Army Science Board
Issue Group Study

Moving Army Tactical Command and Control System (ATCCS) from a Character-Oriented Message System to a Data-Oriented Message System

April 1994

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Study Panel Members

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Terms of Reference

- Develop and document what is meant for ATCCS to have a "data-oriented message transfer capability" rather than the current USMTF character-oriented message transfer capability
- Investigate what others are doing in the area of data-oriented messages
- Review technologies and methodologies applicable to the issues in developing the use of data-oriented messages
- If possible, compare several approaches to achieving data-oriented message transfer capability, highlighting their differences in terms of measures of effectiveness (MOEs) and cost
- Recommend a long-term objective and a strategy for reaching that objective

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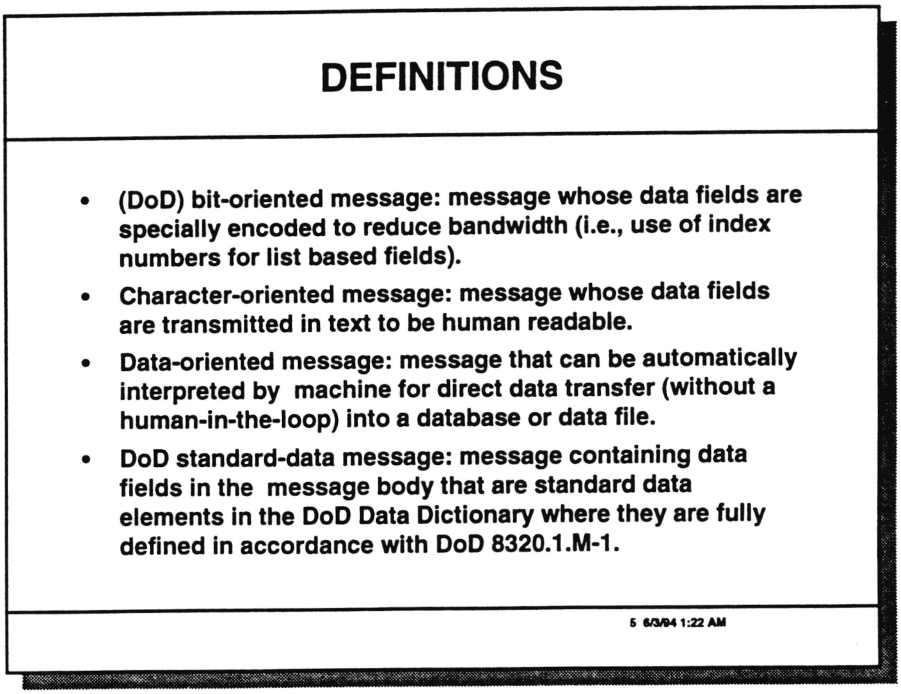


The main difference between character-oriented and bit-oriented messages is the emphasis of character-oriented on human readability and bit-oriented on transmission efficiency. Both message types can support free (unstructured) text and direct data transfer (without a person-in-the-loop) by machine into a database or file, The representation format of bit-oriented messages must be interpreted by software to be read by humans.

Examples of bit-oriented message usage are Tactical Data Information Link (TADIL) messages that deal with realtime, specific limited information and Variable Message Format (MILSTD 188–220) messages that deal with time sensitive limited information that may require a response. An example of character-oriented message usage is the US Message Text Format (USMTF) messages.

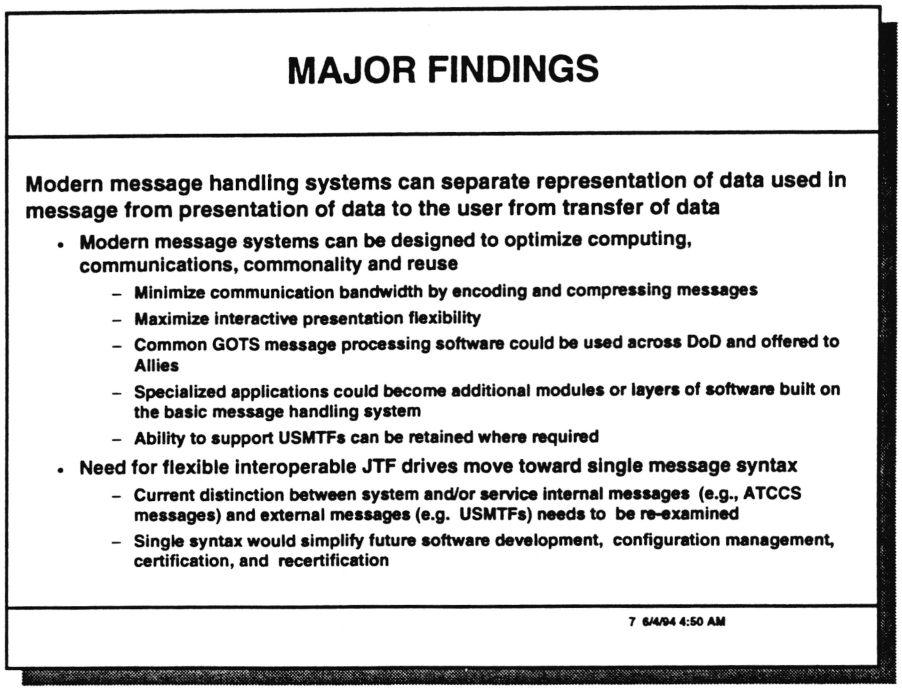
The text body of an unstructured message (e.g., email) contains only text and is not machine understandable though it may be scanned for keywords or phrases to determine routing for human review.

Data-oriented messages can either be character-oriented or bit-oriented. They contain data for automated processing and could also contain free text. The automated processing currently is specific to an application and as a minimum requires mapping tables. Free text fields in the messages pose a problem since they are not interpretable by machine and it is not clear how they should be handled.

Future DoD standard-data messages can be either character-oriented or bit-oriented. The difference between DoD standard-data messages and data-oriented messages will be that DoD standard-data messages may be able to be machine processed in an application independent way for applications, databases, and file systems that use DoD data-standards and have a structure consistent with the DoD Data Model. The fields in the message body are defined as standard data elements in the DoD Data Dictionary where they are fully defined in accordance with DoD 8320.1M-1.

Multi-media messages are messages whose interpretation will vary according to the type of object(s) being transmitted (data, voice, graphics, images, video, etc.). The message may contain a collection of objects that are defined according to standards (e.g., international standard X.400).

In the future, messages could be formatted or self describing. USMTFs, TADILS, and VMF messages each have a format that is described formally in terms of their respective syntaxes. These formal messages are agreed to by the MCEB (and other nations and NATO where appropriate) and registered and maintained by DISA/JIEO. The syntax of USMTFs are often complex allowing many variations or varieties of messages. Multiple USMTFs may be required by a single usage (e.g., to update a single graphics screen). This is quite cumbersome and wasteful of bandwidth. The implementation and use of DoD data standards should allow ad hoc exchange of data by "self-description," the use of standard data element identifiers to describe the data contained in the message.



USMTFs were designed to be both human readable and machine processable in an era when many users communicated through teletype machines. Modern message handling systems can use processing power to separate presentation, the interaction of computer and human in preparing and interpreting USMTFs, from representation of the USMTF's data in storage and from data transfer. Data presentation, representation and transfer can be accomplished without the use of USMTFs. Such systems can still produce USMTFs in full text format for transmission to people using teletypes.

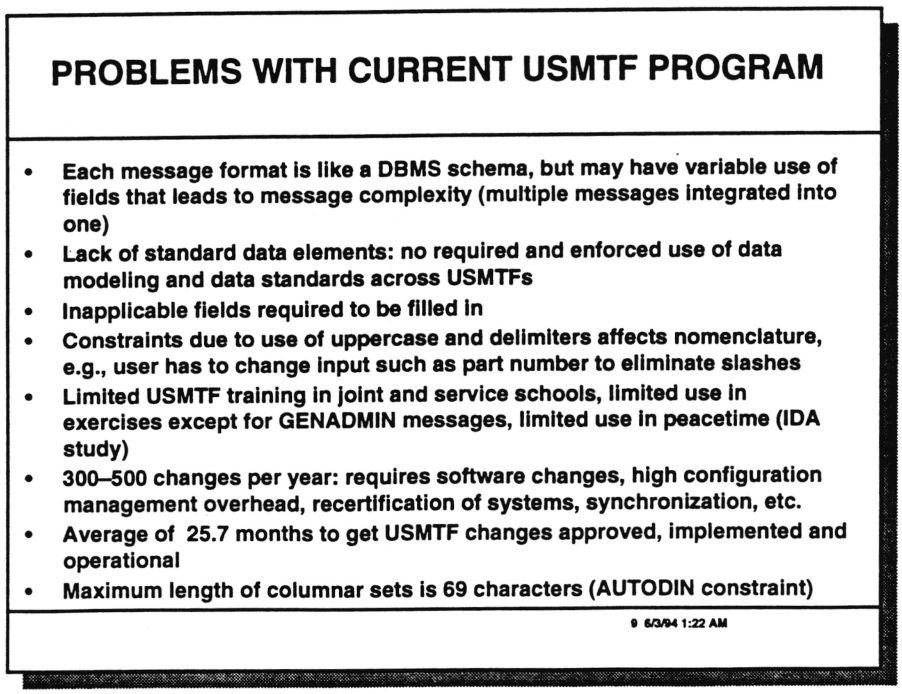
Modern message handling systems can enable users to create and interpret USMTFs through graphic presentation screens customized to the mission-tasks at hand rather than the USMTF syntax. This can reduce training costs, errors in messages, bandwidth, time to process data, and, increase the use of data-oriented messages in exercises and on the battlefield. The exception will be people still using TTYs, who will continue to need training in creating and understanding USMTFs. Mission-task customized messages can be interactively created and error checked on graphic screens, optionally encoded and compressed for transmission, and uncompressed and decoded on the receiving end where the data may be automatically entered into applications or reviewed in a mission-task oriented way on a computer screen. Full text readable USMTFs can still be generated by an application program and transmitted to users with only TTY receivers.

