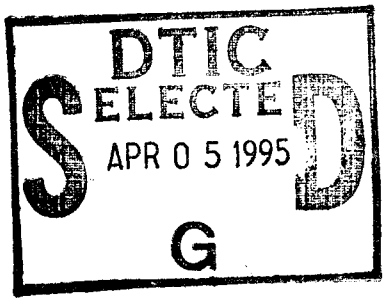
Logistics Management Institute

The Quad-Service Satellite Transmitting and Receiving System for Medical Supply Support

A Battlefield Interoperability and Communications System Prototype

Volume I



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This report documents the design and development of a prototype information communications system for quad-service use in a theater of operations. The prototype was designed to allow seamless integration of legacy information systems operated by each of the four services, and is based on a combination of software interfaces and commercial satellite communications hardware. The QSTARS-MS^2 prototype has been tested in a variety of garrison and deployment settings, including extensive use in Somalia and the former Yugoslav republics. The prototype demonstrates the feasibility of achieving joint interoperability through rapidly deisgned interfaces between legacy information systems. The prototype also offers world-wide, portable, and affordable satellite communications capability through the use of the International Maritime Satellite network.

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Significant credit for the rapid development of the concepts and systems described in this report belongs to a number of individuals, chief among them Lieutenant Colonel John Harris of the U.S. Central Command Surgeon's Office and Colonel John Clarke of the Defense Medical Systems Support Center. The Component headquarters of the four Military Services also contributed immensely to the rapid progress made on this project. The development of close working relationships and strong inter-Service cooperation is a testimony to the dedication of all the organizations involved.

Because this project involved the design and development of a prototype systems hardware and software capability, the systems offices for the military medical departments were asked to significantly contribute to this project. The staffs at the Army's Theater Army Medical Management Information System Program Office, the Air Force's Standard Systems Center, the Navy's Naval Medical Information Management Center, and the Marine Corps' logistics activity at Albany, Ga., all deserve accolades for their responsive, proactive support.

Finally, great credit is due the staffs of all the units participating in the prototype demonstration. More than any other factor, their intelligence, motivation, and positive attitude ensured the success of the prototype demonstration. Their continued support will ensure that the full potential of interoperable systems using worldwide, real-time communications links is realized throughout the four Military Services.

Preface

The Quad-Service Satellite Transmission and Receiving System for Medical Supply Support (QSTARS-MS^2) constitutes both a major change in the way medical logistics support is delivered to medical organizations and a technical breakthrough which makes extensive use of current technologies. This report reflects these two sides of the project by dividing the available documentation into two volumes.

- This volume (Volume 1) describes the organizational context and the functional changes to it that are now occurring, and is intended to inform executives and senior staff officers within the joint military structure.

- Volume 2 includes procedural guides for QSTARS-MS^2 users, technical documentation on the technologies used in the project, and documentation on the medical and non-medical information systems with which QSTARS-MS^2 interfaces. Volume 2 is intended for system users and others with a need for enhanced technical details.

The Quad-Service Satellite Transmitting and Receiving System for Medical Supply Support: A Battlefield Interoperability and Communications System Prototype

Executive Summary

Medical logistics units deployed in 1991 for Operation Desert Storm had great difficulty communicating with the "Single Integrated Medical Logistics Manager," or the theater source of supply for medical materiel. Operation Desert Storm required an unprecedented degree of inter-Service support and interaction. The integration of the Military Services' medical logistics systems, and the communications infrastructure necessary to make that integration fruitful, were not adequate for the task. To communicate productively, medical units were forced to improvise by quickly creating expedient and often unwieldy logistics links to fulfill their missions. A telling example is the procedure used by the Navy to resupply its two hospital ships. Supply requests were sent to the theater source of supply from the hospital ships on a floppy disk that was carried by helicopter from the ship to the Navy's support center on Bahrain. From there, the disk was carried to the Army forward support element on Bahrain, where it was reformatted using the Army's computer into the proper Army-compatible format. A second disk containing the reformatted requests was then produced and transported by military truck several miles over a causeway to the theater supply source at the Saudi port city of Dhahran. The disk was then read by their computer and the requests were processed. The opposite procedure was employed for the transmission of supply status responses from the theater supply source to the hospital ships.

After Operation Desert Storm, the U.S. Central Command (CENTCOM) recognized that a solution to the communications problem was needed quickly. Because the joint policy for medical supply does not call for the Army to act as the Single Integrated Medical Logistics Manager in all deployment scenarios, the Services must be able to communicate their requirements electronically to all other Service-unique medical logistics systems. With the assistance of other DoD organizations, the CENTCOM staff developed new functional processes, information systems interfaces, and communications systems to fulfill the need for integration, and it has tested its prototype system solution. This report evaluates the prototype's suitability for both small- and large-scale military operations.

The prototype system-based solution developed by the CENTCOM's medical logistics working group is tightly integrated to effectively support the Services. The prototype system uses portable computer hardware with satellite communications capability. The prototype, designated the "Quad-Service

Satellite Transmitting and Receiving System for Medical Supply Support" (QSTARS-MS^2), uses off-the-shelf commercial computer hardware and communicates through the International Maritime Satellite worldwide network. The prototype configuration also involved the development of system-to-system interfaces between the medical logistics information systems used by the four Military Services.

The prototype was field-tested during Operation Restore Hope in Somalia. A recent quad-Service test during the Operation Bright Star exercise proved the feasibility of the technologies used and integrated in the QSTARS-MS^2 system. The prototype system solves the problem of sharing information between differing medical logistics systems, and it can communicate on a battlefield or other deployed setting anywhere in the world. Ultimately, the field tests provided what is perhaps the strongest testimony to the effectiveness of the QSTARS-MS^2 configuration.

Although this project begun as a test of limited duration, QSTARS-MS^2 has since become operational on a day-to-day basis. In fact, it was the routine means for transmitting medical logistics information between the extremely remote deployment location in Somalia and the sustaining bases in the United States and Europe. Further, CENTCOM staff members say that they intend to use QSTARS-MS^2 in any other required medical deployments.

The QSTARS-MS^2 prototype addresses the immediate needs of the Services for interoperability and portable communications capability. Although development of the QSTARS-MS^2 prototype involved only limited funds and part-time management, it solves problems that threaten to seriously degrade medical support in future military contingencies. The methods used to develop the prototype may also serve as models for future quad-Service efforts. However, the system remains a prototype that must be refined before it is fully deployable.

We recommend that the Defense Medical Logistics Standard Support Program Executive

- immediately fund the acquisition of several satellite terminals and associated computer hardware to field the QSTARS-MS^2 prototype on a limited basis,
- develop a long-term acquisition and support strategy,
- further develop the QSTARS-MS^2 prototype to ensure simplicity and supportability,
- live-test the prototype more vigorously to guarantee true wartime viability,
- use QSTARS-MS^2 frequently in actual deployment environments,

- consider the use of QSTARS-MS^2 concepts to support other medical and nonmedical functions, and

- continuously refresh the technologies used in the QSTARS-MS^2 prototype to ensure that they remain current and compatible with future commercial standards and fighting requirements.

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The Quad-Service Satellite Transmitting and Receiving System for Medical Supply Support

Statement of the Problem

In the late 1980s, military medical logisticians began planning for a deployment scenario that featured one of the three military medical services as a designated "single integrated medical logistics manager" (SIMLM) to support all medical supply needs in a theater of operations. Several major plans call for the Army to assume the SIMLM role for support to contingency operations. With the designation of the U.S. Army Medical Materiel Center, Europe (USAMMCE) as the European Command Single Integrated Medical Logistics Manager (SIMLM) in 1987, systems planners began to develop automated interfaces among the medical supply systems used by the Army, the Navy, and the Air Force.

