THE MOBILE INTEGRATED TACTICAL TERMINAL (MITT)

A Case Study in Rapid Development

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The first Mobile Integrated Tactical Terminal (MITT), latest development effort by the Army Space Program Office (ASPO), was recently fielded to the 319th Military Intelligence Battalion at Fort Bragg, N.C., only 36 months after Concept Studies Approval (Milestone 0).

This rapid development was possible because we used *concurrency* throughout the acquisition process: we did more than one thing at a time, and we didn't wait to complete administrative requirements before proceeding with other phases of the program.

Also, we used an innovative approach to transition this program from a highly classified contracting and development process to a standard program development. This allowed the program to take advantage of both the highly technical, rapid and unique development process possible in the classified world and the standardized, supportable and reproducible development process possible in the acquisition world.

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Major Pfluke describes the MITT power system to BG John E. Longhouser, USA, then Assistant Deputy for Systems Management, Office of the Assistant Secretary of the Army (Research, Development and Acquisition).

While this is a unique program with unique circumstances, some of the procedures used and lessons learned are relevant to the acquisition community at large. In an era of shrinking budgets and rapidly moving technology, all program managers (PMs) must strive continuously to shorten the acquisition cycle; some of the experiences of the MITT program may apply to this need. This article describes how this successful acquisition took place so rapidly.

Background

The ASPO director is the PM of the Army "Tactical Exploitation of National Capabilities" (TENCAP) Program. The ASPO is not in the Army Program Executive Office (PEO) structure under the Assistant Secretary of the Army (Research, Development and Acquisition) but is a field operating agency of the Department of the Army Deputy Chief of Staff for Operations and Plans. As such, ASPO executes the TENCAP program as approved by the TENCAP general officers steering group, which is cochaired by the Army Deputy Chief of Staff for Operations and Assistant Secretary of the Army (Research, Development and Acquisition). The ASPO is the Army focal point for technical, fiscal and operational interactions with the national space community; and, as such, develops, tests, fields and sustains tactical systems for national and theater intelligence products.

Photo by Larry Shank, courtesy of the U.S. Army Laboratory Command

In 1978, the ASPO fielded its first signals intelligence system, the Electronic Processing and Dissemination System, its first intelligence systems. Since then, 24 other TENCAP systems of various sizes, missions and complexity have been developed, fielded and are operating throughout the world at Army divisions, corps and echelons above corps. The systems are supported by contractor field-service representatives permanently on site with each piece of equipment. The computers in the original TENCAP systems are dated, the software is expensive to maintain, and the systems are operating at their maximum level with no growth potential.

The ASPO coordinates with key personnel in TENCAP cells at every command where TENCAP equipment is used to expedite actions appropriate to that command. This allows the ASPO to obtain a materiel requirement approved by the TENCAP General Officers Steering Group while formal documentation is still in the Training and Doctrine Command (TRADOC) pipeline. Thus, ASPO traditionally strives for "the 80-percent solution" during development, and relies on close contact with the user in the field and extensive preplanned product improvements to refine system capabilities. This allows the PM to write rather general specifications for the contractor, and then work closely with the contractor and the user during system development.

Pre-Milestone 0 Activities

From 1987-89, 16 different Mission Need Statements (MNSs) were generated at various divisions and schools expressing a requirement for TENCAP capability at lower levels on the battlefield. During the Gulf War, all five Tactical High Mobility Terminals were deployed, and three were sent forward with divisions for the first time. Tactical High Mobility Terminals are highly mobile systems that allow a single operator/analyst to receive, analyze, archive and disseminate signals intelligence and imagery intelligence products. Intended for use at the Corps Forward Command Post, these systems proved extremely successful at the division level, validating in wartime experience the need for such a system in divisions.

Even before the Gulf War, it was clear that a material solution was indicated to get more TENCAP capability on the battlefield. The Tactical High Mobility Terminal was the best system for use at division level, but expensive to reproduce because the government did not own the technical data package (the five systems in existence were prototypes and never intended for a more extensive fielding). Also, several of the systems were mounted on five trucks and the MNSs called for a smaller system. Finally, the systems were already pushing the limits of their intended processing capacity, and it seemed short-sighted to reproduce a system headed for obsolescence.

Thus, based on informally stated requirements from the field (a formal consolidated MNS was never written) and the clear need for a material solution, the TENCAP General Officers Steering Group directed on 6 July 1990 that ASPO pursue the prototype development of a smaller and updated Tactical High Mobility Terminal. Five prototypes would be built for test and evaluation. The PEO for Intelligence and Electronic Warfare would assist ASPO in documentation and development to ensure the technology used was consistent with the Intelligence and Electronic Warfare Systems open systems architecture. Milestone 0, Concept Studies Approval, was achieved.