Computer graphic screens could be very flexible and capable of being tailored by users to serve mission-task needs from the user's perspective as well as being flexible in supporting changing mission-task needs. The screens would be designed to capture the specific mission-task information needed, fill in relevant data from existing databases and select (or aid in the selection of) appropriate USMTF formats in which to put the data if this were necessary for transmission to TTY users.

Currently, three message preparation systems and two message processing systems are being developed cooperatively by the Services and DoD agencies. J-6 has indicated that they will soon select the best-of-breed message preparation system. The Army should participate in this selection of single message preparation GOTS system to be used throughout DoD and as Common ATCCS Support Software (CASS). In addition, the Army should evaluate and trade off the use of the CASS message processing system and champion the Army selection with J-6. Until standard data elements exist and are used throughout DoD, there will be a need to develop specific mappings between data-oriented message data and mission-task application specific data structures. These would probably be implemented in a higher level application layer than the CASS message system.

Currently, the Army and other services think of their message types as system internal (e.g., within ATCCS), service internal (e.g., Navy OTHT Gold), or external (e.g., USMTFs, TADILS, VMFs). The new world environment requires flexibility in the formation and command of JTFs, horizontal data dissemination on the battlefield that will reach across services and functional areas, and the use of fully/partially replicated distributed data in servers whose locations and contents may be transparent to users. These needs will make it difficult to know what systems a C3I system may need to exchange messages with and what data may need to be exchanged. A common message syntax and common registered database of all message formats and fields would enable C3I systems to rapidly reconfigure their connectivity to fit the situation before going to the battlefield and in response to realtime battlefield needs. It could also reduce the cost of message system software development, configuration management (maintaining different databases of message formats), and certification and recertification of C3I systems using various message syntaxes.

Future use of a DoD standard data model and data definitions could enable use of ad hoc self-describing messages. Registered message formats could consist of formats for messages representing formal reports and for messages agreed to by Allies. The rest could be ad hoc messages . This is not such a big step, since one of the criticisms of USMTF usage today is that many USMTFs often have to be sent to accommodate " ad hoc" data for which there is no applicable message format design.



Each USMTF format is like a DBMS schema with its own data dictionary defining the fields and sets used in the message. The message structures may be quite complex since the syntax supports repeating fields, sets, and segments, as well as variable formatting determined by the value of one or more fields. This allows multiple messages to be described in one complex USMTF format.

There is a current ongoing discussion about the complexity of messages vs the number of message formats. Message complexity is a problem when USMTF preparation and usage and thus training are closely tied to USMTF formats. For example, a person having to send a collection of data that is not contained within a single USMTF format currently has to have knowledge and training to select an optimal collection of USMTF formats to carry the data. A message processing system may be able to relieve the user from dealing with USMTF formats for predetermined messages for his/her mission area and even (with more effort) for ad hoc messages. This will probably require a machine interpretable common data dictionary of all USMTF fields and would probably require as much effort as doing data standardization. A system goal could be to make the USMTF formats transparent to the user unless the user were at a TTY.

There are no data standards across USMTFs for either data fields, or sets. The same field name may have different meanings when used in different USMTFs. Fields with the same meaning may be named differently in different USMTFs. There has also been little effort to standardize data in Army databases with the data in USMTFs. There may not be agreement in meaning between USMTF data fields and fields in the datasets the receiver will store the USMTF data in. This requires either human-in-the-loop or special software to perform appropriate data translations.

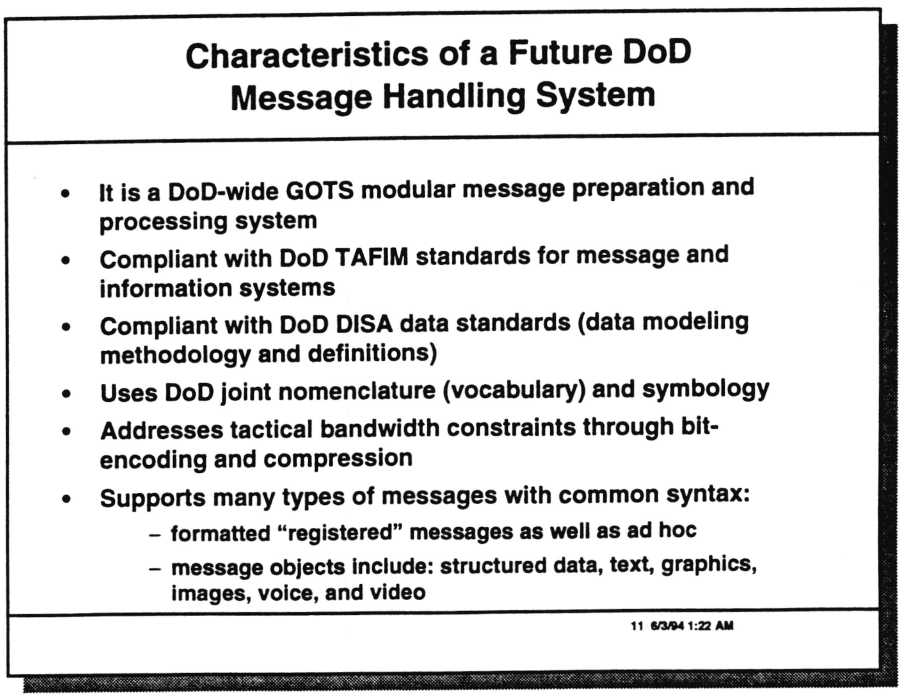
Since a USMTF format may be used for many purposes, all the fields may not be applicable when a user is filling out a message . Fields must be filled in to maintain the correct format, even if only with a delimiter to indicate there is no information.

USMTFs are constrained by the character set of the TTY and the reservation of delimiters. Messages must be in upper case and do not have the use of all punctuation characters (particularly the slash). Perpetuating this will cause problems when nomenclature standards have been established. For example, a message ordering a part that uses a slash within its part number currently requires the slash to be replaced with a dash or some other acceptable character.

The IDA study reported limitations in USMTF training and USMTF usage in exercises and in peacetime missions. An exception was the use of GENADMIN messages (free text) which are used like email. Reasons for failure to use USMTFs included the user being unaware of alternatives to the GENADMIN message, too much effort was required in preparing one or more structured messages, some of the formats are internal to the log/admin systems, and some of the message formats may not support the functions they were designed for.

The large number of USMTF changes per year requires a large staff commitment to: get concurrence, synchronize changes in software and message format databases and tables, recertify message systems and C3I systems that use the message systems, and do configuration management of the whole process.

The IDA study reported an average of 25.7 months from start to end in getting USMTF changes operational.



This is the study team's vision of the future DoD message handling system and is consistent with current efforts and vision briefed by the Army PM Common Hardware Software (CHS), PEO Command and Control Systems (CCS), J-6, and others and by literature on information technology and standards. The important point is that there is one DoD-wide basic message handling system that is part of the Common Application Support Software (CASS) layer of the ATCCS technical architecture. The basic message handling system is modularly designed so that application specific modules can be easily implemented in a higher application layer of the architecture. These modules are specialized by mission area to provide mapping tables and algorithms necessary to translate message data to mission databases and mission database data to messages. As DoD data standards mature, this specialized software will shrink in size and function. Therefore it must exist only at the application level to minimize the impact of change.

The future GOTS Message Handling System (MHS) will be compliant with the DoD Technical Architecture Framework for Information Management (TAFIM). The TAFIM in turn, attempts compliance with international, national, federal, and military standards (in that order). This may help to make the GOTS MHS appealing to Allies which should help ease interoperability problems in Combined operations.

The ultimate goal is to establish DoD data standards across all DoD systems, data systems as well as message systems and information processing applications. This will support interoperability and reduce the investments that are now being made in mapping tables and translation software to enable data exchange across stovepipe systems. The JUDI effort is a good demonstration of what can be done to create brute force translation between message formats and systems but is an interim demonstration and not a long term solution.

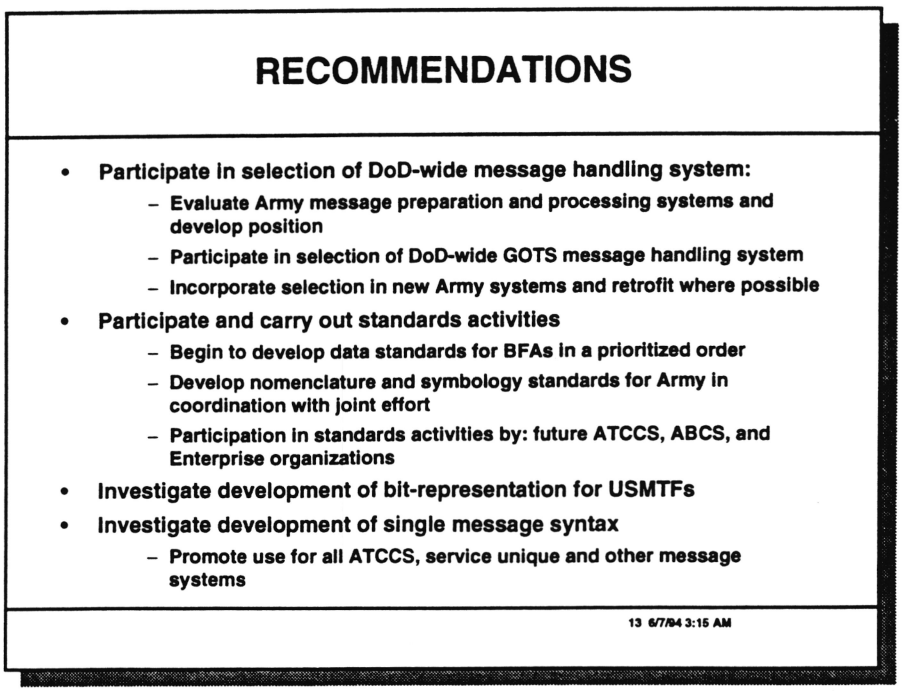
Translation technology has progressed from one-to-one solutions (N X N), to a common translation standard where each system translates its data to and from the standard (2N solution), to data standardization, where all systems employ the same data standards and translation is, for the most part, unnecessary.

