

INTRODUCTION

The authors listed in the heading collaborated to provide significant details about the AN/UYK-43 computer development. Thanks to the Club's newsletter editor, Mary Beth Ruhland for grammatical and punctuation editing. This update supersedes the 2008 Legacy Anthology entry by Lowell Benson and John Westergren; copied on pages 6 & 7 below. An epilogue including links to associated Legacy Anthology articles is on page 5. This paper was re-formatted for the web by Lowell, <https://vipclubmn.org/cp32bit.html#UYK43>.

3.5 AN/UYK-43 Updated November 2025

The AN/UYK-43 is the third generation Naval Tactical Data System (NTDS) large-scale mainframe computer that was specified as the emerging AN/UYK-7 replacement, [first generation USQ-17 and USQ-20 computers had transistor electronics and the second generation UYK-7 had integrated circuit electronics]. The UYK-43 was conceived by the Navy's engineers in Naval Electronic Systems Command (NAVELEX), Washington, D.C., and numerous Navy laboratories around the country. A competitive solicitation and eventual "fly-off" was conducted between the two premier computer developers at the time, International Business Machines (IBM) and Sperry UNIVAC. The development and production contract was won by Sperry UNIVAC in 1981. Sperry Defense Systems Division subsequently became Unisys/Loral/Lockheed Martin. Our Stories posted July 2007, <https://vipclubmn.org/Articles/CPFwin.pdf>; page 4 therein has the AN/UYK-43 contract win article, written by Michael A. Bukovich.

UNIVAC had also provided the computers for the Navy's first two generations, starting with responding to the Navy's requirements in the 1950s for a general-purpose, real-time, shipboard, multipurpose, programmable computer, the AN/USQ-17. The UYK-43's innovations included a designed-in maintenance processor¹, cache memory for performance enhancements, Instruction Set Architecture (ISA) improvements, plug-in North Atlantic Treaty Organization (NATO) serial interface, fault/failure tolerance, and numerous manufacturing innovations. Much of the logic design was implemented using gate array technologies. Many of these innovations pushed the state-of-the-art beyond what was previously available. Even though its basic architecture and design was complete in the mid-1980s, it was still performing in multiple mission critical combat systems throughout the surface and subsurface Navy 30+ years later. [John Westergren]

In situations when an incoming missile or aircraft are threatening a vessel, microseconds become critical. Making timely, accurate, quick decisions saves lives. Much of the design of each of the AN/UYK-43 areas described below was performed cohesively in concert to achieve that real-time response.

¹The maintenance processor was the result of an Internal Research & Development (IRAD) project; item 3 on page 12 of <https://vipclubmn.org/PeopleDocimg/Vol1Book01.pdf>.

Packaging: Since the UYK-43 was destined to become the Navy's standard computer for multiple systems, it needed to be easily installed on both surface ships and submarines. The submarine requirement caused the unit's physical size to be designed to fit through a standard submarine hatch, and the unit was subsequently loaded onto many vessels like torpedoes were loaded. This single requirement demanded that a number of innovative packaging approaches be taken, with eventual manufacturing and production challenges, each meeting the Navy's requirements of the day.

Cooling: The dense packaging of electronics in the UYK-43 enclosure generated a huge amount of heat. The most efficient method of removing that heat from the unit was through a complex method of heat exchangers to a water-cooling system, and on to the ship's cooling system. This significantly increased the ability to tightly package the electronics while keeping them at an efficient operating temperature that extended their life and optimized their performance.



Instruction Set: Computers execute instructions as defined by their program and programmers. The AN/UYK-43 utilized the basic instructions previously developed for its AN/UYK-7 predecessor, taking full advantage of the huge investment already made by the Navy in mission critical application programs. More efficient instructions were also developed for the AN/UYK-43 to improve the computational capability of the processor: floating point arithmetic, trigonometric functions, etc. The combination of improved memory access, gate array, and packaging techniques took giant leaps in technology to improve processing performance speed. The support software was also upgraded to take advantage of the new capabilities and technology.

