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AN ANALYSIS OF THE JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS) AS A MOBILE SUBSCRIBER EQUIPMENT (MSE) ALTERNATIVE

USA-USN-USAF-USMC

JOINT TACTICAL COMMUNICATIONS OFFICE
FORT MONMOUTH, N.J.

Section 1

INTRODUCTION

1. Purpose: This report examines the feasibility of utilizing the Joint Tactical Information Distribution System (JTIDS) as the core for development of a Mobile Subscriber Equipment (MSE) Subsystem.

2. References: The following references were utilized in conducting the analysis:

A. System Segment Specification for JTIDS Class 2 Terminal, Specification Number DCB 78S3000, Coordination Draft, 6 August 1979 (SECRET).

B. JTIDS Vulnerability Study, Vought Corp., 31 January 1978 (SECRET).

C. Analysis of Foreign and Commercial Mobile Subscriber Equipment (MSE) Alternatives, TT-E-SD, March 1979.

D. Joint Operational Requirements for Mobile Subscriber Equipment, JSCM-101-79, 2 April 1979.

3. Scope: The analysis performed herein is to determine the technical feasibility of developing a MSE subsystem, utilizing the existing JTIDS architecture, which could meet the existing operational requirements as defined in the Joint Operational Requirements for Mobile Subscriber Equipment.

4. Organization of the Report: Section II contains a description of the proposed US MSE system plus a detailed list of user and system architectural (interface) requirements. The user requirements are supported by the approved JOR for MSE. The architectural requirements have been extracted from TRI-TAC architectural documents.

Section III contains a description of the developmental JTIDS system as derived from the references in para 2 above.

Section IV highlights the most significant areas of conflict between the system architectures described in Sections II and III.

Section V contains the analysis conclusions.

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TRI-TAC	Communication Equipment
JTIDS	Communication & Radio Systems
MSE	Trunks (Communication)
Tactical Communications	Telecommunication
Radio Receivers	Radio Transmitters

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report examines the technical feasibility of developing a Mobile Subscriber Equipment (MSE) Subsystem utilizing the existing Joint Tactical Information Distribution System (JTIDS) Architecture which could meet the existing operational requirements as defined in the Joint Operational Requirements (JOR) for Mobile Subscriber Equipment. A comparison of the two system architectures (TRI-TAC + JTIDS) is made with a brief description of some of the more significant problems that would result from integration of two systems.

Section II

TRI-TAC Mobile Subscriber Equipment

1. Requirements:

Over the past nineteen years a requirement has been identified for a mobile subscriber system to provide the essential communications capability for the combat, combat support, and combat service support elements of the division and separate brigade areas. Specific requirements have been documented at various stages in the development of different systems. These include RADA, MALLARD Single Channel Access (SCA), INTACS, EUROCOM, and TRI-TAC. The US requirements were most recently documented in the approved JOR for MSE, 2 April 1979. EUROCOM requirements have been documented and updated since 1974. The US requirements represent the synthesis of requirements from past programs and are primarily derived from the INTACS study. The following user oriented system requirements have been identified:

(1) Secure radio telephone communications terminals for installation and operation in mobile platforms (wheeled and tracked vehicles, aircraft, and ships) and communications shelters.

(2) Discrete addressal capability for voice, record and data traffic calls to a wide variety of users, including switched system subscribers.

(3) Communications capability to operate in a rapidly changing combat environment.

(4) Operational capability, under worldwide terrain conditions, for up to 400 terminals within an area of coverage ranging from 35 X 60 km to 50 X 160 km.

(5) Mobile Subscriber Terminals not to exceed a weight of 70 pounds and a volume of 2 cubic feet.

(6) Objective procurement cost of approximately $15K per terminal or less.

2. TRI-TAC Mobile Subscriber Access (MSA) Subsystem Description:

The Mobile Subscriber Equipment (MSE) contained in the MSA Subsystem includes the Mobile Subscriber Central (MSC), the Mobile Subscriber Terminal (MST), and the Access Units (AU). The following paragraphs describe the TRI-TAC architectural concepts for the Mobile Subscriber Equipment.

2.1 Mobile Subscriber Centrals:

MSCs will be designed to provide a flexible self-organizing arrangement with connectivity from MST to MSC, MSC to switch, and MSC to MSC. Static subscribers who are isolated from the trunk network (static enclaves serviced by both unit level and trunk/access switches) are to be provided access to mobile subsystem and ultimately to the trunk network via AUs. Multichannel trunking between MSC and static switches would provide additional intersubsystem connectivity. NRI facilities for interfacing with designated net radios can also be provided at the MSC.