The interfaces developed to support the fixed communications and inter-Service support requirements of forward-deployed forces in Europe did not include any of the hardware needed to operate in a non-European theater, nor did they include software links to support wartime medical supply systems. As forces began their deployment in support of Operation Desert Shield (ODS) and Operation Desert Storm in August 1990, formal doctrine or guidance for the actual support requirements under the SIMLM concept did not exist. However, the establishment of the Army's colocated 47th and 32nd Medical Supply, Optical, and Maintenance (MEDSOM) battalions as the Theater SIMLM on 15 October 1990, produced an immediate requirement for unit-to-unit communications among the Army's MEDSOM and the Army, Navy, Air Force, and Marine Corps units being supported.

While Army units operating the Theater Army Medical Management Information System (TAMMIS) could interface with only minor shortfalls, other customers could not communicate their requirements to the MEDSOM through automated links. Interfaces between TAMMIS and the systems operated by the other three Services did not exist: direct automated file transfers between the Services were not possible. Further, even TAMMIS users found that, although the software links existed to support TAMMIS-to-TAMMIS communications, the communications hardware needed to transmit their data was not readily available. Assets such as the Army's mobile subscriber equipment that had been planned for in the development of wartime communications systems were quickly commandeered to support nonmedical and medical command and control needs. Logistics links, then, were largely forged without the benefit of automation and electronic communications.

Some customers were forced to use complicated and inefficient communications solutions. For supply requests being sent to the MEDSOM from the Navy's two hospital ships in the Persian Gulf, a floppy disk containing requests in the Military Standard Requisitioning and Issue Procedures (MILSTRIP) format was carried by helicopter from the ship to the Navy's support center on the island nation of Bahrain, just off the coast of the Saudi Arabian mainland. From there, the disk was carried to the Army forward support element on Bahrain, where it was reformatted using a TAMMIS computer into the proper format for TAMMIS. A second disk containing the reformatted requests was then produced and transported by military truck several miles over a causeway to the MEDSOM at the Saudi port city of Dhahran. The disk was then read by the MEDSOM's TAMMIS computer and the requests were processed. The opposite procedure was employed for the transmission of supply status responses from the MEDSOM to the hospital ships. Other units had to employ their own cumbersome means to communicate with their supporting MEDSOM battalions.

The obvious shortcomings of the medical logistics automated information system in ODS meant that a huge number of urgently needed medical supplies were handled as off-line "walk-throughs." Other results of unsatisfactory communications and systems interoperability included increased use of supply sources in CONUS. Many customers found it easier to communicate with their home bases or stations, often asking in "letters from the front" for supplies to be sent through the regular mail service.

To address the shortcomings, medical logisticians began working at the conclusion of ODS to find improved means for transmitting supply requirements. Those efforts culminated with a meeting in June 1992, at U.S. Central Command (CENTCOM) headquarters in Tampa, Fla., during which CENTCOM staff formally requested that the Office of the Assistant Secretary of Defense (Health Affairs) assist in finding a rapid solution to the problem. Health Affairs accepted the tasking with the agreement of the Defense Information Systems Agency, the medical logistics chiefs of the three Services, and the Joint Staff Medical Readiness Division.

During the past 21 months, an informal CENTCOM medical logistics working group, which first convened in Tampa, was chartered and continues to work to develop a prototype system solution to the Military's communications shortfalls. After conducting preliminary research and investigations into technological possibilities and limitations, the working group concluded that the solution developed should conform to the following expectations:

- The prototype system should rely on satellite communications technology to ensure that it would be truly portable and able to support a "come as you are" contingency anywhere in the world.

- The system should use off-the-shelf hardware and software to the greatest extent possible, including commercial satellites and satellite terminals, to shorten development time frames, reduce prototype costs, and simplify procurement requirements.

- The prototype should rely on the MILSTRIP communications protocol for most of its transactions. As the working group began to identify solutions to the needs of the four Services, it quickly became evident that automated information system interoperability could be achieved by using the MILSTRIP protocol as an area of common ground among the Services.

The Military's Defense Digital Network and its other existing communications "pipelines" remain the preferred solution and first choice for worldwide military communications. However, the need for robust and viable alternatives to those military systems was clearly recognized by the medical logistics working group. This need has recently been reinforced by the DoD's decision to make increased use of commercial satellite capabilities for a variety of DoD functions. The next section of this report provides greater detail about the decision criteria and alternatives evaluated during the QSTARS-MS^2 prototype development process.

The medical logistics community faced two related challenges as it began to develop a prototype quad-Service battlefield communications system. The first challenge was to address the shortfall of communications capability available in the theater of operations. Planners had long realized that limited communications capabilities would not satisfy all potential users, but resource constraints made an ideal communications solution for the medical community impossible. Communications shortfalls meant that most communications capability in ODS was used to support critical command and control requirements, leaving little excess capacity to support other needs. Innovative but unorthodox workaround solutions were developed during and immediately after the Persian Gulf conflict, but their expedient nature made it necessary to seek a better integrated, more standardized design. Furthermore, even those expedient solutions did not address the basic shortfalls in the availability of communications links between geographically dispersed operating forces.

The second challenge confronting the community was the need to integrate its existing logistics information systems to allow for the computer-to-computer interchange of electronic data. Each of the four Services has developed and fielded its own information system to support the particular requirements of its medical units. Air Force units deployed in a theater of military operations operate the MEDLOG-Junior system, an MS-DOS-based system designed to provide a scaled-down, laptop version of the Air Force's MEDLOG (medical logistics) information system. Army units operate TAMMIS, a UNIX-based software suite that operates on a variety of micro- and minicomputer platforms. Deployable Navy medical units rely on the Micro-MICS, an MS-DOS microcomputer-based version of the Navy's Medical Inventory Control System (MICS). Finally, Marine Corps medical units operate the Asset Tracking for Logistics and Supply System (ATLASS), a general (nonmedical-specific) inventory management system that supports tactical units on an MS-DOS-based microcomputer platform. During the prototype demonstration and testing, the Marine Corps units involved also operated the Landing Force Asset Distribution System (LFADS), a second nonmedical inventory management system that can be used by deploying Marine forces in some circumstances. The challenge of interchanging data

those five systems is eased by the existence of the MILSTRIP transaction formats, which are used by all of the Services' systems. As with other data interchange processes, however, even the existence of a common protocol for transaction formats leaves considerable work to be done before true interoperability can be achieved.