Processing: No processor packed more power and capability into such a small package as the UYK-43. Only later, as processing technology continued to improve, were others able to attain the levels of performance provided by the UYK-43 to the Navy's many applications.

It remained in use over 30 years (and counting) after its original design, which is unparalleled in commercial computing and processing technology. Imagine still being able to effectively use a processor that you were using 30, 20, or even 10 years ago. The innovative architecture that stretched the bounds of memory, large-scale circuit integration, packaging, cooling, and manufacturing technology came out of close cooperation between the U.S. Navy customer and the Sperry-UNIVAC development team.

The AN/UYK-43 design team exercised the engineering disciplines comparable to those teams who created the 1967 45-year CP-901, item 9 of <https://vipclubmn.org/Articles/OceanSurveillance.pdf> and the 1971 40-year FAA IOP, <https://vipclubmn.org/aircontrol.html#Genealogy>.

Gate Arrays: The UYK-43 led the usage of Large-Scale Integration (LSI) gate arrays where hundreds of thousands (eventually millions) of integrated circuits can be produced on a single piece of silicon. This greatly increased the speed and efficiency of performing the computer instructions and calculations which previously used discrete/individual logic circuit devices. UYK-43's usage of LSI significantly increased performance and the ability of mission-critical defensive or offensive systems to respond to demands much more effectively.

This was proven repeatedly, e.g., in 2008 with the destruction of a failing satellite by the Aegis cruiser, USS Lake Erie. The UYK-43 computer is the central processor for the Aegis combat system which allowed an SM-2 missile to have a direct/physical impact with the 17,000-mile-per-hour failing satellite — a bullet hitting another bullet.

Memory: The UYK-43 made major advances in storage memory technology through the usage of much faster semiconductor memory technology versus the previous core memories. This was done for both main memory and cache memory, utilizing the fastest memory technologies available for actual instruction execution. However, to populate/load that cache, one additional architecture innovation had to be developed and that was to do multiple memory references simultaneously in anticipation of the processor needing that information. This had never been done before and became an industry standard approach used today.

Fault Tolerance and Recovery: Never before, had a computer been architected to be able to diagnose, isolate, and reconfigure itself so it could stay operational, and then inform its human operators of the situation so they could make effective repairs without impacting the overall system operation.

Input/Output: The UYK-43 was recognized throughout the computer industry as being one of the very best at quickly and efficiently bringing in large amounts of external sensor and other data. Then, after the central processors make the appropriate calculations and determinations, get that information to a human quickly. In situations when an incoming missile or aircraft is threatening a vessel, microseconds become critical. Making timely, accurate, quick decisions saves lives!

Technology Insertion: From inception, technology insertion was part of the Navy's plan and supported by Sperry. During its life cycle, multiple technological upgrades were planned and made available. This was made possible by the increased speed, complexity, and capacity of the semiconductor technologies, including larger gate arrays and memory capacity. A few of the upgrades included: higher performance processor and Input/Output Controller (IOC), higher capacity and faster memories, and the optional Tactical Control System (TCS) coprocessor for the submarine community and other users. The support software was also updated to take advantage of the increased capabilities and performance.

Manufacturing: None of the above could have been accomplished without taking all the innovative design approaches to "practice" and being able to efficiently and cost-effectively produce computers as required by the Navy.

New methods for printed circuit board and cable manufacturing had to be created. LSI fabrication techniques pushed the state-of-the-art of silicon fabrication. New approaches to electronic assembly, integration, and testing were conceived and put into practice daily to produce a reliable product for the Navy. Many of today's accepted Lean Six Sigma methods and practices were started on projects like the UYK-43. [John Westergren]

Reliability: The UYK-43, because of its cooling system design meeting the Navy's initial requirements, has been recognized for having very high reliability. According to Sperry/Lockheed Martin Quality personnel, based on Navy data around 2010 it was the most reliable computer in the Navy combat systems.

Production unit team leaders are pictured here under, note the three authors.