Each MSC will provide the capability to handle 12 simultaneous calls and provide a 16-channel TDM trunk for interface with the switched system where required. All radio access and relay channels would be used on a demand-assigned basis. The switching function is to be accomplished by a processor-controlled digital switch which is integrated with the MSC and provides a termination capacity adequate to handle the radio channels, the interface trunks, and some local wire line terminals (if desired).

Memory modules will be provided for routing tables, classmarks, radio net designators, central designators, calling line identifiers, and directories. COMSEC equipment will be provided for end-to-end security and electronic key distribution.

In order to provide the call capability between local mobile subscribers, between mobile subscribers served by neighboring MSCs, and between mobile subscribers and static subscribers, the MSC will be designed to perform the following functions:

(1) Acceptance of a call from a MST on any access channel:

a. Query and identification of the calling MST.

b. COMSEC coordination.

c. Routing and table maintenance.

d. Switching.

e. Signal conversions.

f. Call completion.

g. Channel force-clear.

h. Paging/preemption.

(2) Organization of calls to a local MST.

a. Paging (preemption if required).

b. COMSEC coordination.

c. Signal conversions.

d. Call completion, in coordination with the static switch or neighboring MSC, if applicable.

e. Channel force-clear.

(3) RF channel coordination and control as required for a given access technique.

(4) Booking of new MSTs.

(5) Distribution of timing and synchronization signals to MSTs as required.

(6) Monitoring of the RF spectrum, recognition of jamming or interference and initiation of the AJ mode if available.

(7) Operator intervention on emergency calls.

2.2 Mobile Subscriber Terminals (MST):

The MST should be capable of discrete address communication by two methods; i.e., direct user-to-user or via an MSC.

In direct user-to-user operation, the MST will perform discrete addressing, signaling, channel selection, and control for the call. The radio will be capable of operating on a number of different channels. The MST will employ a channel memory to keep track of available frequencies and frequency synthesizers to provide the capability for the transmitter and receiver to operate on any selected channel. The control logic/processing capability of the unit will provide the coordination and interface among the signaling and supervisory functions and the transmitter and receiver. In addition to the discrete addressing capability, the MST will also provide a local conferencing/netting capability to allow for emergency calls and/or MSC-independent conferences.

The MST will consist of a single channel radio transmitter/receiver with associated antenna, control module, and secure terminal equipment. The MST will operate at 16 kb/s and support secure voice and nonvoice communications. The control module will perform the necessary RF-channel coordination in cooperation with the MSC or AU or another MST depending upon deployment considerations.

The specific functions which will be performed by the MST include:

(1) RF channel selection and coordination procedure.

(2) Initiation and acceptance of calls including channel seizure, crypto synchronization, called line identification procedure, key variable transfer, dialing, release, and channel force-clear.

(3) Precedence access of the MSC.

(4) Emergency access of the MSC.

(5) MSC operator recall.

(6) Direct communication between MSTs on a discrete address basis and on a conference/net basis.

2.3 Access Units (AU):

Access units will be deployed at selected static switching centers to provide a call capability between mobile subscribers and the static subscribers served by the switched system. AUs will be attached to the static switches as appliques and appear as MSTs to neighboring MSCs, MSTs, or other AUs.

The AU will be physically similar to a MST except that 2 to 4 channels rather than a single access channel will be provided. The components of the AU will include radio sets and antenna(s), frequency synthesizers, DSVT(s), modems, COMSEC, memory, processing, and patching capability. In addition to the functions provided by the MST outlined above, the AU will provide an interface with a collocated switching center.

Section III

Joint Tactical Information Distribution System (JTIDS)

1. Introduction: The Joint Tactical Information Distribution System (JTIDS) is currently under development. Three terminal classes have been identified for development. The Class I terminal (the largest, most powerful of series) is expected to go to production in FY80. The Class II terminal (designed for shipboard and aircraft applications) is expected to enter FSED in FY80. The manpack, or Class III terminal, is currently in conceptual development and no estimates are available concerning further development efforts. The Phase I JTIDS system is illustrated in Figure 1. The following is a brief description of JTIDS system as it is currently being developed.

2. System Description: JTIDS is a digital information distribution system which provides communications, navigation and identification (CNI) capabilities in an integrated form. JTIDS operates as a "broadcast" (receiver-oriented) system simultaneously providing all information to all authorized subscribers.

JTIDS derives its basic capabilities through the use of Time Division Multiple Access (TDMA) technology. Netted digital links interconnect subscribers by employing a common frequency band and omni-directional radiation of energy. Code division multiplex techniques, superimposed on the basic TDMA structure, are utilized to extended the system to multi-netted operations. Participating subscribers are assigned to one or more nets and are allocated specific time slots during which they may transmit and receive information on a specified net. Each subscriber has access to all information on his assigned net(s), therefore, selective filtering is employed to extract only the information of interest.