THE PROTOTYPE QSTARS-MS^2 SELECTION AND DEMONSTRATION – FINDINGS AND ANALYSIS

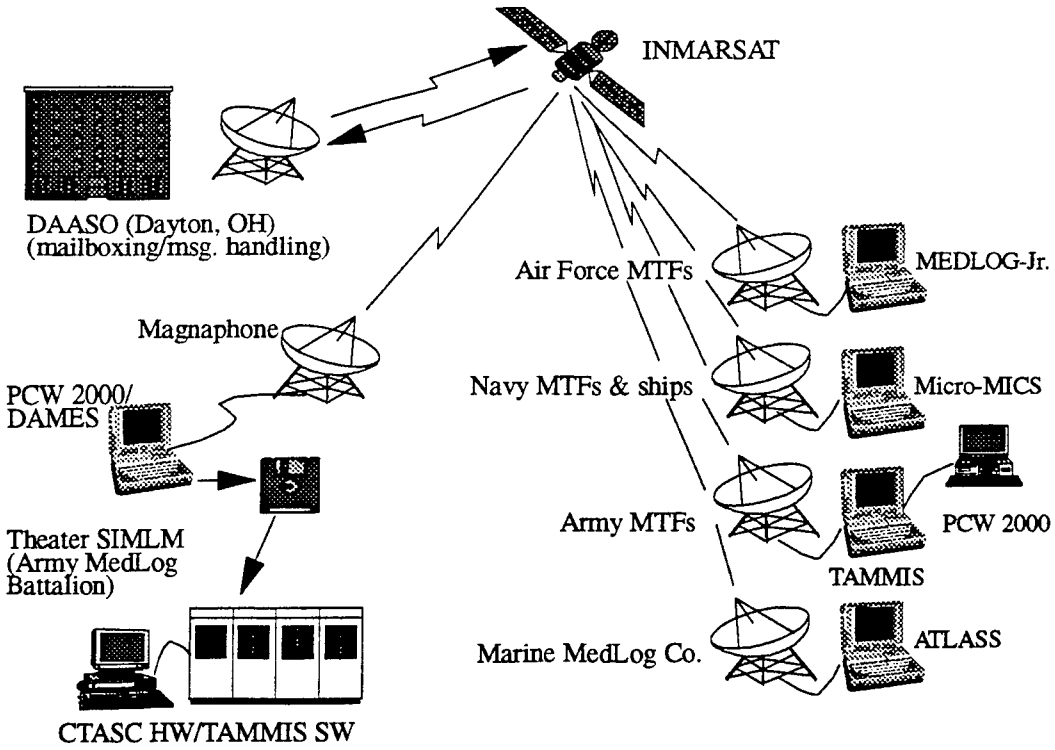
System Architecture

The quad-Service working group evaluated several hardware and software solutions in its search for a workable prototype to address medical logistics communications shortfalls. The specific technologies being applied (e.g., portable satellite communications terminals) were not in and of themselves "leading edge" or state-of-the-art technologies, and they could not achieve the degree of integration desired by the working group. In general, the prototype solution developed uses current, but not state-of-the-art, technologies. The feature of the prototype that does reflect state-of-the-art capability is the depth of integration of those technologies to effectively support the specific requirements of the Military Services. In addition to the broad requirements discussed earlier, the group's hardware and software candidates were selected to meet the following criteria: simplicity, ease-of-use, affordability, reliability, and transportability.

The QSTARS-MS^2 solution that was eventually tested and refined for the battlefield medical logistics systems communications requirement relies on a combination of government proprietary message-handling software and off-the-shelf hardware for satellite communications and message preparation. Figure 1 shows the functional architecture of the QSTARS-MS^2 prototype.

For message handling, QSTARS-MS^2 uses the Defense Automatic Addressing System Office (DAASO) in Dayton, Ohio, as the communications focal point. Each of the units or organizations using QSTARS-MS^2 sends and receives requisitions, supply status, and other logistics transactions that can be handled using the Defense Digital Network, Automated Defense Information Network (AUTODIN), or commercial telephone lines or satellite communications links of the Defense Automatic Addressing System (DAAS). Upon receipt of an incoming transaction, DAAS routes it to the designated recipient through its own internal message-handling protocol. QSTARS-MS^2 users are assigned dedicated "mailboxes" that are addressed by the particular DoD Activity Address Code assigned to them. The Defense Automated Message Exchange System (DAMES) software at DAASO allows users to upload transactions to DAAS and to download any mailbox files from DAAS during the same on-line sessions.

To provide connectivity and communications software for communicating with DAAS, each of the QSTARS-MS^2 configurations incorporates a combination



Note: DAASO = Defense Automatic Addressing System Office; DAMES = Defense Automated Message Exchange System; INMARSAT = International Maritime Satellite; ATLASS = Asset Tracking and Logistics Automation System; DMSO = Division Medical Supply Officer; MTFs = Medical Treatment Facilities; CTASC = Corps/Theater Automated Data Processing Support Center, Phase II.

Figure 1.
Prototype QSTARS-MS² Functional Architecture

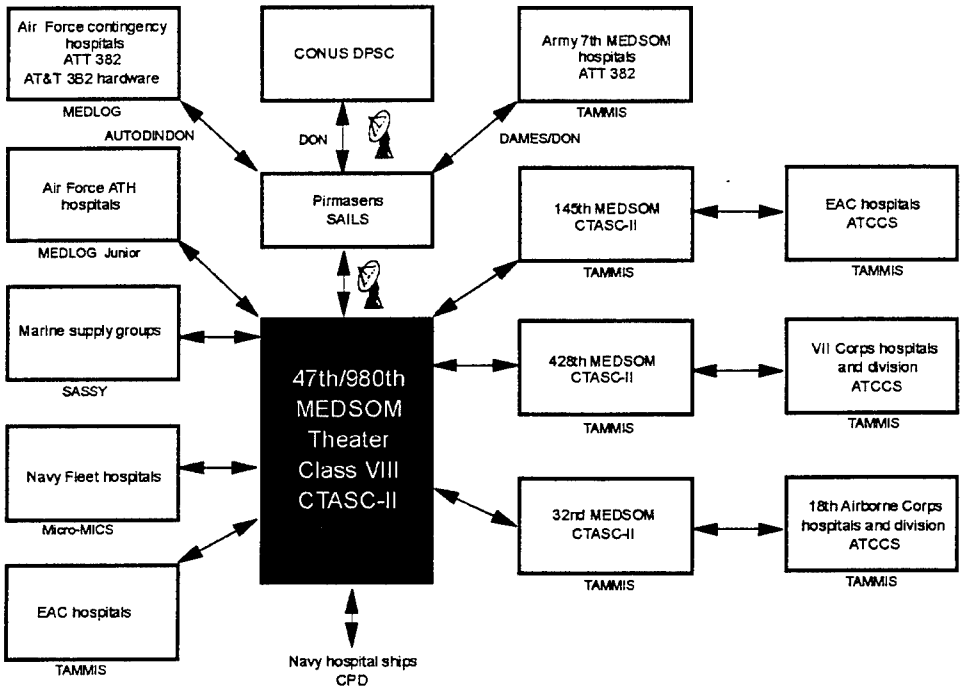
of two communication packages; these are the DAMES (mentioned above) and the Streamlined Alternative Logistics Transmission System (SALTS). DAMES and SALTS are described in more detail in Appendix A and B, respectively. These software packages can reside on the Services' medical logistics system or on a separate MS-DOS-based microcomputer. In the case of the Army and Marine Corps, a separate MS-DOS microcomputer, the Personal Computer Workstation 2000 (PCW 2000) provides a platform to host the DAMES or SALTS software. The PCW 2000 also provides additional functionality in the form of a hardware "bundle" consisting of a cellular telephone, a CCITT Group III-compliant[1] FAX/modem, a small laser-quality plain-paper printer, and an integrated universal power supply. The PCW 2000 is described in more detail in Appendix C. The FAX/modem provides communications capability using commercial or military land lines or satellite connections. Air Force and

[1]CCITT is the Consultative Committee on International Telephone and Telegraph, an international communications standards organization that develops protocols for interorganizational and international communications. Group III is the internationally accepted protocol for telefax communications.

Navy users are able to load the DAMES or SALTS software on their Micro-MICS or Medlog-Jr. computers, since both of those systems are MS-DOS-based.

Satellite communications are made available through the INMARSAT network. INMARSAT, a commercial satellite system, provides worldwide coverage through a series of geosynchronous satellites located in equatorial orbit. For purposes of the QSTARS-MS^2 prototype, communications with the INMARSAT are established using a Magnavox Magnaphone satellite terminal, a portable, collapsible device that provides telephone and data transmission service. The INMARSAT system, including the Magnaphone terminals that communicate with it, is described in detail in Appendix D. An information paper on the security of transmitting military medical information using commercial satellites is in Appendix E.

