211)

Timetable

Month	Year	Major Development
Sep	1981	Navy initiates EMSP engineering development program
Aug	1982	AT&T awarded full-scale development contract for EMSP
Jun	1989	Navy reorganizes program; emphasis on SEM-E
	FY1990	Initial low-rate production of SEM-B
Mar	1992	Navy contracts for 150 UYS-2A(V) SEM-E units
	1993	Initial low-rate production of SEM-E
Jan	1995	SEM-E production contract awarded
	FY1996	Completed Demonstration Testing III (Reliability Demonstration)
Nov	FY1997	Detailed design review
May	1998	Four UYS-2A(V) SEM-E units sold to Spain
Spring	FY1999	Acceptance Test Readiness Review

Worldwide Distribution

This is a **US Navy** program, with four (4) UYS-2A(V) SEM-E units sold to **Spain** in 1998 under the Foreign Military Sales program.

Forecast Rationale

Production for the UYS-2(V) (all variants) is believed to be completed. The order of four UYS-2A(V) SEM-E units from Spain in 1998 under the US Foreign Military Sales program was construed as more of a political move rather than a spark in a possible international market. No further production other than for spares or support is expected.

Ten Year Outlook

Production complete. The forecast chart has been omitted. **This report will be archived next year, 2002**.

*   *   *