Each subscriber enters the net and maintains the system time independently. Initial entry is executed by the reception of any message transmitted by any other unit that has achieved synchronization. The system does not maintain a directory of active subscribers. Although at least two reference units are required (a Net Time Reference and a Navigation Controller), the system is essentially nodeless since any terminal can be assigned these functions.

The system provides for jamming resistance to enemy electronics counter measures and security against evesdropping and spoofing. The system can be operated in up to four modulation modes, as conditions dictate. Performance in each mode is identical except for the degree of resistance to jamming and interference.

Operation of the system is at microwave frequencies, nominally 1 GHz. System power is adequate to provide for line-of-sight ranges of

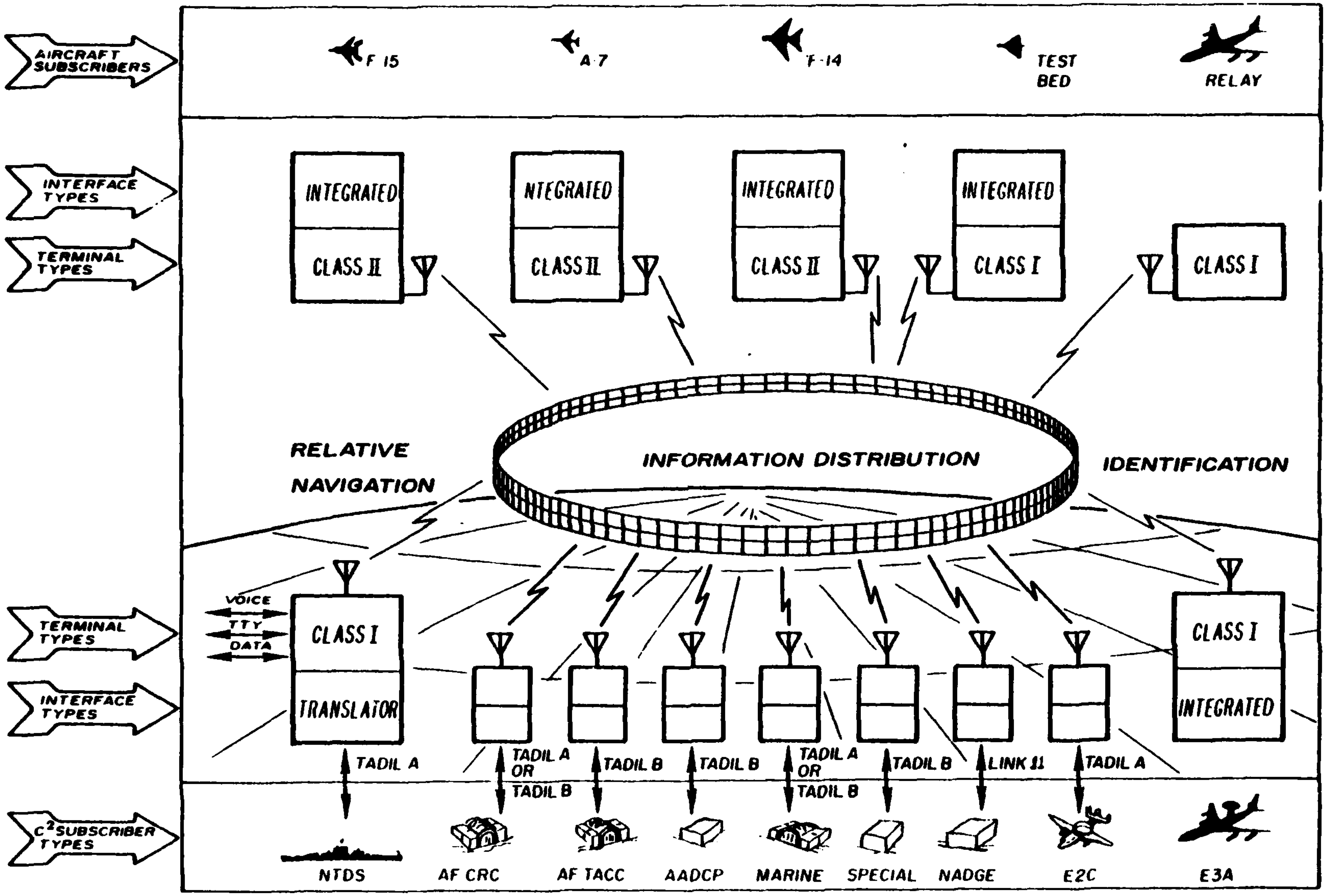

Figure 1 JTIDS PHASE I SYSTEM

operation up to 500 nm. The radio coverage of the system can be extended to as much as 1200 nm by using airborne relay stations.