Figure 2 complements Figure 1 through a notional depiction of a "sample" theater of operations in a quad-Service environment. Although Figure 2 depicts the logistics architecture in ODS and Operation Desert Storm, a similar architecture is likely in any mature quad-Service theater of operations. It should be noted that, for the most part, units participating in ODS did not have the benefit of satellite communications capability.



Note: DPSC = Defense Personnel Support Center; DON = document number; ATH = Air Transportable Hospital; SASSY = Supported Activities Supply System (USMC); EAC = echelons above corps; CPD = Central Processing and Distribution; SAILS = Standard Army Intermediate Level Supply (system); CTASC-II = Corps/Theater Automated Data Processing Support Center Phase II; ATCCS = Army Tactical Command and Control System.

Figure 2.
Medical Logistics Architecture in Operation Desert Shield

Testing the QSTARS-MS^2 Prototype System

Following the selection of the QSTARS-MS^2 prototype architecture, the working group began preparations for incremental testing of the hardware/software configuration. Figure 3 depicts the progress of the QSTARS-MS^2 system through its informal testing. Because the system was developed as a prototype, and because additional integration work is expected to be completed in the near future (see "Recommendations,") formal testing has not been completed. To date, system testing has been intended to prove principles and validate concepts. Actual operational testing and evaluation of a fully developed system has not yet taken place. Further development under the aegis of the Defense Medical Logistics Standard Support (DMLSS) structure will allow more formal testing at a later date. The demonstration of the prototype's configuration and its informal testing, and testing of the software interfaces and the message-handling services of DAASO were completed in four successively more integrated steps, beginning with early concept testing at Fort Belvoir, Va., and Philadelphia, Pa.

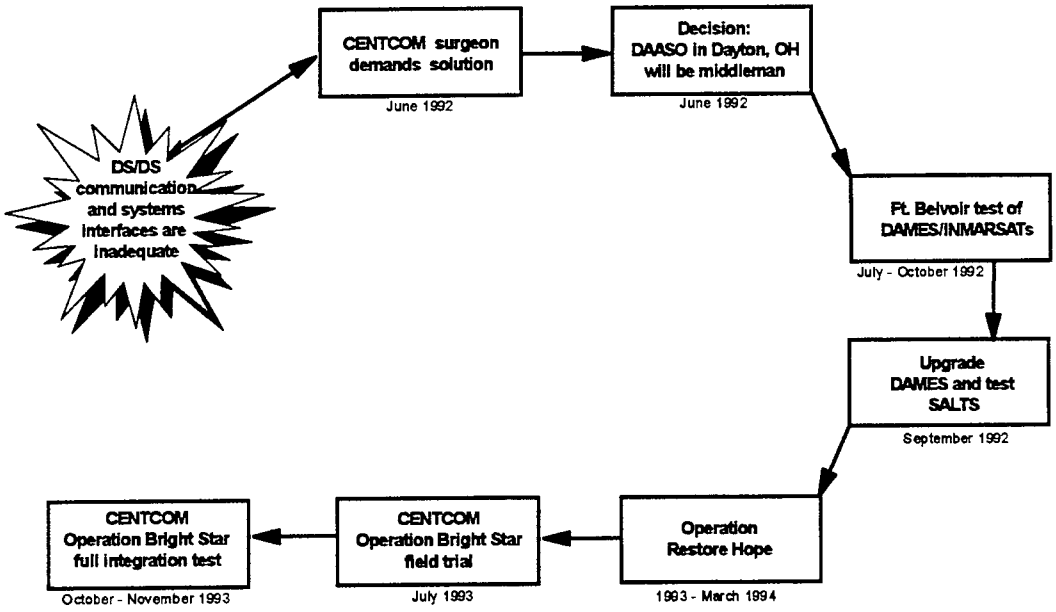


Figure 3.
Progress of QSTARS-MS^2 Through its Informal Testing

First Step: Concept Testing at Fort Belvoir, Virginia

Informal testing of the QSTARS-MS^2 concepts began with a small-scale demonstration of satellite transmission capabilities between the U.S. Army Medical Department Activity at Fort Belvoir, Va., and the Defense Personnel Support Center (DPSC) in Philadelphia, Pa., from July through October 1992. During the 2-month period of test activity, connectivity was established using the INMARSAT system linked via ground terminal to the Fort Belvoir hospital.

A variety of supply transactions were transmitted and received during the test, which proved the potential for using INMARSAT transmissions of logistics transactions. However, the bulk of the transactions handled at Fort Belvoir were transmitted using existing ground-based telecommunications links. A second important purpose of the Fort Belvoir test was the evaluation of both SALTS and DAMES software capabilities.

Both DAMES and SALTS proved capable of supporting medical logistics transactions. Both software formats supported MILSTRIP transactions and provided adequate message-handling and mailboxing capability. Test observers concluded that both systems offered the potential for future use during medical contingency operations, although SALTS lacked a convenient means for managing multiple file transfers within a single communications session. SALTS transactions seemed to require longer processing times before being received by the destination organization, although no empirical testing was documented to confirm this. Some test observers speculated that the perceived longer receipt times might be due to the fact that DAMES accesses DAASO directly, while SALTS accesses DAASO as an external customer.

The original requisition and supply status determination process for Fort Belvoir is shown in the top half of Figure 4. Requisitions were written to, and status read from, 9-track tapes. The tapes were driven back and forth to the Fort Belvoir Message Center. The Message Center read the tapes and exchanged transactions with DPSC through DAAS by using AUTODIN. Requisitions routinely required 1 to 3 days to reach DPSC. Supply status took 4 days to receive. A batch of requisitions was occasionally lost.

The new process (based on the prototype solution) is shown in the bottom half of Figure 4. Requisitions and status are exchanged with an on-site microcomputer that is connected through modems to DAAS. Both commercial telephone lines and INMARSAT terminals have been used for communications. Both DAMES and SALTS have been tested as viable communications software.

Testing at Fort Belvoir proved the feasibility of two major communications concepts. First, the testing proved that satellite communications offered significant potential for responsive, cost-effective transmission of logistics transactions. Second, the test proved that off-the-shelf government software communications packages, such as DAMES and SALTS offered sufficient capability to forestall any need to develop such a package from the ground up. The Fort Belvoir test location, though, offered only limited opportunities for testing the quad-Service dimensions of the QSTARS-MS^2 concepts, and it provided no opportunity to test the configurations in a field environment.