Common nomenclature and symbology needs to be addressed as part of the data standardization process. This means that names of objects such as equipment, parts, installations, forces, etc. which compose the domain of a standard data element must be standardized. For example an M1-A1 tank may currently be named "M1-A1" or "M1A1" or "m1-a1" in different datasets. With nomenclature standards, the same name would be used by all datasets (either directly or indirectly through encoding). DoD symbology standards are essential for interoperability of a JTF. It is imperative that the Army, for example, use proper names and symbols for representing objects from other services in order to share information with them.

The GOTS MHS should be capable of translating structured message data into bit encoded information as necessary to reduce communications bandwidth. Special compression algorithms may be used for specific types of objects such as images, voice, video. Since these are inside the message envelop, their compression would be performed by the MHS.

Currently, each message system has its own syntax and database of message formats. The study team did not see any good reason for proliferation of message syntaxes and recommends further study into whether a single formal syntax could satisfy the needs of all message systems. Irrespective of whether or not a single syntax is appropriate, all message formats would be resident in a single database.

The GOTS MHS would support formatted messages that are "registered" in the JIEO database in a way similar to how USMTFs and TADILS are handled now. These messages would have specific formats in accord with formal military reports or forms structures and, of course, would include all formats the US has agreed to through international agreements (e.g., USMTFS). In addition, unplanned or ad hoc messages would be recognized as a type of message which, with the establishment of data standards, would be self describing messages.



The study panel has four main recommendations to the Army with respect to moving the Army ATCCS from a character-oriented message system to a DoD data-standard oriented message system: participate in selection of a DoD-wide message handling system; participate and carry out standards activities; investigate development of bit-oriented USMTFs; and investigate the development of a single message syntax.

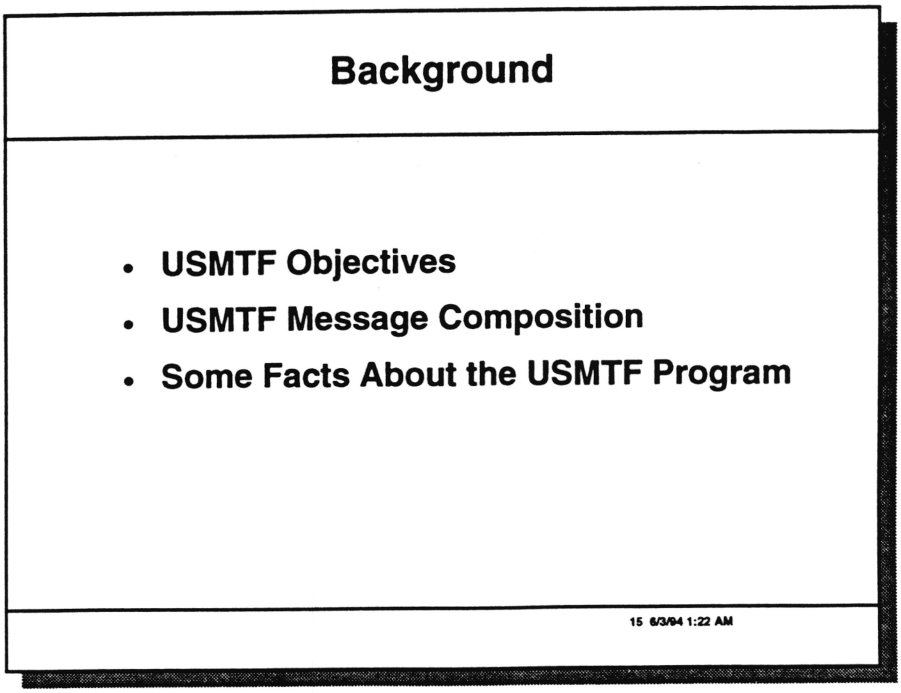
The Army should gather its near-term and future requirements for a single ATCCS message handling system and use the requirements in an evaluation of the current choices for message preparation software (e.g., JAMES, JAMPS, MTF Editor) and message processing software (e.g., JMAPS, ASAS MHS) . The Army should promote their choice by participating in the joint message system selection process. The study panel vision of a future system is intended to suggest long term requirements that need to be considered in ensuring that a near term MHS architecture and philosophy can evolve over time to meet the long term needs. The DoD-wide MHS selection choice should be incorporated into the ATCCS BFAs and retrofitted as necessary in existing C3I systems.

The Army should continue its development of C3I standards by beginning with the C2 Common Core Data Model and extending it to BFAs in a prioritized order. For each BFA, standards should be developed for data entities and attributes, nomenclature and symbology specific to that BFA and where the BFA extends across services standards should be jointly developed. Standards will need to be coordinated for those entities, attributes, etc. that are needed by the BFA and outside of the BFA but for which no standards yet exist. The data standards should be used in USMTFs (and other message formats) in the BFA area which may entail proposing USMTF format changes to the MCEB.

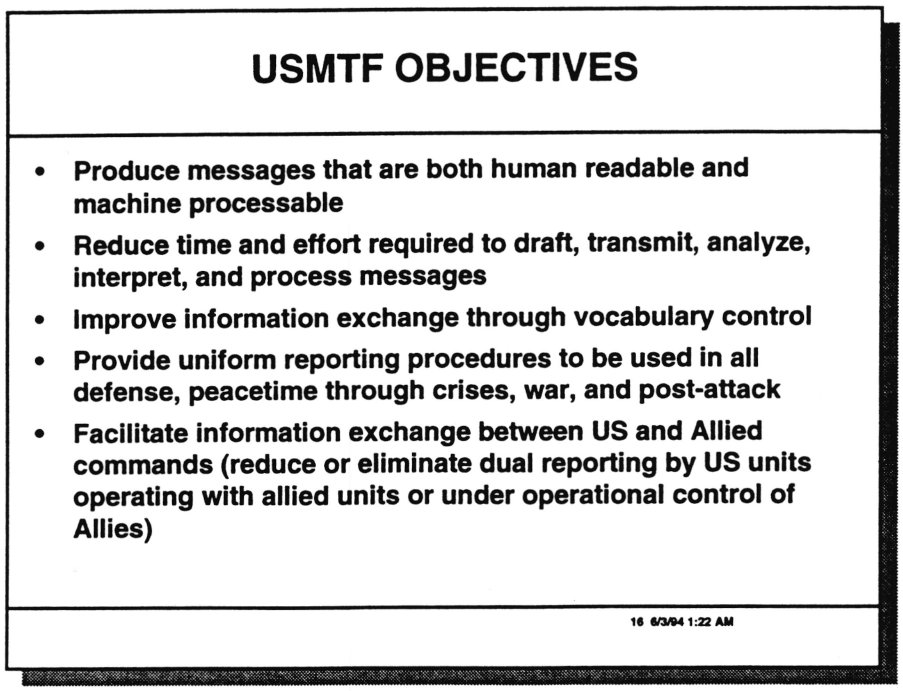
The Army should participate in standards activities that are relevant to the Army requirements for a future message system (e.g., DoD standards, data related standards, message related standards). Army organizations that need to either participate or share in developing the Army's position on future MHS requirements include ATTCS, ABCS, and the Enterprise strategy.

The Army PEO CCS should investigate the need for reduced bandwidth for tactical messages and if it is a real need, then investigate the feasibility of bit-encoding data-oriented message data fields. If bit-encoding is needed, then this should be part of the MHS requirement since it will impact near term MHS development.

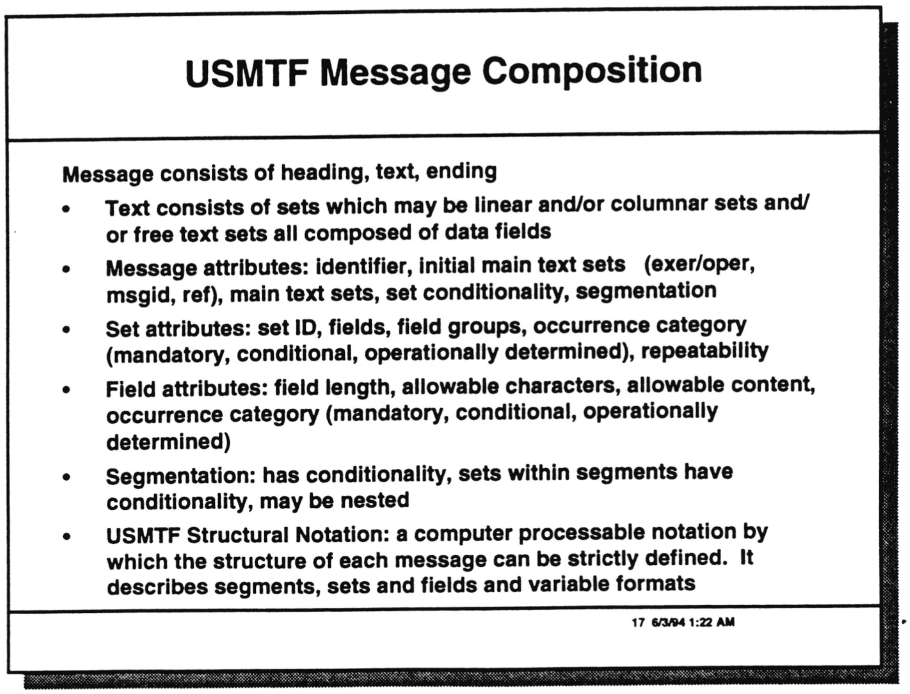
The Army should investigate the desirability of developing a single message syntax for USMTFs, TADILS, VMFs, ATCCS messages, etc. and if found to be desirable, should present this to the Joint Staff as a potential requirement for the future DoD MHS message development. The primary motivation for this is the potential for cost savings in development and maintenance and the flexibility that is achieved by not having to implement multiple translators to achieve interoperability.