All terminals are capable of providing the radio relay function in addition to performing all other assigned functions. The relay function operates on the principle of time slot delay relaying such that messages received in specified "receive" slots are retransmitted in specified "transmit" slots. In addition to relaying messages received in relay receive slots, the terminal processes those messages as required for its own normal use.

The system architecture can best be described by considering the time division format (see Figure 2). Time is divided into epochs and time slices, a day (24 hours) contains 112.5 epochs. An epoch is 12.8 minutes in duration and is divided into 98,304 time slices. The time slice is 1/228 seconds or 7.8125 ms. The 98,304 time slices in an epoch are divided into three sets (A, B and C), each set containing 32,768 time slices. Time slices are uniformly distributed in the epoch such that time slices of set A follow time slice (n-1) of set C and precedes time slice n of set B. The basic message unit is the time slot which is a subset of a time slice. To limit the classification of this report, the details of the time slot are not provided.

JTIDS can distribute information in two data formats; free text or unformatted messages and standard message formats. Each message is compressed into one or more time slots. Digitized voice (16 kb/s, CVSD) is one form of free text message for the system. The system has a free text throughput of 28.9 kb/s with EDC, or 59.5 kb/s without EDC which is not optimized for the use of 16 kb/s voice.

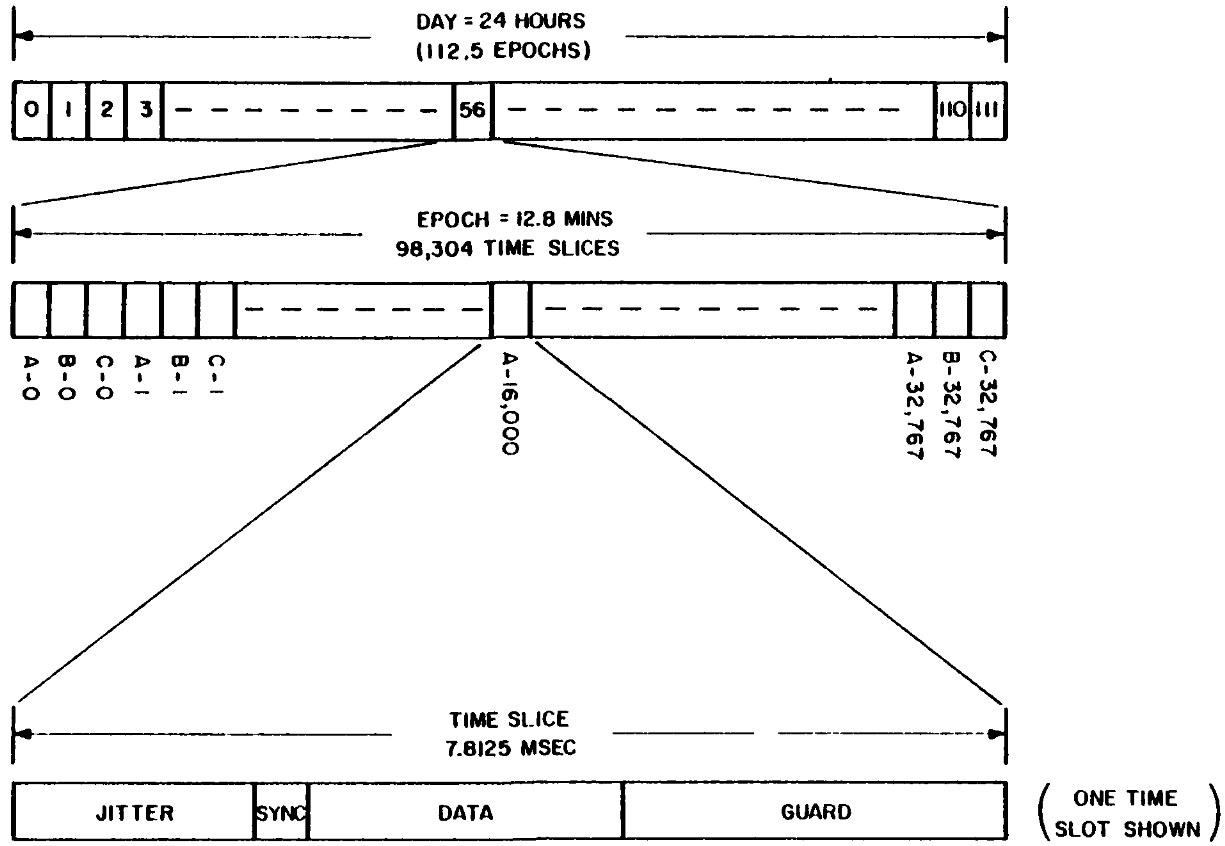

Figure 2 TIME DIVISION FORMAT

Section IV

Evaluation

1. Introduction: The system architectures for JTIDS and TRI-TAC were designed to fulfill different user requirements. The resulting systems are different enough that any attempt to integrate their architectures would result in a number of problems. This section contains a brief description of some of the more significant problems.

