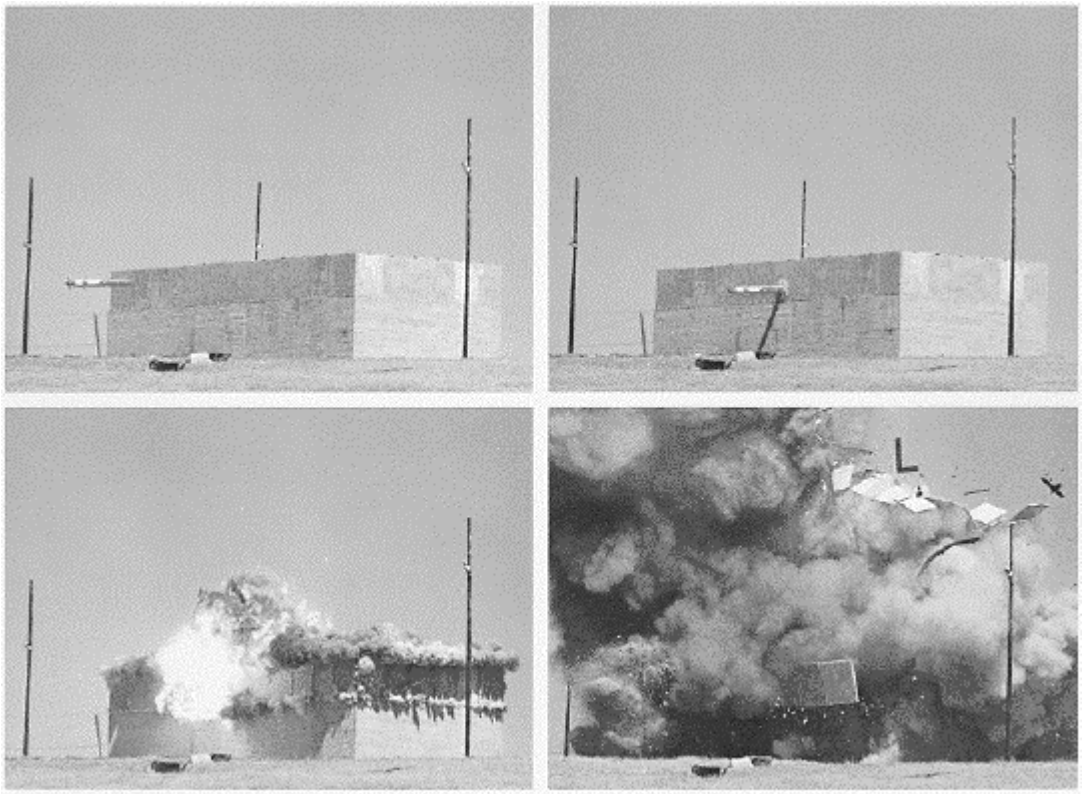
TOMAHAWK



THE CONVENTIONAL TOMAHAWK, DEVELOPED BY HUGHES MISSILE SYSTEMS COMPANY, PERFORMS HORIZONTAL TARGET ATTACK.

Navy ACAT IC Program

Prime Contractor

Raytheon

Baseline III and Prior

Total Number of Systems:	2,805 missiles
Total Program Cost (TY$):	$12,481M
Average Unit Cost (TY$):	$1.4M
Full-rate production:	3QFY84

Baseline IV Tactical Tomahawk

Total Number of Systems:	1,365 missiles
Total Program Cost (TY$):	$1,863.4M
Average Unit Cost (TY$):	$1.4M
Full-rate production:	3QFY03

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

Tomahawk is a long-range cruise missile designed to be launched from submarines and surface ships against land targets. Three primary variants are currently operational: (1) Tomahawk Land Attack Nuclear (TLAM-N) (not deployed); (2) Tomahawk Land Attack Missile-Conventional (TLAM-C); and (3) Tomahawk Land Attack Missile-Conventional Submunition (TLAM-D). Each missile is contained within a pressurized canister to form an all-up-round (AUR). The submarine AUR is launched from

torpedo or vertical tubes. Surface ships employ a vertical launching system (VLS) to launch various missile types, including the Tomahawk AUR. Engagement planning, missile initialization, and launch control functions are performed aboard the launch platform by a Combat Control System (submarines) or Tomahawk Weapon Control System (TWCS) (surface ships). Targeting, mission planning, and distribution of Tomahawk tactical data are supported by the Tomahawk Command and Control System (TC2S).