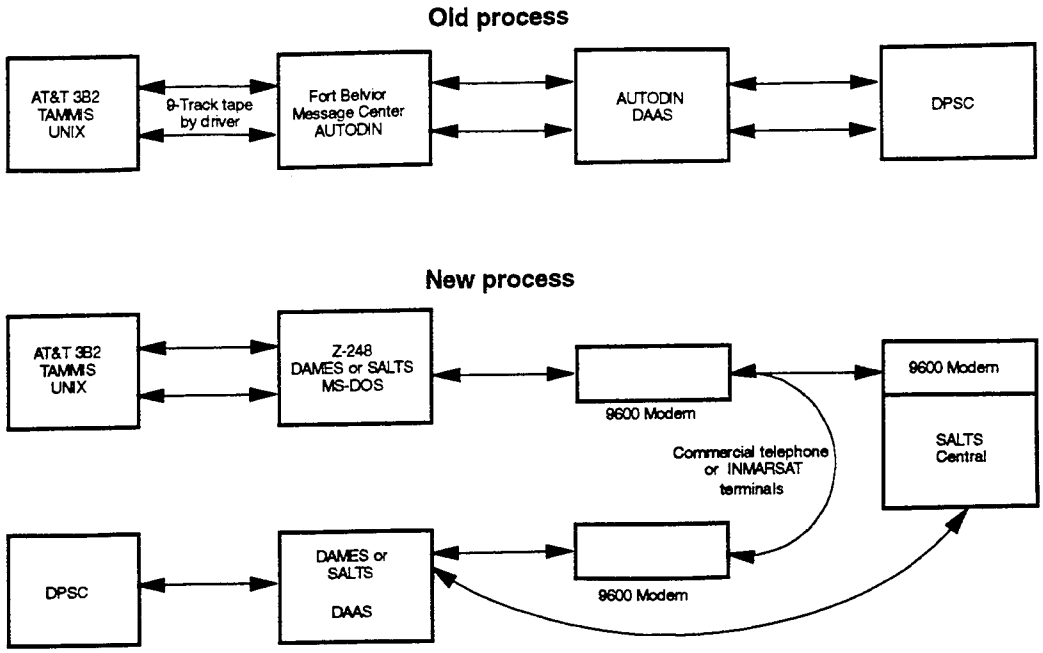


Figure 4.
Fort Belvoir Requisition and Supply Status Process

SECOND STEP: INTEGRATION TESTING DURING OPERATION RESTORE HOPE IN SOMALIA

To provide remote data communications testing and to establish the feasibility of using the satellite communications processes in a field setting, Army planners developed a testing protocol for use during Operation Restore Hope in Somalia. Army units participating during Operation Restore Hope were given QSTARS-MS^2 prototype equipment. Using that equipment, request processing from the 32nd Medical Logistics Battalion and the 86th Evacuation Hospital to the U.S. Army Medical Materiel Center, Europe (the European theater SIMLM), was accomplished using DAMES. The INMARSAT terminals were used for communicating through DAASO to USAMMCE for the requisitions and status.

The DAMES software was loaded on a Zenith laptop microcomputer connected to an external modem. The modem was then connected to the INMARSAT terminal for communication with DAASO. Initially, the output file of requisitions from the TAMMIS was loaded into word processing software to remove the carriage returns at the end of each requisition. A later modification to TAMMIS did away with this step. Requisitions were routed to USAMMCE using USAMMCE's data communications routing identifier. Narrative messages required a narrative communications routing identifier.

Ultimately, Operation Restore Hope provided what is perhaps the strongest testimony to the effectiveness of the QSTARS-MS^2 configuration. Although this was initially begun as a test of limited duration, QSTARS-MS^2 has since been

made operational on a day-to-day basis. It is in fact the routine means of transmitting medical logistics information between the extremely remote deployment location in Somalia and the sustaining bases in the United States. As of the date of this report, the system is still in use, and CENTCOM staff members have informed us of their intent to use QSTARS-MS^2 (if available) in any other required medical deployments.

Third Step: Quad-Service Field Testing During Operation Bright Star

Operation Bright Star, concluded in 1993, is a biennial exercise conducted by CENTCOM to simulate the deployment of U.S. forces in a multilateral contingency in Southwest Asia. Exercise simulation includes both the actual deployment of medical units to the region as well as the participation of on-station medical units in the exercise.

To provide the quad-Service testing needed, and to place the QSTARS-MS^2 systems in the appropriate field environment, the CENTCOM working group agreed to test the prototype during the Operation Bright Star exercise. Operation Bright Star offered the ideal setting for the test: It involved medical units from all four Services; it was conducted under the auspices of the CENTCOM staff; it involved deployment of units to remote overseas locations; and it generated significant exercise medical logistics traffic.

In preparation for the CENTCOM exercise, field trials were held during 26 through 30 July 1993. The testing was between representative Component medical units and the 147th Medical Logistics Battalion at Fort Sam Houston, Tex.[2] The field trial involved the movement of medical requisitions using DAMES and SALTS via satellite. The corresponding supply status information was sent in a similar fashion from the 147th Medical Logistics Battalion back to the participating units. The field trial validated that ATLASS, MEDLOG-Jr., Micro-Medical Inventory Control System (Micro-MICS), and TAMMIS could interface and communicate. All test sites used an MX2020 Magnavox Magnaphone Turbo for the satellite communications.

Each participant in the July 1993 field test (and the Operation Bright Star test, which is described in the next subsection of this report) had a different role, and each used a slightly different software-hardware configuration. These roles and configurations are described briefly below.

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[2] During the development of the QSTARS-MS^2 prototype, the Army converted its Medical Supply, Optical, and Maintenance battalions to the much more robust and capable Medical Logistics Battalion structure. As a result of this conversion, the Army's 47th MEDSOM Battalion was converted to the 147th Medical Logistics Battalion (Rear), which was designed to function in a theater-level role and which could assume the responsibilities of a SIMLM with little augmentation.

147th Medical Logistics Battalion (Rear) (U.S. Army)

The 147th Medical Logistics Battalion, located at Fort Sam Houston, Tex., functioned as the SIMLM for the field test. Requisitions were received, processed in TAMMIS, and the resulting status was returned.

The DAMES was tested using a U.S. Robotics Courier Modem 9600. The data were exchanged by floppy diskettes between the microcomputer running DAMES and the TAMMIS. The MS-DOS-formatted diskettes were read and written to using UNIXPCU, a PC-to-UNIX transfer software utility. An MS-DOS-formatted 750 K diskette containing requisitions was read by both the CTASC-II and ATCCS systems. The procedures followed are described in Appendix F.

47th Field Hospital (U.S. Army)

The 47th Field Hospital at Fort Sill, Okla., tested DAMES for sending requisitions and receiving requisition status. The procedures are the same as those for the 147th described immediately above.

5th Medical Group (U.S. Air Force)

The Air Force 5th Medical Group at Minot, N.D., tested sending requisitions and receiving status back using DAMES. Requisitions and status were moved to and from MEDLOG-Junior using the MS-DOS copy command. The files were copied to and from the DAMES directory. The procedures are in Appendix G.

Initial requisitions were indented by 7 and 14 positions with multiple duplications. The indentations were corrected after further testing. The duplications were removed by TAMMIS.

5th Fleet Hospital (U.S. Navy)

The Navy's 5th Fleet Hospital, based at Camp Pendleton, Calif., tested using both DAMES and SALTS. The two packages resided on the same MS-DOS-based laptop microcomputer as Micro-MICS.

A 14400 bits per second (bps) modem was used for testing SALTS. A 2400 bps modem was used at 1200 bps for testing DAMES. Micro-MICS 2.1 provides access to DAMES through its utilities menu. The procedures are included in Appendix H. SALTS was tested similarly, by naming the files as expected by Micro-MICS and invoking SALTS manually.

Medical Logistics Company, 1st Marine Expeditionary Force (U.S. Marine Corps)

The Marine Corps' Medical Logistics Company, an element of the 1st Support Battalion, 1st Marine Expeditionary Force, tested from Camp Pendleton by sending requisitions brought over on a floppy diskette from ATLASS. Both DAMES and SALTS were tested using the communications equipment as described above for the Navy. The TAMMIS procedures are in Appendix I.

Defense Automatic Addressing Systems Office Operations

During the field testing, most network controller, routing, and message-handling functions were handled by DAASO, in Dayton, Ohio. DAASO operates a continuous, around-the-clock data services organization that supports DAAS users worldwide. Among its support functions, DAASO

- determines both depot and commercial suppliers;
- provides an on-line redistribution network for material;
- provides users with up-to-date status of requirements;
- analyzes data bases and prepares logistics reports;
- receives, processes, routes, and transmits supply requisitions and related information;
- customizes reporting as requested; and
- maintains an official repository for logistics-related data bases and publications.