2. Discrete Address. JTIDS is a digital information broadcast system. It is not designed for a discrete address capability which permits information to flow between two users. The development of a discrete address capability within the JTIDS system would be a major change to the JTIDS architecture. To incorporate discrete addressing would increase cost and complexity and reduce the message handling capacity.

3. Area Coverage: JTIDS area coverage is excellent, if airborne relays are employed. The primary purpose of JTIDS is to support air and anti-air warfare, i.e., mission areas where extensive geography must be covered and information changes quickly. An MSE subsystem is designed to provide communications within a limited division deployment area near the FEBA. The microwave frequencies used for JTIDS only allow ground mobile users a maximum range of less than 20 km without elevated antennas. The ranges would be decreased if the terrain included hills, heavy foliage or buildings. Division area coverage would require use of radio relays. If ground relays were utilized, numerous stations would be required to cover a division area (the number would depend on the actual dimensions of the area and the local terrain). The relay function could be accomplished with a single low performance aircraft, however, the life expectancy of the craft in the forward battle area would determine the utility of the MSE system. It should also be noted that the JTIDS system capacity is decreased with each relay (i.e. a one-for-one increase in time slots utilized for each relay).

4. Number of Nets: JTIDS is designed for a maximum of 128 nets. This is a theoretical number which is not physically realizable. Preliminary tests indicate that the maximum number of nets in a geographic area without mutual interference, will be approximately 20. If a half-duplex MSE system was developed within the JTIDS architecture it would be limited to 10 erlangs (assuming one relay), which is far less than the current user estimates of traffic loading in the MSE subsystem.

5. Switching and Signaling: Switching and signaling functions would have to be integrated in JTIDS to allow for telephone type service in the MSE system. To implement the switching functions, some type of central, or control unit, would have to be added to the nodeless JTIDS system. The cost of the central would be high. The RF portion of a 12-line central could include as many as 12 Class II terminals resulting in a cost of

over $1 M without considering switching or interface units. If a new terminal were developed to handle the relay of 12 simultaneous calls, the RF costs could probably be decreased. A signaling scheme would require the use of additional time slots, further limiting the availability of the system for command and control data.

Additional development effort would be required to unique user interface for JTIDS terminals used in an MSE application. These modified JTIDS terminals would have to interface with the output of TRI-TAC DSVTs and DNVTs.

6. COMSEC: The COMSEC architectures for JTIDS and TRI-TAC are incompatible. A development effort by NSA would be required to provide a Black interface between the systems to satisfy the requirement for the MSE subsystem to interface with the TRI-TAC static system.

7. Mobile Terminals: JTIDS orginally included three classes of terminals. The Class III (manpack) terminal is not actively being developed at this time. Further development depends on the outcome of of the PLRS/JTIDS Hybrid development effort. As currently designed, the Class III terminal will not have a voice capability. The mobile terminal would, therefore, have to be the Class II terminal. The current cost estimate for this terminal is $100K, approximately five times the estimate for the TRI-TAC MST.

Section V

Conclusions

1. This analysis has examined the TRI-TAC MSE system and the JTIDS Phase I to determine if it is technically possible to develop a cost effective integrated MST/JTIDS system. While it is technically feasible to design a fully integrated system, the resulting system performance would not adequately meet the original design requirements of either system. The following is a list of some of the more significant problems with the integrated system:

a. A discrete address system would have to be developed.

b. The extensive use of 16 kb/s voice, combined with discrete address signaling would severely tax the JTIDS system capacity.

c. Area coverage for a ground based system would require radio relays which further limit system capacity.

d. The number of non-interfering JTIDS nets does not adequately meet user requirements.

e. COMSEC architectures are incompatible.

f. Development effort would be required to modify the JTIDS terminal interface with TRI-TAC DSVTs and DNVTs, develop a Mobile Subscriber Central and incorporate a TRI-TAC signaling scheme in the JTIDS system.

2. In view of the above, the development of an integrated MSE/JTIDS system is not viewed as feasible from a system performance standpoint.