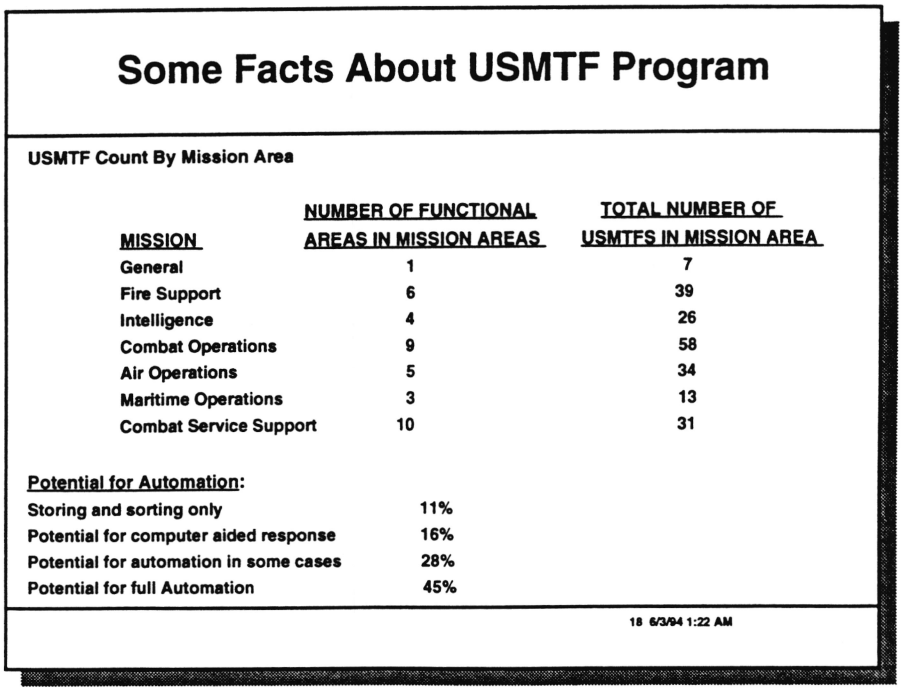
Recommended reference: IDA Paper P-2788, "Assessment of the U. S. Message Text Formatting Program," J. R. Shea, Project Leader, January, 1993.



Taken from Joint Pub 6—04.10, October 1992, Page I-1.



Taken from "United States Message Text Formatting Handbook," Defense Information Systems Agency Joint-Interoperability and Engineering Organization, 1 October 1992.



Some Facts About USMTF Program

USMTF Count By Mission Area

MISSION	NUMBER OF FUNCTIONAL AREAS IN MISSION AREAS	TOTAL NUMBER OF USMTFS IN MISSION AREA
General	1	7
Fire Support	6	39
Intelligence	4	26
Combat Operations	9	58
Air Operations	5	34
Maritime Operations	3	13
Combat Service Support	10	31

Potential for Automation:

Storing and sorting only	11%
Potential for computer aided response	16%
Potential for automation in some cases	28%
Potential for full Automation	45%

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Taken from: IDA Paper P-2788, "Assessment of the U.S. Message Text Formatting Program," J. R. Shea, Project Leader, January, 1993.

Answers to Issues in Terms of Reference

- Meaning of ATCCS having DoD Standardized-Data Message Transfer rather than Current USMTFs
- Technology and Methodology Relevant to Standardized-Data Messages
- Review of What is Needed and Being Done with respect to USMTFS by the Army
- Review of What is Needed and Being Done with respect to USMTFS by the Other Services
- Review of What is Needed and Being Done with respect to USMTFS by the JCS and DISA

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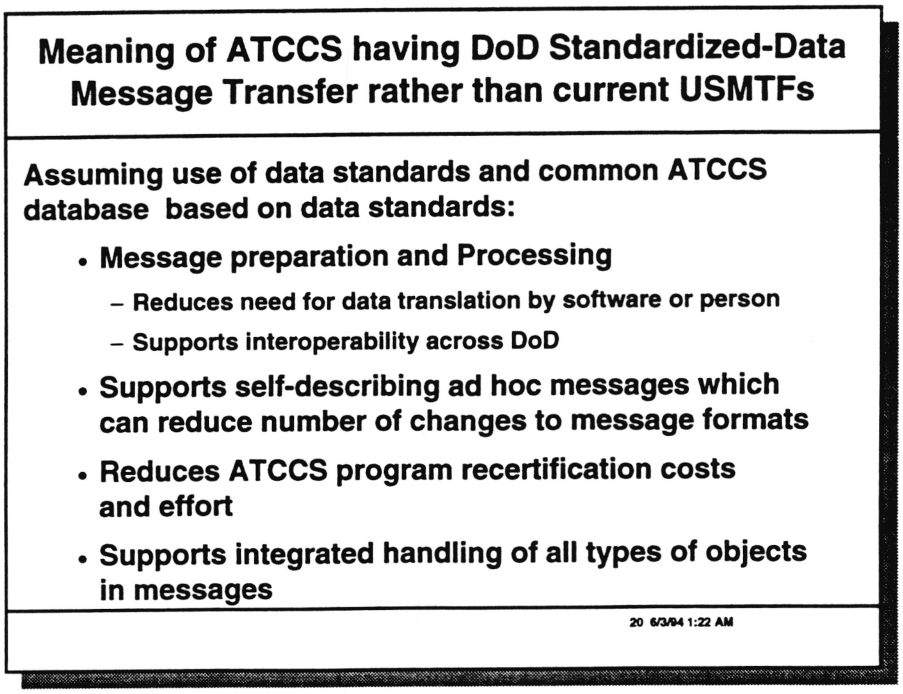
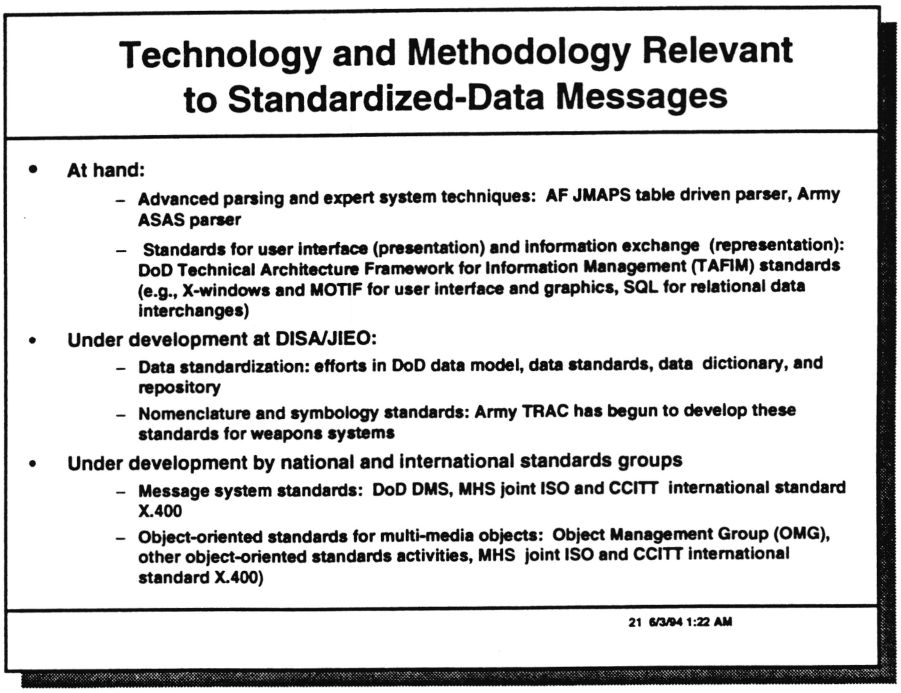


Assuming there will be DoD data standards and an ATCCS common database that uses those data standards then for ATCCS to use DoD standardized-data message transfer rather than the current USMTFs can mean cost savings in software development of mission specific MHS translation modules, recertification costs, and training costs. The use of data standards will support the use of ad hoc messages and this capability could reduce the number of USMTF changes (except for those needed by other nations) and the large costs required to carry those out.

Recertification costs less because USMTF changes should not affect or, at the most, minimally affect mission related MHS software—special translation of data between message data fields and the ATCCS database data will not be needed. Training costs will decrease if users can, for the most part, be supported by a modern MHS that frees them from having to select and compose messages using USMTF formats and read them in USMTF format. With data standards, the MHS could either automatically or as an interactive aid help in selecting the USMTF messages in which to send an ad hoc data message to users at TTYs. With data standards an ad hoc self-describing DoD standard-data message could be used in place of a set of USMTFs for all except TTY users.

This supports interoperability across DoD because data fields in all messages will be standard, and, machine processable standards information will be available in the DoD data dictionary permitting the data to be processed in a relevant manner.