Phase 0: Concept Exploration and Definition

The purpose of concept exploration and definition is to evaluate the feasibility of alternative concepts and determine the most promising solutions. Two separate evaluations for this system were: the software architecture and associated hardware suite, and the vehicle/shelter/trailer system configuration. The ASPO formed two teams of experts to address the problem.

The software/hardware team of experts were from the program office, the contracting office, and the supporting Federal Contracts Research Center. Their study began on 8 August 1990, and included coordination visits with 16 different Department of Defense (DoD) agencies engaged in intelligence, electronic warfare, communications and computer technology. Their final product was a 15 November 1990 decision brief, recommending the hardware and software approaches to be pursued in the newly designated MITT.

Because of the Gulf War, the TENCAP General Officer's Steering Group did not meet in the December/January timeframe to give formal Concept Demonstration Approval (Milestone 1) for the software effort. The contracting process proceeded with an informal approval from the co-chairs of the group. As with all previous contracts for other TENCAP signals intelligence systems, cost-plus-award-fee contract was awarded to rehost Tactical High Mobility Terminal functionality onto a UNIX baseline. (This meant the MITT could execute all of the functions of the previous system but could use the most modern computer technology.) Authority to proceed was granted on 1 February 1991, and the contract was expected to be a 22-month effort.

As the software contracting process was taking place, a second team of experts was formed to evaluate alternative concepts for the system. When the software/hardware experts had visited the Army Research Laboratory in Adelphi, Md., they were so impressed with the type of work in packaging VME-based computer systems in rugged tactical cases and vehicles being done there that it was decided that the Army Research Laboratory experience would be invaluable to the program. The Laboratory had extensive UNIX expertise and had written software packages that would pertain to the program. Four engineers from the Laboratory gained the appropriate security clearances to participate in the program and began work on the system design.

The system design team was two teams — the four Laboratory engineers and a complement of engineers from the defense contractor. The contractor team was expert in aerospace and satellite technology and had more than 20 years of experience in TENCAP systems. The team had people thoroughly familiar with the software package and a network of field service reps who dealt with TENCAP systems and TENCAP missions daily, worldwide. The team was accustomed to working with large vans, however, in special units with highly trained soldiers, and with minimal thought given to supportability or commonality with other Army systems because of their ongoing maintenance contract. Additionally, since they had enjoyed a long-term, sole-source relationship with ASPO, they were somewhat expensive.

The teams each designed the system independently. A series of iterative design concept meetings were then held to take the best ideas from each design. Also, the teams had a joint conference with the PEO for Intelligence and Electronic Warfare and several Intelligence and Electronic Warfare PMs at Vint Hill Farms, Va., to share ideas and ensure system compatibility and component commonality. The sessions fully utilized the respective expertise of the teams to come up with a concept which would not have been possible by either team alone. The PM's challenge was to help everyone set aside egos and suspicions and work together (a challenge that continued throughout the program).

The Mobile Integrated Tactical Terminal is a heavy high-mobility, multipurpose, wheeled vehicle (HMMWV) with shelter that contains two workstations and multiple communica-

tions paths. It pulls a trailer-mounted 15kw generator. A second heavy HMMWV carries the crew and their cargo.

After this series of iterative system design concept meetings, the final product of the system design team was a 21 May 1991 decision brief recommending the system configuration. The concept was aggressive. The design depended on several key pieces of equipment not yet available, including the heavy variant of the HMMWV, miniaturized cryptographic equipment, the SUN SPARC 2E card (the smaller, more rugged computer card that would allow the system to use the most recent workstations available), and the 400-amp alternator for "under the hood" power. Successful completion of the total system depended on the timely fielding of these other systems. All of this equipment was late for a variety of reasons — the minicrypto still isn't available; and the PM executed some creative "workarounds" to keep development on schedule. The result of accepting this risk was that when the system was fielded, it reflected current technology, and was the first military system fielded with this equipment.

As work on the MITT Operational Requirements Document had begun at the Army Training and Doctrine Command and the initial draft was being staffed, we developed a revolutionary acquisition plan. The TENCAP signals intelligence systems, to date, had been contracted to the same contractor, because of that contractor's unique technical expertise. The systems had been intended as prototypes or low-density systems and, thus, were used in the field without complete military specification documentation, integrated logistic support (ILS) package, or comprehensive manuals. They were developed with minimal technical input from the program office (because of their extreme complexity, the program office often did not have the technical expertise to give precise guidance and make engineering decisions).