To support medical units participating in the Operation Bright Star exercise, DAASO installed three modems operating on a rotary line. In addition, DAASO "help desk" services were available to all users of the DAMES software. While some users noted that it was sometimes difficult to obtain a telephone connection, DAASO access was generally acceptable during the Operation Bright Star exercise. Other users — particularly the Marine Corps users at Camp Pendleton — noted that the help desk could not always answer technical questions, particularly when the questions concerned the hardware and software configurations at the users' sites. Units that anticipate using the DAASO services are encouraged to take steps to obtain a Comm R/I well before they deploy, because the process of applying for and receiving an identifier can take considerable time and effort.

FINAL STEP: FULL PROTOTYPE INTEGRATION TESTING DURING OPERATION BRIGHT STAR

The Operation Bright Star exercise included the deployment of the 47th Field Hospital and the 5th Medical Group to Egypt, and the participation through simulated activity of the 1st Marine Expeditionary Force, the 5th Fleet Hospital, and the 147th Medical Logistics Battalion (which functioned as the theater's SIMLM). The QSTARS-MS^2 prototype configuration was tested at all these units during the Operation Bright Star exercise.

The reliability and availability of INMARSAT and DAASO services during Operation Bright Star was generally very good. For example, during the Operation Bright Star exercise, the Air Force's 5th Medical Group initiated 19 transmissions to the 147th Medical Logistics Battalion. Within those 19 transmissions, users experienced several minor problems. The total number of minor problems encountered exceeds the number of transmissions because some transmissions experienced multiple problems, as indicated below:

- Ten instances during which a Communications Satellite Corporation's operator intervened directly
- Eight busy signals
- One instance in which DAASO did not respond
- One abnormal transmission termination (unexplained)
- One abnormal termination due to CRC errors.

Generally, connectivity through the QSTARS-MS^2 hardware and software was quite good. The aggregate total for successful connections after three or fewer tries was 97.1 percent, as shown in Figure 5. Also pictured in Figure 5 is the extremely low failure rate for units in the Operation Bright Star test. Units were able to establish a successful connection with DAASO 98.9 percent of the time — a figure far better than would normally be expected, even in regular telephone communications.

Navy units exercised the prototype configuration using both DAMES and SALTS services during the Operation Bright Star test. Those units developed a routine in which one transmission was sent each morning using DAMES, and a second transmission was sent during the afternoon using SALTS. While both DAMES and SALTS provided acceptable support, Navy users have expressed a preference for DAMES, largely because of slightly slower response times and frequent software updates for SALTS users. In addition, Navy units experimented with using the QSTARS-MS^2 configuration to improve asset visibility and the ability to cross-level supplies with other units. For example, the Navy's 5th Fleet Hospital occasionally passed supply requisitions laterally to the 47th Field Hospital and the 5th Medical Group.

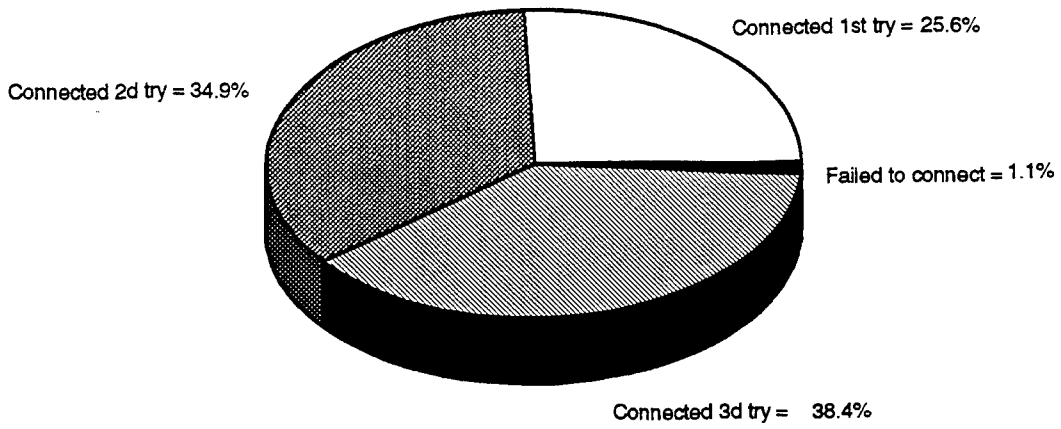

Figure 5.
Connectivity Statistics for Establishing DAMES Connections

The Marine Corps participants in the Operation Bright Star exercise noted exceptionally good responses from the QSTARS-MS^2 configuration. Because a final determination on the target software for Marine Corps use has not yet been made, Marine Corps units used the ATLASS and LFADS, both described earlier.

Army units participating in the Operation Bright Star exercise also noted more than satisfactory results. However, some users expressed a desire for improvement of the DAMES software. Specific comments were focused on the "clumsiness" of the DAMES utilities menu, which sometimes required several sequential steps to perform a single task. Note was also made of the lack of clarity in the DAMES documentation; several users were unhappy with the overall quality of the documentation, particularly with regard to the setup of DAMES and its relation to individual modems and "S-register" software switches.

The QSTARS-MS^2 test was conducted during the Operation Bright Star exercise period of 12 through 18 November 1993. Logistics transaction volumes handled during the test are summarized below in Tables 1 and 2. Table 1 depicts the transactions transmitted from the 147th Medical Logistics Battalion, and Table 1-2 depicts the transactions received at the 147th.

The transaction volumes found in the tables above illustrate two facts. First, systems interoperability and file transfer capability were conclusively demonstrated for all four Services. No difference in communications capability was evident between units transmitting and receiving from a "home base" (i.e., nondeployed) location and those operating from a deployment location. All units occasionally experienced a degradation in satellite signal strength, although these problems appeared to have more to do with local weather conditions, timing, and antenna placement than with any other intrinsic factors.

Table 1.
Transactions Sent from 147th Medical Logistics Battalion

Location	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
5th Med. Group (Egypt)	90	40	70	180	100	150	105
Med. Log. Co., 1st MEF (Calif.)	0	0	30	205	50	0	90
47th Field Hospital (Egypt)	0	0	85	145	50	70	50
5th Fleet Hospital (Calif.)	0	80	95	260	200	40	280

Note: MEF = Marine Expeditionary Force.

Table 2.
Transactions Received by 147th Medical Logistics Battalion

Location	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
5th Med. Group (Egypt)	250	40	80	105	100	100	105
Med. Log. Co., 1st MEF (Calif.)	0	90	100	150	50	0	50
47th Field Hospital (Egypt)	0	50	220	150	50	100	105
5th Fleet Hospital (Calif.)	150	80	50	265	150	160	245

The second fact indicated by the transaction volumes is that the volume of exercise play during Operation Bright Star did not approach volumes that could be expected during an actual conflict on the scale of ODS or other theater-level contingency. As stated in the Recommendations section, CENTCOM and Joint Staff planners should bear this fact in mind when planning future exercises.

THE VIEWS OF TEST PARTICIPANTS

The QSTARS-MS^2 Concept

All units participating in the QSTARS-MS^2 prototype testing agreed that the concept offered significant potential for improved wartime support. While relationships between the 147th Medical Logistics Battalion and its quad-Service customers require further development, each of the participants was pleased with the satellite communications concept. The QSTARS-MS^2 functional processes seemed to be dexterous and inspired confidence. Units quickly became comfortable with the configuration being tested.