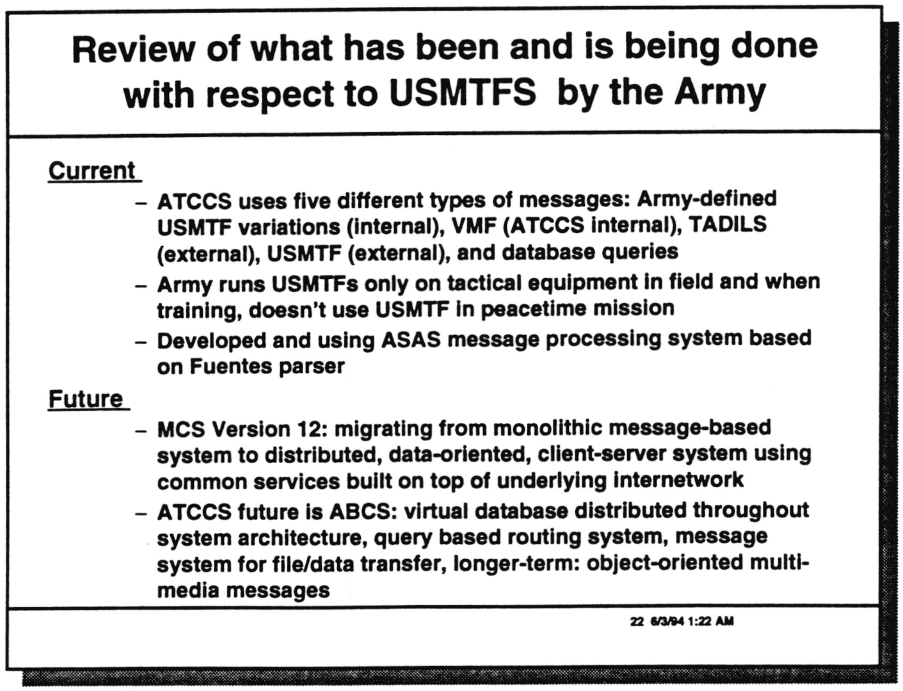
Data standards will also extend to object standards and the future MHS should be able to concatenate all types of binary objects in a single message, handling each type according to its standard.



We have divided appropriate technology and methodology into three categories: at hand, under development by DISA/JIEO, and under development by international standards groups.

The technology on hand that has an influence on the MHS is the advanced parsing techniques being used by JMAPS and the Army ASAS USMTF message processing system, and standards for user presentation and information exchange. The parsers are data driven and differ from each other in that JMAPS utilizes parsing tables derived from the JIEO USMTF database while the ASAS parser uses rule sets defined for each format from a common ruleset. The standards efforts include user interface, data management services, and data interchange services as described in the TAFIM (1 November 1993).

Methodology for data standards is under development by DoD/C3I and DISA/JIEO and includes the use of IDEF1X for data models, and the 8320 document series describing policy and procedures for data standardization. Requirements for a data repository are also being developed as are methods for extracting data from legacy systems through reverse engineering. Reverse engineering could be applied to the USMTFs to extract and model their data entities, attributes, relationships and domains. DISA/JIEO is also working on standardization of nomenclature and symbology and at least one effort has been undertaken in the Army by TRAC to standardize nomenclature for weapon systems.



The current description of the Army use of different types of messages was derived from briefings and conversations with Army ATCCS and CHS personnel.

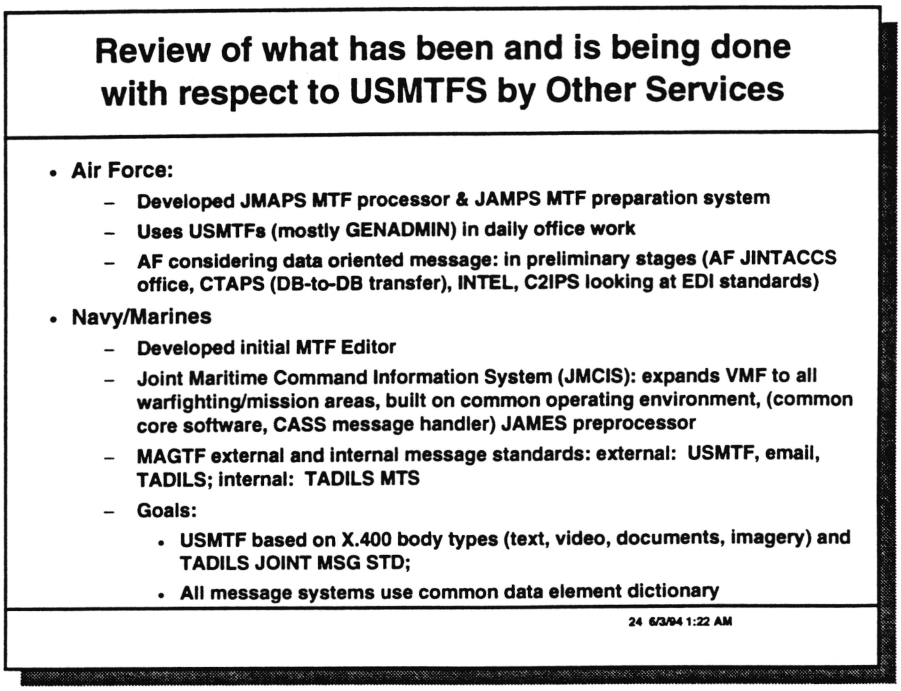
Army and J-6 both mentioned the Army's lack in using USMTFS in peacetime day-to-day operations. USMTFS are currently treated as tactical messages to be used in exercises, training, and battle. The IDA study seemed to indicate that the most commonly used USMTF was the GENADMIN message. It was often used to email data that could have been better described in a formatted USMTF. The increased use of GENADMIN email messages actually defeats the push toward direct data entry of USMTF formatted data since data in GENADMIN messages is treated as free text and is not machine processable.

One of the study members who also participated in the "Command and Control on the Move," Army Science Board study, recalls being shown in a Division exercise, the use of MCS to receive position locations updated in GENADMIN messages which were re-entered by the operator as data updates.

The ATCCS ASAS program developed the ASAS message processing system which is currently the choice for use throughout ATCCS, though it has not yet been accredited by JIEO. When the study team was briefed by PM CHS and CECOM and questioned them about JMAPS, they seemed confident that the ASAS System was better though no formal evaluation had been made.

The future systems plans agree with the open systems TAFIM approach at least in their broad principles.

Relevant standards being developed by national and international standards groups include standards for message services, data services, and information exchange and the realization that they all need to come together to form a comprehensive and integrated set of open system standards. Of particular interest is the work in object-oriented standards because the future DoD MHS needs to be able to pass multi-media objects in a single message. The majority of the data services standards have been based on relational technology that doesn't currently support objects such as images, voice, video.



The Air Force developed the JMAPS MTF processor and the JAMPS message preparation system. The study panel was briefed and given a demonstration of the integrated use of the two systems. On questioning the scope of JMAPS use, we determined:

(1) It has been accredited by JIEO for USMTF processing and it has found errors in the JIEO USMTF message format databases

(2) It has been used operationally on a limited set of USMTFS, the most grueling being the Air Tasking Order (ATO) (where it has automated the handling of a 600 page ATO)

(3) The developers believe it is extensible to TADILS and VMF message handling.

The Air Force has recently mandated USMTFs in peacetime office use to train people in peacetime on the MHS they will use in wartime. However, the IDA briefer cautioned that this has resulted mainly in the use of the USMTF GENADMIN format for email, which is much less user-friendly than other email systems

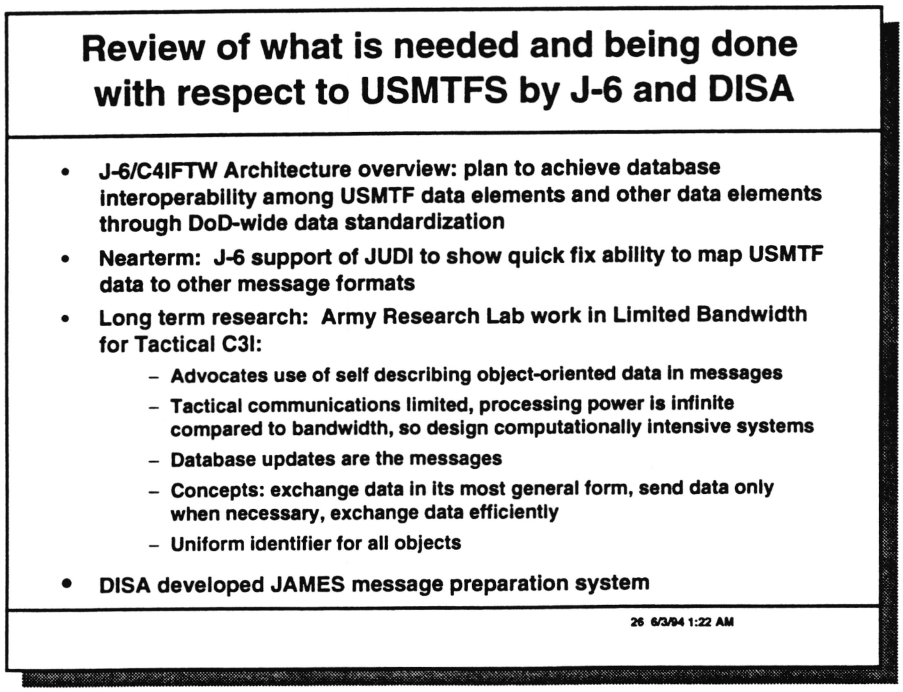
The Air Force plans for automating the movement of message data to databases is mainly a heads up. The study group did not receive more detailed briefs in this area.

The Navy and Marines developed the MTF Editor which is currently being considered by J-6 as a potential best-of-breed selection for the DoD message preparation system with JAMES & JAMPS enhancements. The Army is using the MTF Editor on a DOS platform.