Left Side: Dave Kaminski, Bob Jablonski, John Westergren, Tom Krocheski, Fred Sauer

Right Side: Gary Hokenson, Jim Bratsch, Doug Wiedenman, Don Fodness, Paul Richardson

Other Key Engineering Personnel Not Pictured: Jack Metzger, Finley McLeod, Dale Wandersee, Jerry Pertl, Roy Brandenburg, many talented engineering personnel, BJ Bertram, and the Software Group.

EPILOGUE

In May 2012 we had posted a synopsis of the AN/UYK-43 Computer written by Unisys/Lockheed Martin engineer David Shelander, <https://vipclubmn.org/Articles/AnUyk43Computer.pdf>. That paper includes a scanned 1984 letter from J. A. Mallonee, US Navy AN/UYK-43 project manager. Mr. Mallonee shakes Jerry Nickel's hand, Jerry was on the Sperry UNIVAC program management team.



There is an AN/UYK-43 on display at the Lawshe Memorial Museum in South St. Paul, MN – shown with volunteer Bob Pagac.



The Museum also has a history poster “*The Enduring Legacy of the Naval Tactical Data System*,” <https://vipclubmn.org/EngDocImg/15.%20Q-70.pdf> which includes some AN/UYK-43 summary information. Part of the text thereon is: “*First put to use in 1984 these computers are gradually being replaced by AN/UYQ-70 units. However, some UYK-43s will remain in service into the 2020s.*”

AN/UYK-43 Serial #1,000 was delivered September 13, 1994 – a decade after the first delivery in 1984. Left to right were Mike Bukovich, Unisys Marketing; Ernie Martaga, Advanced Physics Lab (APL) at Johns Hopkins University; Ken Wander, APL; Joe Mallonee, Naval Sea Systems Command (NSSC); and Dave Watson, NSCC.



The authors of cp32bit.html Computers Chapter 55, section **3.5 Updated November 2025**, are proud to have been part of this Sperry-UNIVAC AN/UYK-43 Excellence in Engineering! Thanks to Bob, Doug, and John for providing this update to our Legacy Anthology, <https://vipclubmn.org/People7.html#Westergren>. Thanks Mary Beth for fixing punctuation errors sentence structure hiccoughs.

LABenson, VIP Club Historian.

Original Chapter 55, section 3.5 text:

The AN/UYK-43 is the third generation (USQ-20 [1st] to UYK-7 [2nd] to UYK-43) NTDS computer and was specified as the emerging AN/UYK-7 replacement. It was conceived by the Navy's engineers in NAVELEX, Washington, and numerous Navy laboratories around the country. A competitive solicitation and eventual "fly-off" was conducted between the two premier computer developers at the time, IBM and Sperry Univac. The development and production contract was won by Sperry Univac in 1981, eventually becoming UNISYS/Loral/Lockheed Martin. Univac had also provided the computers for the first two generations starting with responding to the Navy's requirements in the 1950's for a general purpose, real-time, shipboard, multi-purpose, programmable computer, the USQ-20. The UYK-43's innovations included a designed-in maintenance processor*, cache memory for performance enhancements, plug-in NATO Serial interface, instruction set architecture (ISA) improvements, fault/failure tolerance, and numerous manufacturing innovations. Much of the logic design was implemented using Gate Array technologies. Many of these innovations pushed the available state-of-the-art beyond what was previously available. Even though its basic architecture and design was complete over 30 years ago, it is still performing in multiple mission critical combat systems throughout the surface and sub-surface Navy today. [John Westergren]

*The maintenance processor was the result of an Internal Research & Development project. [lab]

A bit of irony is that in the late 70s, UYK-7 enhancement studies project contracted with two University of Minnesota professors, Dr. Peter Paton and Dr. Bill Franta, to do cache memory performance studies. They used Fortran software executing on the CDC 1604 to obtain performance results for several cache architecture designs. These studies provided data to help design the AN/UYK-43 system and to solve a subsequent cache memory 'I/O flushing' problem in the commercial 1110 computer series. Lowell Benson was the engineering manager responsible for interfacing with the University. Dave Kaminski was the lead design engineer - he later was one of the AN/UYK-43 design engineers. [lab]

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