Since the MITT would bring TENCAP capability to the division for the first time and since the total number of MITTs was potentially more than 100 systems (at one point the MITT was to be the prototype for the Common Ground Station), this approach would no longer work. Instead, while the contractor was building the five approved prototypes, one additional system would be built at the Army Research Laboratory. This sixth system would allow the Army Research Laboratory to validate the contractor's engineering drawings and bring them up to level-three standards, and to make minor changes in the system (which would not affect form, fit and function) to enhance producibility. Moreover, the Army would develop a second source of TENCAP expertise to help reduce the cost of future systems, and the laboratory could produce an ILS package for the system.

The May 1991 TENCAP General Officer's Steering Group meeting was, in effect, a Concept Demonstration Approval (Milestone 1) decision, although the software contract was signed three months earlier, and the Operation Requirements Document was not complete. The software and hardware concept baselines were approved. The steering group withheld judgment on the final system configuration (whether to use a trailer or a second HMMWV, or both, to transport the generator and other equipment) pending further evaluations. The acquisition plan and concept for testing were approved. The program was underway; ten months had elapsed.

Phase 1: Demonstration and Validation

The purpose of the Demonstration and Validation phase is to design the system and demonstrate critical processes and technologies. The TENCAP General Officer Steering Group did not expect or require specific requirements be met for the program to move from Phase 1 to Phase 2. Consequently, the program made no clear delineation between demonstration and validation *and* engineering and manufacturing development. This allowed much work to be done concurrently, without preparing for a set of arbitrary milestones.

To save time, the software System Requirements Review and System Design Review were combined into a Requirements and Architecture Technical Interface Meeting. Although the software program was complex (more than 500,000 lines of code), it was primarily a rehosting of existing code onto UNIX. While not trivial, it was assumed that the requirements and structure were already fairly well-defined. Unfortunately, neither the contractor nor the program office had much UNIX experience, and a considerable learning curve had to be overcome in every phase of software development.

In retrospect and despite an eventual significant slip in the software development schedule, this consolidated approach was still a good idea. There was probably not enough UNIX expertise to do a such a thorough System Requirements Review and System Design Review to justify the time and expense involved. The final Software Requirements Specification was released on 31 July 1991.

A directed subcontract should have been submitted to an experienced UNIX software contractor or, at the very least, an intensive UNIX training program for the software team and the contractor's hiring of some UNIX experts. Some UNIX training was done up front, but the software team had other TENCAP commitments throughout the development which prohibited them from becoming proficient rapidly. Also, the level of program classification made rapid hiring of experts impossible.

Our contracting office issued a separate hardware request for proposal for the design and manufacture of five systems immediately after the Milestone 1 decision. The contractor briefed the proposal three months later, on 28 August 1991. The first inklings of the challenges of having two separate design teams work on the system became evident during fact finding, as the contractor, in some cases, reverted to less-risky solutions than had been proposed by the Army laboratory and endorsed by the program office.

Many of these differences were resolved early in the process; others persisted throughout the program. Understandably, the contractor leaned toward a design with known and available components to meet cost and schedule. The Army Research Laboratory wanted innovative solutions using the latest available technology. The PM was in constant arbitration.

The hardware contract was signed, and the contractor received authority to proceed in December 1991. Despite the fact that the design was not finalized, several long-lead-time purchases were initiated immediately. This resulted in the purchase of some excess parts as the design matured, but these parts were utilized for spares on other systems.

The hardware development did not include a formal Preliminary Design Review (PDR). Because of the numerous iterative design reviews held in the Concept Exploration phase and because the parts purchase process was well underway, the formal PDR seemed superfluous.

Phase 2: Engineering and Manufacturing Development

The purpose of the Engineering and Manufacturing Development phase is to mature and finalize the selected design, validate the manufacturing and production processes, and test and evaluate the system. The primary obstacle in this phase was getting the contractor (who was building five systems) to keep the Army Research Laboratory (which was building one system 3,000 miles away) informed and up-to-date on drawings, parts and design decisions. However, this teaming relationship was key in the PM's ability to influence the design, processes or testing.

Involving the Laboratory allowed the PM to have an independent set of engineers evaluate design and process decisions at every step, and helped keep the system design compatible with existing Army systems. Thus, despite the classification of the development, the system was not built in a vacuum, but was kept in step with mainstream Army components and developments. Additionally, sophisticated technologies developed by the contractor could be researched further and incorporated into other Army systems by the Laboratory.

Although the hardware design was still not final, the Critical Design Review (CDR) for hardware and software was held from 10-12 March 1992. The TENCAP General Officers Steering Group had approved the final configuration of two HMMWVs and a trailer, and most of the design was set. However, the system was overweight; the delivery schedule for some of the critical components were slipping; the software design was behind; and the Operational Requirements Document was not yet approved (approval came in June 1992).