The Navy and Marines have developed the Joint Maritime Command Information System (JMCIS) which is built on a common operating environment (COE) and includes the CASS message handler (i. e., ASAS message handler) and uses the JAMES message preparation system.

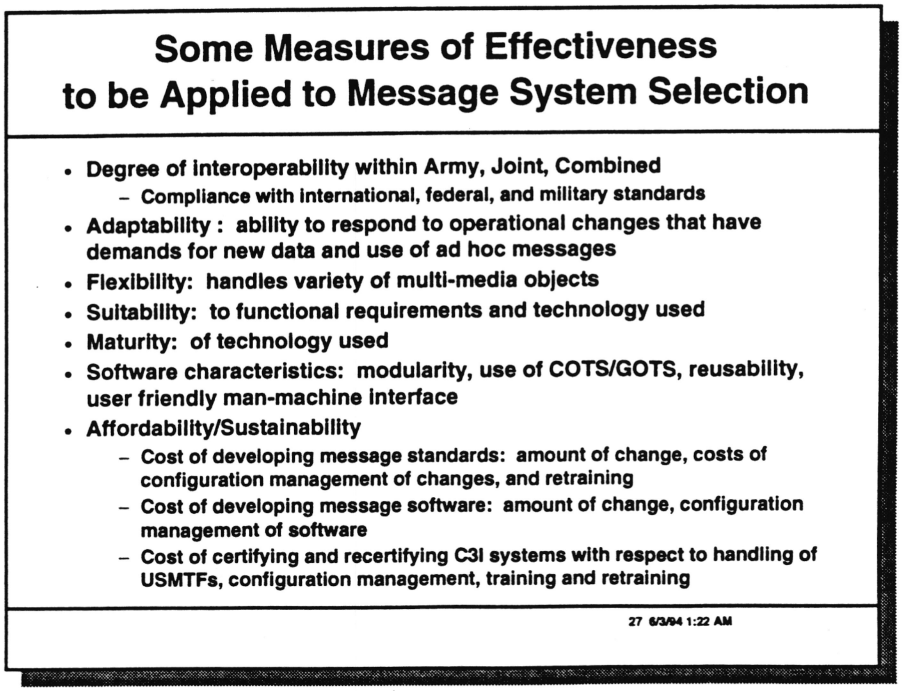
The Navy and Marine have looked at an evolution of message standards from current USMTF, email, TADILS to the future where they plan to use USMTFs based on X.400 body types (multimedia) and TADILS joint message standard. Though the study panel did not explore this further, the Marines have a driving need to handle tactical messages as near to realtime as possible and with as low a bandwidth as possible. This may be the reason for their future view of two message formats—but this should be explored further.

The Navy Warfare Tactical Data Base (NWTDB) Management Initiative includes an objective C4I Data Base Architecture that utilizes standardized data elements (including MTF and TADIL formats) to facilitate the exchange of data by automated systems.



The long term J-6 goal under the C4I for the Warrior program is to achieve interoperability across services' databases and message systems through data standardization. The Joint Universal Data Integration (JUDI) system is a quick-fix early demonstration using brute force data translation for proof-of-concept that translation across messages can be done in a timely manner to provide interoperability among JTF components.

A very interesting effort J-6 is supporting for the long term is an Army Research Lab project exploring limited bandwidth for tactical C3I. They have some interesting ideas on how to encode data fields and data values and it would be worthwhile for the Army to investigate this effort more thoroughly.



The Degree of Interoperability within Army, Joint and Combined forces is a measure of the amount of application specific development needed to interoperate. For example, in applying USMTF data to an application database: requiring a person-in-the loop or special software for each USMTF denotes a low degree of interoperability; a JUDI solution may be slightly higher, data standards across USMTFs still higher; and the use of DoD data standards very high. Compliance with international, national, federal and military standards in that order often relate to the degree of interoperability to fight Combined, as a JTF and across the Army.

A MHS is adaptable if it is relatively low in cost and effort to accommodate operational changes involving new data demands and/or if it can accommodate ad hoc messages in a user friendly manner.

An MHS system is flexible if it is able to handle a variety of different multi-media message objects (graphics, text, images, video, etc.)

An MHS is suitable if it effectively handles the functional requirements and uses technology solutions that are applicable, straightforward, and employ relevant standards.

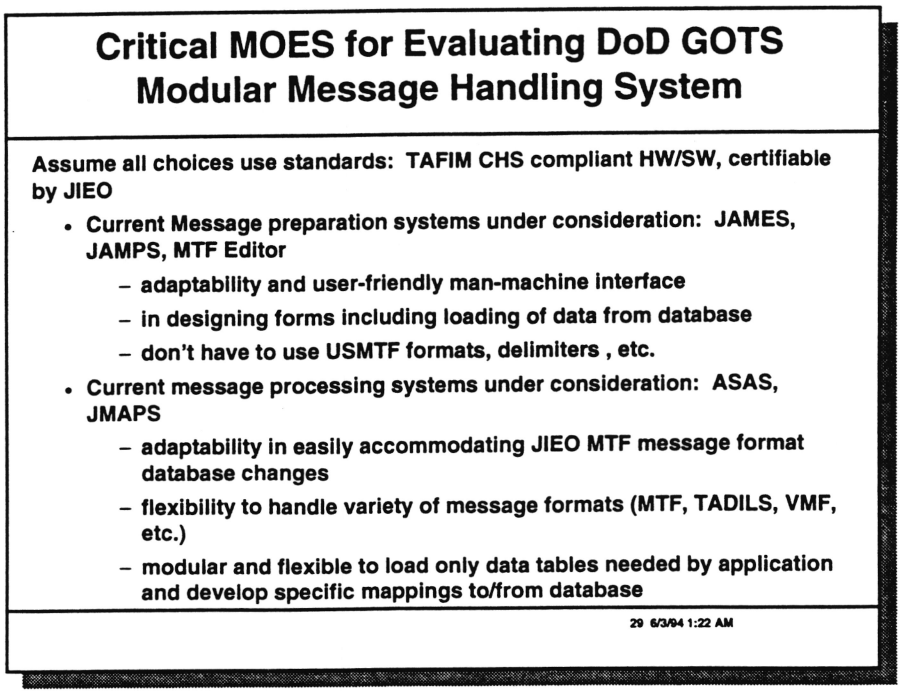
Technology used in MHS is mature if it has been accepted and used successfully by a number of applications (e.g., greater than 10) for a period of time (e.g. 2 years) in a stressful system configuration and environment.

Positive software characteristics of an MHS include modular development, maintenance and testing, incorporation of COTS/GOTS products, reusability and reconfigurability of component parts (often related to modular development and the use of a well defined application programming interface) and user friendly man-machine interface.

In estimating the cost of developing changes to message standards one needs to consider the number and extent of the changes for calculating configuration management of the changes from inception to fielding, the cost of related software changes in C3I systems, and the cost of retraining users.

In estimating the cost of MHS software development, one needs to consider cost of developing new software changes and the configuration management of the software.

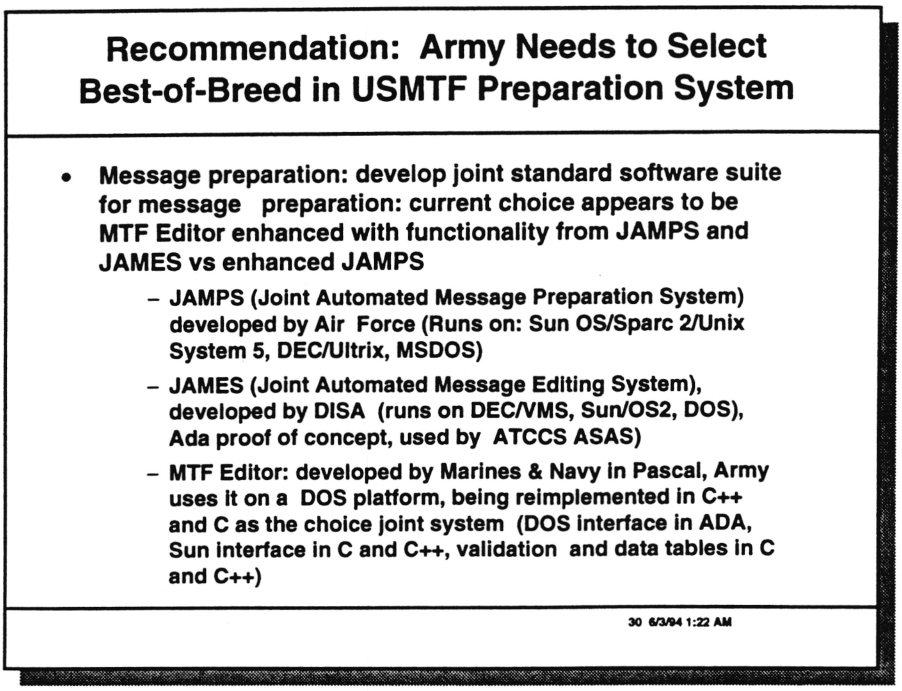
An additional cost in implementing USMTF format changes is recertification of the message handling system (MHS) and re-certification of the C3I Systems using the MHS.



The most critical near-term measures of effectiveness for evaluating message preparation systems are (1) adaptability to USMTF changes (including software modularity), and (2) user-friendly man-machine interface for developing messages including automatic and semi-automatic loading of data from a database.

The most critical near-term measures of effectiveness for evaluating message processing systems are (1) adaptability to USMTF changes, (2) flexibility to handle a variety of message formats (MTF, TADILS, VMF) and (3) modular software that accommodates applications specifying mappings to/from databases.