Tomahawk provides a recognizable example of a ***precision engagement*** system in the U.S. inventory, and has done so since its IOC in 1984. Upgrades leading to the Block III TLAM-C and TLAM-D configurations have improved the system's flexibility. Additional technological innovations are currently in development, and are envisioned to further increase Tomahawk's responsiveness and exploit ***information superiority*** to a very high degree.

BACKGROUND INFORMATION

Development of the Tomahawk began in 1972. The program originally included a Tomahawk Anti-Ship Missile (TASM) in addition to the three land-attack variants. IOT&E began in 1981. DOT&E submitted B-LRIP reports for TASM and TLAM-N in 1984; TLAM-C in 1985; and TLAM-D in 1991.

The Block III upgrades to TLAM-C and TLAM-D include: (1) Global Positioning System navigation; (2) improvements to the terminal update system (DSMAC IIA); (3) time-of-arrival control; and (4) a new warhead for TLAM-C. The Tomahawk Weapon Control System software was also upgraded to a Block III configuration. A major upgrade to the Theater Mission Planning Center (TMPC) (hardware and software) was undertaken at approximately the same time. Operational Test and Evaluation of the Block III AUR was completed in FY92 and TWCS testing was completed in FY93. Operational Test and Evaluation of the upgraded TMPC was completed in FY94. End-to-end FOT&E of the Block III Tomahawk Weapon System (TWS) was also completed in FY94.

Improvements to Block III TWS are ongoing. The most recent upgrades are software version Theater Mission Planning Center 3.1 for the TC2S and further development of the Advanced Tomahawk Weapon Control System (ATWCS). ATWCS is planned as a comprehensive upgrade to the current TWCS, replacing the 1970s vintage hardware and re-hosting/upgrading the software. ATWCS implementation is proceeding in two stages, first replacing the current TWCS Track Control Group then the current Launch Control Group. The ATWCS Track Control Group Replacement (TCGR) OPEVAL was completed in FY99 and introduction of TCGR into the Fleet is proceeding.

The next major upgrade, Baseline IV Phase I Tactical Tomahawk, is in development. The Tactical Tomahawk will be more responsive and more flexible than current variants. The AUR will be equipped with a significantly more capable mission computer, a two-way satellite data-link, and an anti-jam Global Positioning System receiver. The Tactical Tomahawk is to be capable of being redirected to secondary pre-planned targets after launch ("en route flex"). The missile will also be able to receive a new or modified mission plan after launch ("in-flight retargeting"). Meanwhile, the missile will be able to provide information on its in-flight status and confirm arrival in the target area ("battle damage indication"). Improvements to the mission planning and launch platform weapon control systems will reduce the overall Tomahawk planning cycle. Crews aboard launch platforms will be able to plan some types of missions from launch to impact. The EMD contract for the Tactical Tomahawk AUR was awarded in June 1998. The Tactical Tomahawk is currently scheduled to enter Government Developmental Testing in FY02 and Operational Testing in FY03.

TEST & EVALUATION ACTIVITY

Test event OT-IIIE, evaluating the latest TC2S software release, was extended into FY00. Software version TMPC 3.1 introduced the Post-Digital Scene Matching Area Correlator-Global Positioning System (PDGPS) capability. This feature permits the use of the Global Positioning System aiding after the inertial navigation system has received a Digital Scene Matching Area Correlator (DSMAC) update. As a result, inertial navigation system drift is sharply reduced and the accuracy of the DSMAC update can be preserved over greater distances. With PDGPS, the separation between the final DSMAC scene and the target can be increased five-fold (compared with the current allowable maximum) with no loss in terminal accuracy. This capability allows greater flexibility in pairing DSMAC scenes with targets. The mission planning phase of OT-IIIE was conducted at U.S. Pacific Command Headquarters, employing the operators and maintenance personnel of the Cruise Missile Support Activity. Twenty operational missions and one Operational Test Launch (OTL) mission were prepared. After an initial failure (unrelated to the TC2S), the OTL mission was flown in 3QFY00. Changes in the Navy's modeling and simulation directives have necessitated an expansion to the scope of the verification, validation, and accreditation processes associated with the simulations used for validating Tomahawk mission plans. Initial validation of the mission plans is complete, but the Navy is currently assessing the simulations to ensure that they are fully compliant with the expanded accreditation criteria.