Training Factors

An important issue concerns the soldiers depicted in Figure 6. For the most part, the staffs of the units participating in the QSTARS-MS^2 prototype testing did not have formal systems administration, programming, or analysis training. They benefited from substantial technical assistance provided by support staff elements, including many that would not normally be on hand in a deployed setting. The involved presence of special technical experts, such as the CENTCOM staff member pictured in the digital photograph, cannot be counted on during an actual deployment. For QSTARS-MS^2 to succeed, units operating the system must be self-sufficient and self-sustaining. To make the QSTARS-MS^2 concepts operational and routine, initial and sustainment training will be needed so that soldiers, sailors, airmen, and marines can rely on the system during future deployments. This issue is discussed more fully in the Recommendations section of this report.

Quad-Service interoperability was the single most important goal of the medical logistics working group. It was particularly encouraging to note, therefore, that all four Services were able to participate in the Operation Bright Star exercise using their existing Service-unique logistics information systems. Those systems required only cosmetic changes to achieve the interoperability needed for battlefield operations.

Advantages and Disadvantages of the Prototype System

The medical logistics working group reviewed the findings of the integrated testing during a meeting at CENTCOM headquarters during January, 1994. Participants agreed that the prototype was a strong success with the potential to significantly improve the way in which medical logistics support is provided in a quad-Service environment. The group listed the following advantages of the QSTARS-MS^2 prototype over existing capabilities:

- Greater reliability of communications links
- Improved timeliness and responsiveness of logistics support using the prototype
- Greater ease of use of the prototype configuration.

Note: This photograph is a digital image that was produced by using an accessory camera attached to the PCW 2000 used in QSTARS-MS^2 prototype testing. The photograph also shows part of the Magnaphone satellite terminal in the lower right-hand portion of the image. The digital imaging capability of the PCW 2000 could be used during actual operations to communicate identifying information and images about medical products among supported and supporting units. This image transmission capability could provide significant improvement in the process of communicating customer requirements and support capabilities.

Figure 6.
LTC John Harris of CENTCOM with the 147th's Systems Staff

The group also noted that the prototype was not without drawbacks. Those drawbacks related to the Magnavox Magnaphone satellite terminal, which many users felt required some level of "field hardening" to improve its ruggedness and durability. Specific comments dealt with the durability of the mesh-fiber satellite dish antenna itself, and with the susceptibility of the unit's keyboard to dust, dirt, or moisture damage. Other users suggested that use of a dish antenna which was detachable from the receiving unit itself, would aid in positioning and aiming the antenna.

Discussions with representatives from Magnavox and with other users of the Magnaphone hardware indicate that the system has been "ruggedized" to a considerable degree and that it is in use in a variety of hostile environments. The hardware has not been operationally tested and evaluated by DoD, nor has it been ruggedized to military standards. The lengthy period required to achieve this level of ruggedization, though, is probably incompatible with the speed at which the satellite communications technologies are evolving. Magnavox has expressed a commitment to improving the durability and reliability of the Magnaphone product and actively solicits related suggestions from users in the field.

RECOMMENDATIONS

To enhance the capabilities demonstrated during the QSTARS-MS^2 prototype development and demonstration testing, six recommendations are offered.

- *Recommendation 1: The DMLSS Program Executive's office should immediately fund and purchase QSTARS-MS^2.* The procurement of the hardware and software necessary to support the QSTARS-MS^2 concept should be funded and executed as quickly as possible to provide immediate capability to unified command units. The tested QSTARS-MS^2 "package," which consists of the Magnaphone satellite terminal, the DAMES software, the SALTS software, and any laptop and peripheral hardware needed to support DAMES and SALTS, should be procured and provided as follows:

  - Four QSTARS-MS^2 package should be provided, one each to the 147th Medical Logistics Battalion (Rear), the 32nd Medical Logistics Battalion, the 16th Medical Logistics Battalion (Rear), and the U.S. Army Medical Materiel Center, Europe.

  - A selected number of QSTARS-MS^2 packages (probably between 10 and 20) should be procured for testing, training, and contingency use. These packages would be used by other units designated by CENTCOM or other unified commands for contingency response. Accountability and support for these packages should be managed by the USAMMA or other field operating agency (FOA). The packages should be releasable upon request from the surgeon's office of the unified command headquarters or the Joint Staff, J-4, Office of the Deputy Director for Medical Readiness.

  - Other QSTARS-MS^2 packages should be fielded to a small number of medical treatment units likely to be on the "short list" for early deployment in the event of military contingencies. Examples of these hospitals include the Army's 5th Mobile Army Surgical Hospital and 28th Combat Support Hospital, and the Marine Corps' 1st Marine Expeditionary Force. While the number of QSTARS-MS^2 packages to be fielded to medical treatment units is expected to be limited to less than a one-half dozen, it is important that they be procured and fielded quickly to ensure the viability of the overall concept of operations.

  As the functional integration activity for the DoD military medical community, the Program Manager's Office, Defense Medical Logistics Standard Support, an element of the Office of the Assistant Secretary of Defense (Health Affairs), should provide funding and project oversight for the procurement of the initial systems described above. Pre-positioning a limited number of QSTARS-MS^2 packages will provide short-term go-to-war capability to units of all four Military Services on a flexible, as-needed basis. Maintenance by USAMMA or an other field operating agency will provide responsive, centralized visibility and control of QSTARS-MS^2 assets and will ensure that packages are available when and where they are needed. Field

operating agency maintenance should also include broad system support and training responsibilities, thus ensuring a "one-stop shopping" support office for QSTARS-MS^2 users.

- *Recommendation 2: MFIM and USAMMA develop a long-term acquisition and support strategy.* In the longer term, medical logisticians and planners should consider the appropriate strategy for fielding and maintenance of the QSTARS-MS^2 prototype and its successors. As the funding activity and responsible proponent respectively, MFIM and USAMMA should work together to develop a strategy which both insures supportability and which recognizes the need for continuous technology refreshment. Development of a standard configuration through the Army's combat developments process (e.g., the Enhanced Concepts-Based Requirements System) or the DoD's Deployable Medical Systems (DEPMEDS) process may not be appropriate for the rapidly evolving technologies involved in commercial satellite communications. The ECBRS and DEPMEDS management processes are highly useful for less dynamic technologies and are especially notable for their ability to provide integrated logistics and training support for complex systems. However, they may not be amenable to the frequent technology refreshment and upgrade that is likely to be needed to support a reasonably up-to-date configuration. Therefore, it is likely that the QSTARS-MS^2 system will be considered a "prototype" for some time. Continuing enhancements and upgrades of the system will ensure its viability in the rapidly developing satellite communication sector. At the same time, DoD should develop strategies for resourcing, training, and maintaining these "prototypes."

- *Recommendation 3: DMSSC and USAMMA should further develop the QSTARS-MS^2 to ensure simplicity and supportability.* The QSTARS-MS^2 configuration tested during Operation Bright Star is a prototype. By definition, it is not fully integrated, documented, and "seamless." As it exists today, QSTARS-MS^2 requires substantial manual intervention as users manage logistics transactions through the chain of steps needed to process them. However, it is expected that the QSTARS-MS^2 prototype will be further refined and simplified as it evolves from a proof-of-concept prototype to a mainstreamed part of the medical logistics information system of the future. The current QSTARS-MS^2 prototype has been successfully demonstrated in part because of the technical excellence of the systems staff supporting the project at each of the units participating. Its complexity requires continued training and technical support to guarantee success. Through the Defense Medical Logistics Standard Support program, the prototype should be refined and simplified. This effort should involve USAMMA, the Joint Medical Logistics Functional Development Center, and the Defense Medical Systems Support Center. Simplification of the prototype configuration and procedures would reduce that training requirement and improve the chances for successful use of QSTARS-MS^2 during future exercises or contingencies.