The contractor's design style was similar to a "skunkworks." Engineers would design the system on paper, but technicians and engineers building the system were free to make changes and pursue "good ideas" as they were putting it together. Hence, the drawings often lagged behind the actual system design.

The Laboratory often was left out of the information loop and had to scramble to keep up. This frustration, coupled with constant challenges to contractor design decisions (to keep the system common with other Army systems — something in which the contractor had no experience) resulted in occasional hard feelings. For example, the contractor would design and manufacture simple hardware or brackets that were commercially available or even had National Stock Numbers assigned. The Laboratory would research and identify the best part commercially available and cause the contractor to change the design.

The PM's role of arbitrator and team builder was critical. However, the checks and balances imposed by the relationship between the contractor, the Laboratory, and the program office was invaluable to the successful completion of the program. In view of the contractor's skunkworks approach, the teaming relationship proved to be especially effective in validating the manufacturing and production processes used, and helped make the system reproducible at a reasonable cost.

Executing the software contract continued to be slow throughout this phase. The learning curve persisted in every phase of the project, and because of it the contractor had seriously underestimated the time (and, hence, cost) involved. The project was further complicated by the fact that the target system was not working until very late because of the leading technology hardware chosen. The software contract almost doubled in cost, and completion was eight months late. However, several critical components of the system design (the miniaturized cryptographic equipment, the heavy HMMWV, the 400-amp alternator) were also late, and would have delayed the system just as much.

The system was tested by the contractor with the program office and Laboratory present in May and June 1993. As would be expected, many bugs had to be eliminated, especially in the software and communications equipment. The system then was tested at Fort Bragg by the user in July. The gaining unit personnel were trained for 30 days by the contractor. Then, the U.S. Army Intelligence Center and School ran a test, using gaining unit personnel, contractor support, and again observed by the government team. The system was turned over to the 319th Military Intelligence Battalion in July 1993, 36 months after Milestone 0.

Phase 3: Production and Deployment

The purpose of the Production and Deployment phase is to produce and field the system, monitor the system performance, and support the fielded system. This phase went smoothly — the payoff for some earlier stresses.

The remaining four contractor systems were completed in rapid succession, months ahead of the original schedule. This resulted in tremendous cost savings and almost offset the software overrun. Fielding to Fort Bragg, Fort Campbell, Fort Stewart and Europe went smoothly and on schedule.

The Army Research Laboratory system was slower to finish (as expected) because of the additional work of modifying and upgrading the contractors documentation to standard and making minor changes to the system to enhance producibility. This proved to be a large task, and drawing inconsistencies continue to surface. The system was not intended to be fielded right away. The original plan was to keep this system at the Laboratory until the ILS package could be completed, formal testing of the vehicle and trailer could be accomplished at Aberdeen Proving Grounds, and for work on advanced technologies. However, the MITT was so impressive at a demonstration given to the senior Army leadership at the Pentagon in June that the fielding schedule was modified and accelerated, and the Laboratory system was fielded to Korea in January 1994.

For the first time, ASPO had fielded a standard system, with Army manuals, to Army divisions worldwide. More importantly, ASPO now had the technical data package and trained personnel to help bring down the cost of follow-on builds. A contract is being finalized at the Army Research Laboratory to build five MITTs with the development contractor.

Phase 4: Operations and Support

The Operations and Support phase supports the fielded system, monitors the system performance, identifies improvement opportunities, and modifies/upgrades, as required. Here, ASPO systems have always excelled. The ASPO tries to field the 80-percent solution, and then uses a robust preplanned product-improvement program to upgrade the system according to user feedback. A small community of users, supported by contractor field-service representatives, allows for excellent support, feedback and improvements. Semiannual users conferences are opportunities for training and close interface among personnel in the program office and the soldiers whom they support. The MITT was phased carefully into this program throughout its development, and some particularly vexing problems had already been presented to users for ideas and prioritizing.

Conclusion

The use of innovative acquisition strategy was the key to the success of the MITT program. Involving an Army laboratory as an honest broker with an experienced defense contractor resulted in an impressive synergy of talent tempered by the checks and balances of divergent interests. The latest available technology was successfully integrated into a forward-thinking design. Concurrency in design, manufacture, testing, fielding and support hastened the process without compromising supportability or producibility. A flexible approach to the acquisition milestones allowed the program to progress rapidly without artificial barriers, while still fulfilling the essence of the process. Finally, a robust, preplanned, product-improvement program and frequent, direct interface with system operators allows the PM to be responsive to user requirements.