Test event OT-IIL, the OPEVAL for the ATWCS Launch Control Group Replacement (LCGR), was conducted in 1QFY00. ATWCS is the surface-ship fire-control system for Tomahawk. The Track Control Group (TCG) element of ATWCS performs data base management, communications, and planning of Tomahawk over-water flight routes. The Launch Control Group (LCG) element of ATWCS selects missiles for launch, controls the integration of the mission data (detailed instructions for the over-land phase of flight) with the selected missiles, and (when authorized) transmits commands to launch the missiles. OT-IIL test activities included: (1) simulation of Tomahawk missions at laboratory site ashore; (2) exercises of command, control, communications, targeting, and engagement-planning; (3) an operational test launch of a Tomahawk missile; and (4) a maintainability demonstration. The last three activities were conducted aboard USS MILIUS (DDG 69).

TEST & EVALUATION ASSESSMENT

In OT-IIL, all COIs were rated satisfactory. No major deficiencies were observed during testing. ATWCS was judged operationally effective and operationally suitable. Two minor ATWCS LCGR deficiencies involved interfaces between elements of the shipboard Tomahawk Local Area Network (LAN). In one case, the Generic Front-end Communications Processor (GFCP) was not in a "ready" condition when ATWCS attempted to process Mission Data Updates (MDUs). The software's time limit for successful communication expired, forcing a reboot of the ATWCS mission data LAN. In this case, USS MILIUS was unable to comply with tasking within the time period specified by the scenario. This problem could have been avoided if the operators had checked on the condition of the GFCP prior to attempting MDU processing. A second interface problem involved a loss of communications between the TCG and LCG portions of ATWCS. This problem arose during multiple salvo tasking. It originated in an excessively high volume of traffic on the LAN because VLS authorizations were being processed concurrently with a high volume of TCG-LCG interface traffic. The interface exceeded its "time-out" limitation and the loss of communications ensued. In this case, USS MILIUS was able to complete tasking, but only after receiving a 60-minute extension to the tasking window. This problem would probably have been avoided if USS MILIUS had begun the VLS authorization process earlier in the

scenario. Both of these interface problems were corrected prior to fleet release of the ATWCS LCGR upgrade.

Other minor ATWCS LCGR deficiencies affected Human Factors COIs. The ineffective method of alerting operators to system faults and status transitions was a contributing factor in the interface problems described above. The use of an inconsistent numbering scheme for engagements and engagement plans forced operators into cumbersome off-line administrative procedures to ensure that mission-critical tasks and sub-tasks were properly tracked and processed. Operator workload was increased in an already stressful environment. The information on VLS status provided by ATWCS was in some cases incorrect, not prominently displayed, or not presented early enough in the engagement sequence to avoid subsequent problems. The ATWCS launch consoles have an upper monitor that is not used, while the presentation on the lower monitor quickly becomes cluttered. These minor deficiencies will be addressed in the next ATWCS software build.

Although the EMD contract for the Baseline IV Tactical Tomahawk AUR was awarded in June 1998, this program does not have an approved TEMP or LFT&E Strategy. DOT&E has identified three particular areas in which differences between Block III and Baseline IV Tactical Tomahawk designs, despite use of the same WDU-36/B warhead, could significantly affect system lethality. These areas include fuze modifications, significant structural modification to the new missile, and modified terminal engagement parameters. The program manager, PMA-280, has provided design data that substantially address the concerns over the fuze replacement, which will also be addressed during live-warhead end-to-end flight testing. The modeling effort conducted this year, unsupported by test data, fails to adequately address the remaining two concerns. DOT&E has advised PMA-280 that the required LFT&E Strategy must identify testing to support both validation of the modeling effort and a comprehensive system lethality evaluation. PMA-280 has indicated it plans to propose an LFT&E Strategy at the end of FY00.

CONCLUSIONS, RECOMMENDATIONS AND LESSONS LEARNED

The Tactical Tomahawk Weapon Control System will be required to perform limited end-to-end mission planning aboard the launch platform. This rapid response mode of operations is very different from the layered and lengthy preparations required for current Tomahawk launches and needs to be well tested. The concept of operations for this new capability should be developed with care and the development should include consultations with the test and operational communities. The viability of this process must be demonstrated through stringent and realistic testing.

The Tactical Tomahawk program has been restructured several times since its inception in 1994, necessitating numerous ORD and TEMP updates. The overall Tomahawk program has had difficulty in building consensus for TEMP updates through the IPT process. The proposed updates are consistently late in arriving at DOT&E relative to the commencement of testing. The PEO needs to be more proactive in using the IPT process to ensure that the T&E strategy embodied in the TEMP is understood and agreed to well in advance of the earliest phases of testing.

Repeated restructuring of the Tactical Tomahawk program and a delay in acknowledging the limitations of WDU-36/B warhead development testing have contributed to the Navy's failure to develop an LFT&E Strategy for the Baseline IV Tactical Tomahawk AUR for more than two years after the EMD contract award.