An example of the potential for simplification is the use of improved hardware at the Army's TAMMIS-supported medical units. Current TAMMIS software operates on a dedicated UNIX-based hardware platform. Because the DAMES software requires an MS-DOS environment, TAMMIS users during the Operation Bright Star exercise had to use two microcomputers to support QSTARS-MS^2 — one for TAMMIS, hosting the UNIX operating system, and another for DAMES, hosting MS-DOS. New software utilities will allow a single microcomputer to support both operating systems by partitioning system memory and storage devices — a capability that will greatly simplify the current QSTARS-MS^2 procedures at Army units. While EER Systems' "Personal Computer Workstation — 2000" offers intriguing functionality in a single, easily transported case, it is probably not rugged enough or simple enough for extended use throughout the Army's field medical services system.

- *Recommendation 4: USAMMA should oversee rigorous, high transaction volume testing to guarantee viability.* As noted in the discussion of Operation Bright Star prototype demonstration results, the transaction volumes aptly handled by the QSTARS-MS^2 prototype were substantial. However, the several hundred supply transactions passed each day are not as indicative of the actual numbers of transactions in an operational theater. Review of ODS historical documentation indicates that the actual daily transaction volumes during that relatively large-scale deployment numbered in the thousands, not hundreds. The sheer numbers of hospitals and medical units involved in ODS complicated the logistics support requirements by several orders of magnitude. The QSTARS-MS^2 architecture has proven that it is fully capable of supporting limited deployments, such as the recent Restore Hope humanitarian assistance operation in Somalia. Its ability to support larger deployments has not been modeled or exercised. USAMMA's ability to develop and execute a test of this ability makes it the logical agency to accept this responsibility. Of particular concern during this testing should be the capability of the DAASO central communications hub to support dozens or scores of medical customers attempting to communicate simultaneously. Another area of particular interest during a high-volume test of the system should be the capability of the SIMLM to process incoming and outgoing transactions for large numbers of customers.

- *Recommendation 5: USAMMA and the Joint Staff should oversee the exercise QSTARS-MS^2 frequently in actual deployment environments.* As with all prototype configurations, the QSTARS-MS^2 system is only as functional as its users can make it. As noted above, the system is not currently supported with comprehensive training. Documentation of QSTARS-MS^2 procedures is limited to this report and other locally developed instructions. For these reasons, we recommend that the system be routinely used in medical logistics exercises, training scenarios, and other programs to ensure ongoing readiness at all unit locations. During planning for major quad-service exercises, the J-4, Joint Staff, should include QSTARS-MS^2 testing in its plans for medical units. During the actual conduct of the exercises, USAMMA should provide support to participating units before, during, and after the

exercises. Because of the new quad-Service requirements supported by the QSTARS-MS^2 concept, units that might be tasked as SIMLMs, particularly the Army's Medical Logistics Battalions, should be exercised frequently and intensively in supporting quad-Service needs.

- *Recommendation 6: MFIM should evaluate QSTARS-MS^2 for broader use.* The Department of Defense has recently committed itself to expanded use of commercial satellites. This shift away from military satellites and toward broad use of private-sector capabilities implies that the QSTARS-MS^2 prototype is a forerunner of other programs. The concepts and capabilities embodied in the QSTARS-MS^2 prototype are not limited to medical logistics applications. Medical requirements regarding medical regulating, patient transport, medical command and control, and blood-products management could clearly benefit from the application of QSTARS-MS^2 capabilities to their own functions. As the activity responsible for functional process improvement and information systems strategic planning for DoD's medical systems, MFIM should be tasked with this responsibility. Further, other projects, such as the Army's telemedicine project being supported by the Program Manager for the Medical Diagnostic Imaging System should be examined for possible applicability of those techniques and technological approaches to the QSTARS-MS^2 project.

We can easily envision a much broader application of QSTARS-MS^2 functionality to the entire spectrum of military medical communications in a theater of operations. Serious examination of this potential should begin immediately to ensure that the Military's investments in satellite technology can be exploited for maximum benefit. Additional benefit can be gained from the use of the prototype's functionality in peacetime health care facilities. Demonstration testing at Fort Belvoir, Va., shows that satellite communications capability can be applied with favorable results in a peacetime setting. Emerging managed-care concepts for the military health services system will expand and enhance the inter-Service support in peacetime, just as new joint doctrine has expanded it during contingencies.

The broader use of QSTARS-MS^2 concepts, though, will also require continuous upgrading and refinement of the system's technologies. As INMARSAT technology moves from analog capability (INMARSAT "A") to digital processes (INMARSAT "B," "C," and "D"), the Military must ensure that its system is adaptable to these and other technologies of the future. The QSTARS-MS^2 configuration may also require modification to include high-speed data transmission capability, particularly if it is to be a feasible host for functions such as medical imaging.

CONCLUSIONS

The communications capability and systems interoperability described in this report are indicators of a major shift in the way medical support is provided in a theater of operations. Newly developed and emerging plans and

procedures at the Joint Staff, at the Office of the Assistant Secretary of Defense for Health Affairs, and at the unified and specified command level call for much more "jointness" and inter-Service support and cooperation than ever before. At the same time, the use of commercial technologies and business practices to improve theater support offers new levels of effectiveness and reduced costs. The QSTARS-MS^2 prototype illustrates these two trends.

The development and integration testing of the QSTARS-MS^2 prototype clearly proved the feasibility of satellite communications as a routine instrument in quad-Service battlefield medical communications. The QSTARS-MS^2 prototype configuration also demonstrated conclusively the potential for extensive interoperability among the Services, despite the fact that four separate and distinct information systems are in use to support medical supply processes.

The Operation Bright Star participants also learned other valuable lessons, chief of which is the absolute need for proactive, responsive, and informed customer support at all levels. For logisticians and supply personnel at the 147th Medical Logistics Battalion, the needs of Air Force, Marine Corps, and Navy customers posed new and different challenges from those evidenced by the Army units the battalion is accustomed to supporting. Those customers have different support expectations, operate in a different environment, and require medical products that are different from the Army's medical customers. Success in the quad-Service environment requires the SIMLM to be "all things to all people." The role in which the 147th has typically operated is one of greater predictability and stability than is possible in a quad-Service environment. To provide superior customer support to all the Army's quad-Service customers, ongoing, intensive, and realistic training is needed for all units that might be designated as having SIMLM responsibility. We believe that the systems integration capability offered by the QSTARS-MS^2 prototype is a significant step toward true quad-service support using a SIMLM concept. *The Quad-Service Satellite Transmitting and Receiving System for Medical Supply Support is a viable, affordable, and feasible solution to the Military's requirement for worldwide communications capability at the unit level for sustainment of medical logistics information requirements.* The QSTARS-MS^2 program, when adjusted to include the actions recommended above, will provide a much-needed functional benefit at relatively low cost. The program has also exemplified the ideals of quad-Service cooperation.

As a quad-Service effort, the project may well offer valuable lessons for the development of the future Defense Medical Logistics Standard Support system. These lessons may include the use of "ad-hocracy," or loosely constituted ad hoc working groups, and the feasibility of rapid prototyping as a means of establishing and meeting systems requirements. Other lessons may include the viability of commercial or government off-the-shelf hardware and software as a stepping stone to an integrated capability and the option of integrating existing systems functionality to produce an enhanced quad-Service capability.

Participants in the development and demonstration of the QSTARS-MS^2 program are justifiably proud of the steps they have taken forward. The project

is an exemplary demonstration of the capacity of a tightly focused group of dedicated individuals moving quickly to resolve shared difficulties. The program will directly enhance the quality of the Military's wartime health care. Working group participants should be proud of their contributions to the patients, clinicians, and other members of the military health services system.