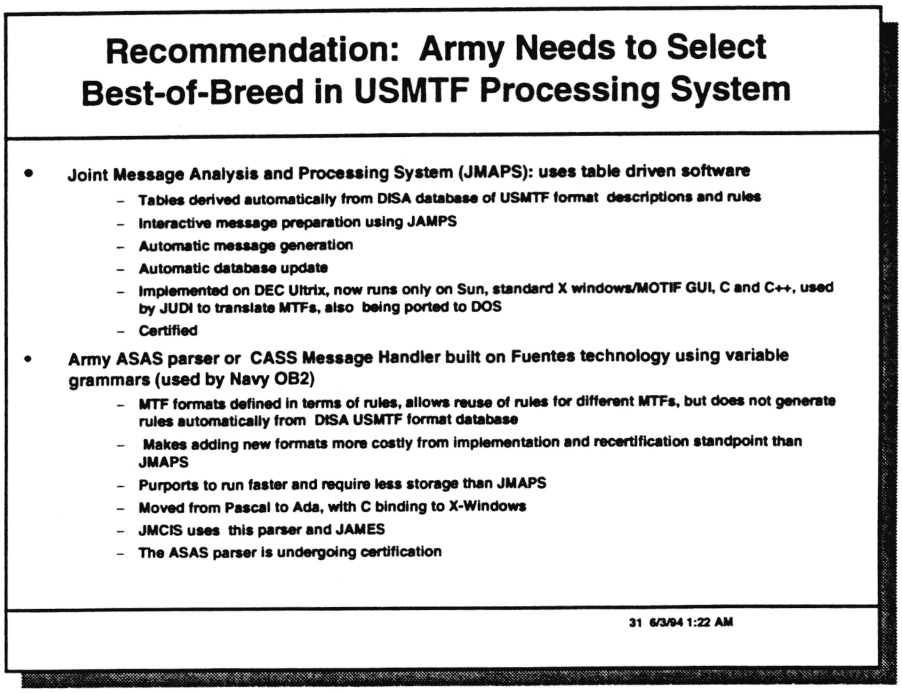
Both types of software should support state-of-the-art graphics interfaces (e.g. X-windows, MOTIF) and hide the details of USMTF arcane formats from the users. They should be able to help the user in selection of multiple USMTFs for ad hoc messages and should load appropriate data automatically from databases whenever possible. They should also perform extensive error checking of inputs before messages are sent out.



A single message preparation system standard is being mandated by J-6 for use throughout DoD. The study panel recommends the Army make a choice, based on Army requirements and measures of effectiveness, of the best-of-breed message preparation system to be used in the near-term and champion its choice to J-6.

Evaluation should include: adaptability in handling USMTF data changes, user friendly interface for filling in task-oriented forms and for developing task-oriented forms; and automated loading of data into forms from databases through well structured mapping routines.

The current choices for message preparation are JAMES, JAMPS or the MTF Editor. The Army currently appears to be favoring the MTF Editor which they are using on a DOS platform.

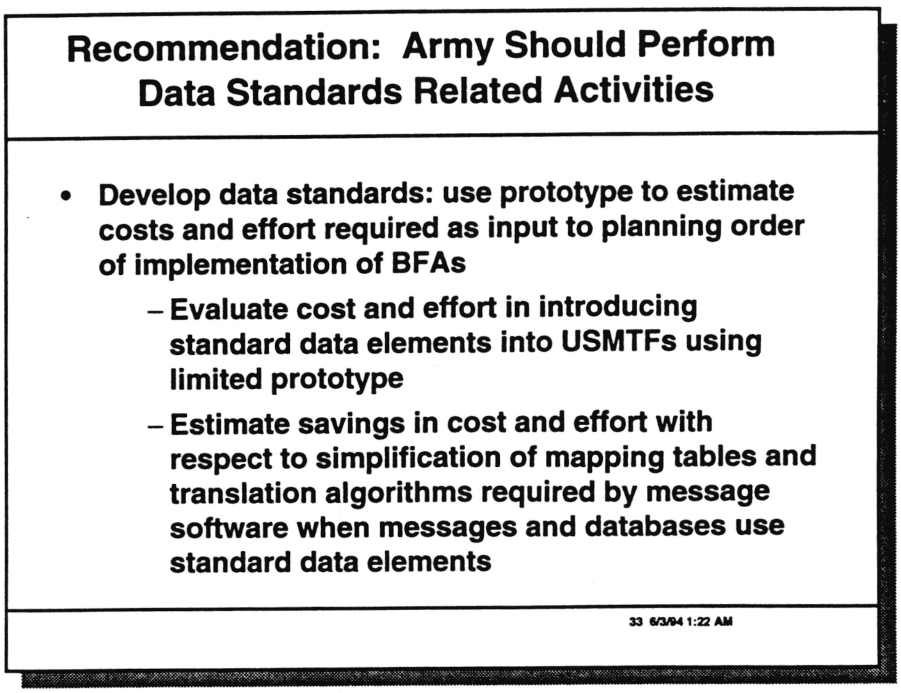


The study panel recommends that the Army future ATCCS, ABCS and Enterprise programs develop a long term framework for the future Army MHS requirements within the CHS common operating environment (COE) compliant with the TAFIM. Input to developing the Army requirements should include the long-term views of (1) the other services and J-6, (2) international and national commercial standards towards integrating MHS with data services and exchange, (3) long-term intent of commercial MHS product developers, and (4) research efforts such as that underway at Aberdeen Research Lab. The outcome should be input to the near term selection of a best-of-breed MHS. Although it would be advantageous to use commercial MHS, tactical constraints such as real time service, encoding to conserve bandwidth, and the need to produce USMTFs for TTY will probably make it difficult to utilize a COTS product without extensive tailoring.

The near-term selection of best-of-breed message processing system needs a careful cost benefit analysis of the ASAS message processing system vs JMAPS. Though the study panel did not investigate the design details of differences between the two systems, areas to evaluate include:

- Ability of each system to meet near-term requirements and evolve to meet long-term requirements
- Software development costs to make stable, reliable GOTS products
- Cost of accommodating the MHS to yearly USMTF changes (i.e., configuration management)
- Recertification costs of C3I systems embedding, incorporating or using the MHS with respect to mission and applications specific translation modules that will need to be added or modified due to USMTF and mission changes.

Near-term considerations include minimum software changes to accommodate USMTF changes, flexibility to handle multiple message syntaxes (USMTF, VMF, TADILS, ATCCS), modularity and flexibility in handling JIEO message format data tables, and performance.

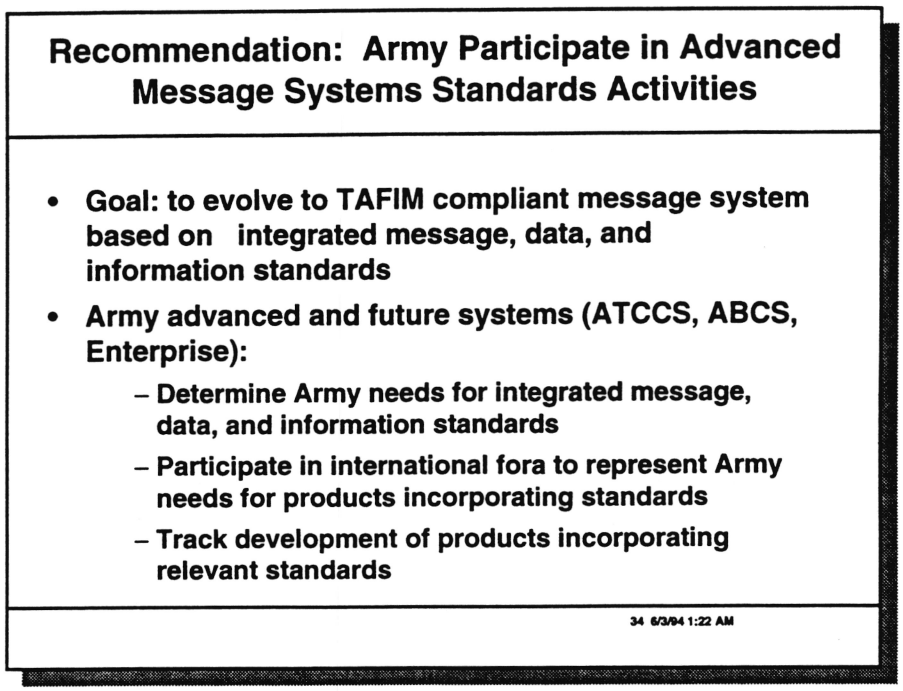


The study panel recommended that the Army develop data standards beginning with the C2 Common Core Data Model and extending it to BFAs in priority order. A further recommendation is that in developing standards for the first BFA, the Army do a scoped prototype to estimate costs and effort required and lessons learned. (The Fire Support Data Model may serve this purpose.) This should reduce the risk and add credibility to a phased plan to produce BFA data standards that can either be used in re-engineering BFA databases and applications or in reverse-engineering legacy databases and applications in order to map their data concepts to the data standards.

The Army (or J-6 or JIEO/CIM) needs to evaluate the cost and effort in introducing data standards across USMTFS again using a limited prototype (e.g. perhaps a small BFA).

A further estimate needs to be made of savings in simplifying mapping tables and translation algorithms when USMTFs and databases all use or are mapped to data standards.

These evaluation studies and prototypes should be used to do a cost benefit analysis of data standardization.



Representatives from the Army advanced and future C3I systems (ATCCS, ABCS, Enterprise) should determine the Army needs and requirements for a long-term integrated MHS and represent the Army requirements in relevant, international, national, federal, and military standards fora. This will help promote COTS/GOTS MHS products that can meet the Army and DoD needs. At the same time, the Army/DoD has to actively track new MHS product developments to ascertain when these may be ready for testing and mature enough for use.

Summary of Recommendations to be addressed by PEO CCS

- Army must define its near-term and long-term tactical MHS requirements
- Army should use near-term MHS requirements in:
  - Current message preparation and processing system selection
  - Participating in message standards fora
- Army should use long-term MHS requirements to
  - Develop data standards and DoD standard-data messages for ATCCS
  - Investigate and recommend feasibility of single syntax message system
  - Investigate and recommend on reducing bandwidth of messages with respect to:
    - bit representation
    - data compression
    - ARL research in trading off communications bandwidth for computation intensity

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Annex A

Terms of Reference

Pages 36—40

DEPARTMENT OF THE ARMY
OFFICE OF THE SECRETARY OF THE ARMY
WASHINGTON, DC 20310-0107

7 July 1993

Office, Director of Information
Systems for Command, Control,
Communications, & Computers

Dr. Walter LaBerge
Chair, Army Science Board
23427 El Greco Drive
Mission Viejo, California 92692

Dear Dr. LaBerge:

I request that you initiate an Army Science Board (ASB) C3I Issue Group study on "Moving Army Tactical Command and Control System (ATCCS) from a Character-Oriented Message System to a Data-Oriented Message System." This study, as a minimum, will address the Terms of Reference (TOR) described below. The ASB members appointed will consider the TOR as guidelines and may include in their discussions related issues deemed important by the Sponsor. Modifications to the TOR must be coordinated with the ASB office.

I. Background.

a. Current Army Command and Control (C2) Information Systems transfer data using character-based U.S. Message Tactical Format (USMTF) messages that are controlled by Defense Information Systems Agency/Joint Interoperability Engineering Organization Joint Chiefs of Staff (DISA/JIEO JCS) Configuration Control Board, and were designed

(1) For transfer by teletype
(2) To be both human readable and computer processable
(3) to support interoperability for service-specific, joint, and combined operations.

b. USMTFs are agreed to by Components and Allies, and are frequently changed to accommodate new requirements. Changes, some 300-500 per year, require coordination among Components and Allies and affect existing Army C2 systems and those under development, putting a large burden on the developing ATCCS information systems and their configuration management.

c. A lack of standards in defining fields (data elements) across USMTFs creates redundancy, in that the same information may be described and represented differently in different messages (e.g., this may result in redundant messages or parts of messages); and creates inefficiencies in that different functions may be needed at the receiving end to translate the same/similar field in different messages into data for storage in a database. Currently, many insertions of data into databases is done by a person in the loop.

d. Since an USMTF is defined or extended to cover many purposes, it is often quite long, and has associated with it obligatory rules that frequently require the user to fill in fields with meaningful data that will not be used by the receiver of the message. This increases message development overhead and communication bandwidth. The estimated utility of USMTFs for ATCCS is 30%.

e. The ATCCS program has begun addressing these problems by (1) using new parsing technology to develop parsing tables from specified grammars; (2) developing Army variants of USMTF messages to work around the problem of having to fill in unnecessary fields; and (3) by developing Army/ATCCS-specific messages. These efforts, based on the assumption that 96% of the ATCCS messages are intra-ATCCS, have not addressed the use of data modeling, and data entity and data element standardization within the Army and across other Components; and may not have given due attention to future Joint Task Force activities. The goal of automatically entering message data into the proper field(s) in databases (or composing messages automatically from database data) may also require use of techniques for mapping data to and from database schemas.

f. The Army would benefit from an objective study to ascertain what a reasonable future objective is for data-oriented message transfers, what the issues are, and a suggested roadmap to get from the current situation to the future.

II. Terms of Reference.

a. Develop and document what is meant for ATCCS to have a "data-oriented message transfer capability" rather than the current USMTF character-oriented message transfer capability, by having discussions with ATCCS Battlefield Functional Area (BFA) designers, developers, and future users about

- Their current and future databases
- Their current use of USMTFs and relevant problems
- The kinds of data messages they plan to produce and process
- How they perceive the current Army directions (as described in I. e above) meeting or failing to meet their current and future needs
- Measures of effectiveness to be used in evaluating data-oriented message solutions.

b. Investigate what others are doing in the area of data-oriented messages including DISA/JIEO with respect to USMTF and C2 standardization efforts, DISA/Center for Information Management (CIM) data standardization efforts, and other Services (e.g., Navy Copernicus).

c. Review technologies and methodologies applicable to the issues in developing the use of data-oriented messages, such as

- o Data standardization methodologies
- o Parsers (including the Fuentes Parser)
- o Exchange of data across heterogeneous database systems (including schema integration and mappings from native systems to and from a common schema)
- o High-level message/protocol languages.

d. If possible, compare several approaches to achieving data-oriented message transfer capability, highlighting their differences in terms of measures of effectiveness (MOEs) and cost.

e. Recommend a long-term objective and a strategy for reaching that objective.

III. Study Approach.

To ensure the study is based on the most current information possible, the study panel will review program activities and data by relevant organizations including

- o Army ATCCS BFA programs (CECOM and others TBD)
- o Army current C2 users and future ATCCS users (TBD)
- o DISA/Joint Interoperability and Engineering Organization (JIEO) Center for Standards (CFS)
- o DISA/Center for Information Management (CIM)
- o Other Services: Navy Copernicus, Air Force Command Tactical Automation Planning System (CTAPS)
- o Technology: MITRE, Software Engineering Institute, universities.

Assessments will be made in accordance with the TOR; and recommendations will be action-oriented; at least some will be near-term. Results of the study will be documented in a final report and presented in a briefing to the Sponsor.

The study panel will maintain close coordination throughout the study with the Sponsor to ensure consistency of perspectives. The Sponsor will be invited to participate in all reviews of demonstrations and program activities.

IV. Study Support.

Lieutenant General Peter A. Kind, Director of Information Systems for Command, Control, Communications, and Computers (DISC4) will sponsor the study. The Staff Assistant will be Mr. Errol K. Cox (SAIS-IDT). The study would also benefit from having an Army technical assistant with knowledge of USMTF issues.

v. Schedule.

The study panel will begin its work upon approval for this study plan by the Sponsor and the ASB Executive Secretary no earlier than July 1993. Proposed time and location of meetings will be determined.

PETER A. KIND
Lieutenant General, GS
Director

Annex B

Study Schedule

8—9 November 1993, Pentagon

Data System Integration Panel	Mr. Billing
USMTF Technical Description	Major Schultze
C2 Data Element Standardization	LTC Robinson
COPERNICUS Architecture	CDR Decker
USMTF Program	Major Broadwell
USAF Message Standards	Major Emmert
Army Enterprise Strategy	COL Long
Constrained Bandwidth	Dr. Chamberlain
Army Battle Command System	
JUDI Data Transfer	Ms. Sharon Muzik

10 November 1993, Dumfries, VA

Marine Corps Interoperability Brief MAGTFC4I	LtCol Knorr

30 November 1993, Pentagon

Interoperability and Standards	LTC Steve Woofinden
The MCEB Board	Mr. Walt Fairbanks
Overview Assessment of the USMTF Program	Dr. Shea
C4IFTW Migration Strategy in System	Dr. Liou and Mr. Walsh
Architecture for Force Level C2	
C2 Architectural Overview	LTC Hartel
Secure Tactical Data Network (STDN)	LTC Hartel

12 January 1994, Pentagon

JMAPS	Dr. Heller and Major
Emmett	
Digitizing the Battlefield	Col Bill Langford

14 January 1994, CECOM

PEO CCS Functions and Organization Overview	PEO CCS
ATCCS Program Status and Plans	PEO CCS
The ABCS Program and the Future	PEO CCS
Detailed Status/Plans of all ATCCS Protocols	PEO CCS
ACCS Common Software Program	PM CHS
Tactical Communications Interface Modem	PM CHS
CHS2 Capabilities/Tech Insertion	PEO CCS

Annex C

Acronyms

ABCS	Army Battle Command System
ASAS	All Sources Analysis System
ATCCS	Army Tactical Command and Control System
ATO	Air Tasking Order AUTODIN
BFA	Battlefield Functional Area
C3I	Command Control Communications and Intelligence
C4	Command Control Communications and Computers
C4IFTW	C4I For the Warrior
CAS	Common ATCCS Software
CCITT	Consultative Committee on International Telegraph and Telephone
CECOM	Communications-Electronics Command
CHS	Common Hardware Software
CIM	Corporate Information Management or Center for Information Management
COTS	Commercial-Off-The-Shelf
CTAPS	TACS Automated Planning System
DBMS	Data Base Management System
DISA	Defense Information Systems Agency
DoD	Department of Defense
EDI	Electronic Data Interchange
GENADMIN	General Administrative
GOLD-OTHT	Gold-Over The Horizon
GOTS	Government-Off-The-Shelf
ID	Identification
IDA	Institute for Defense Analysis
IDEF1X	IDEF for Data Modeling
HW/SW	Hardware/Software

Acronyms (cont'd.)

JAMES	Joint Automated Message Editing System
JAMPS	Joint Automated Message Preparation System
JCS	Joint Chiefs of Staff
JMCIS	Joint Marine Corps Information System
JIEO	Joint Interoperability Engineering Organization
JMAPS	Joint Message Analysis and Processing System
JTF	Joint Task Force
JUDI	Joint Universal Data Interpreter
ISO	Open Systems Interconnection
MAGTF	Marine Ground Tactical Force
MCEB	Military Communications and Electronics Board
MHS	Message Handling System
MILSTD	Military Standard
MOE	Measure of Effectiveness
MOTIF	not an abbreviation
MSG	Message
MTF	Message Text Format
NATO	North American Treaty Organization
OMG	Object Management Group
PEO	Program Executive Office
TADILS	Tactical Data Information Link (TADIL) message
TAFIM	Technical Architecture Framework for Information Management
TTY	Teletype
USMTF	United States Message Text Format
VMF	Variable Message Format