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Information Operations Vulnerability/Survivability Assessment (IOVSA) for the Bradley Fire Support Team Vehicle (BFIST): System Familiarization Phase

by Brian G. Ruth

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Abstract

The Information Operations Vulnerability/Survivability Assessment (IOVSA) process, developed by the Survivability/Lethality Analysis Directorate (SLAD) of the U.S. Army Research Laboratory (ARL) for the purpose of conducting an analysis of the effects of information operations/information warfare (IO/IW) threats on battlefield information systems was applied to the M7 model of the Bradley Fire Support Team Vehicle (BFIST). The IOVSA process consists of five distinct phases which must be completed for a complete analysis of IO/IW threat impact on weapon system capability: (1) system familiarization, (2) system design analysis, (3) threat definition and susceptibility assessment, (4) vulnerability risk assessment, and (5) protection assessment and recommendations. This report documents the IOVSA system familiarization phase for the M7 BFIST with particular focus on those critical information systems relating to battlefield communications.

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Executive Summary

The Bradley Fire Support Team Vehicle (BFIST) will serve as the carrier for the Fire Support Team (FIST), which is the primary means for planning fire support of various types for the maneuver force. In conducting this mission, proximity to the supported unit is essential. The BFIST system will provide the FIST with the capability to automate command and control (C2) functions required to perform joint fire support planning, directing, controlling and cross-functional area coordinations, as well as to provide combat identification. In this report, the system familiarization phase of the Information Operations Vulnerability/Survivability Assessment (IOVSA) process is carried out on the mission equipment package (MEP) as mounted on the M7 model of the BFIST with particular focus on those critical information systems relating to battlefield communications.

The IOVSA process is structured in five consecutive phases as follows:

- Phase 1: System Familiarization,
- Phase 2: System Design Analysis,
- Phase 3: Threat Definition and Susceptibility Assessment,
- Phase 4: Vulnerability Risk Assessment, and
- Phase 5: Protection Assessment and Recommendations.

Each of these five phases encompasses a unique set of procedures and is connected to the following phases through particular products. In the current analysis, the initial system familiarization phase with its related system description and system architecture products is executed. This phase basically involves researching and documenting the information system architecture within the weapon system platform and highlighting information system elements requiring future high resolution analysis within a subsequent phase of the IOVSA process.

The BFIST M7 model integrates the FIST MEP with an M3A2 Operation Desert Storm (ODS) chassis. It maintains the existing Bradley signature and will significantly improve reliability/availability/maintainability, mobility, and survivability. The major subsystems

include an Inertial Navigation System (INS), an eyesafe laser range finder (ELRF), four Single Channel Ground and Airborne Receiver System (SINCGARS) radios, a precision lightweight Global Positioning System (GPS) receiver (PLGR), a Battlefield Combat Identification System (BCIS), a mission processor unit (MPU), a handheld terminal unit (HTU), a lightweight computer unit (LCU), and two tactical communication interface modules (TCIM). A ground/vehicle laser locator designator (G/VLLD), once included as an additional major subsystem in the M7 architecture, has since been deleted.

There exists an option for upgrading the BFIST M7 to interface with the Force XXI Battle Command Brigade-and-Below (FBCB2) "system of systems," which is the Army's principal effort to digitize the battlefield. FBCB2 provides situational awareness (SA) information and distributes C2 orders to all interfaced battlefield weapon platforms via the tactical internet (TI). Interfacing the BFIST M7 with the FBCB2 system would involve the following modifications to the MEP architecture:

- Addition of an Enhanced Position Location Reporting System (EPLRS) data radio,
- Addition of an Appliqué+ bolt-on computer loaded with FBCB2 software,
- Addition of an internet controller (INC) router, and
- Removal of the HTU and associated communication line, which connects the HTU with the LCU, due to space limitations.

There are three different computer software configuration items (CSCI) which operate within the BFIST M7 communication system architecture:

- The TCIM resident software provides communications protocol capabilities for configuring TCIM channels through an X-Windows interface.

- The Forward Observer System (FOS) (Version 11.0) software provides automated digital message and data processing, data storage and recall, and communications capabilities to field artillery (FA) fire support personnel, FA commanders, and FA survey personnel.

- The FBCB2 software provides digital SA and C2 capabilities across all Army platforms.

These CSCIs are loaded on the TCIM, the LCU/HTU, and the Appliqué+ computer, respectively.

In documenting the BFIST M7 information system architecture during the current phase of this IOVSA, there are several indicators that survivability was considered during the information system design process. First, there is considerable redundancy in many of the hardware components. Second, communication system processing is functionally separate from other system processing. Finally, both the FOS and FBCB2 software have been developed in accordance with Army Regulation (AR) 380-19.[1]

As a result of the current system familiarization phase of the BFIST M7 IOVSA process which focused on communication system components, two information system components are recommended for further in-depth analysis in the future: the FOS CSCI and the FBCB2 CSCI. In the next phase of the IOVSA process (system design analysis) both a system functionality assessment and a data flow analysis will be executed.

[1]U.S. Department of the Army. *Information Systems Security*. AR 380-19, Washington, DC, 27 February 1998.

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1. Introduction

1.1 Purpose. In response to information operations (IO) requirements, the Survivability/Lethality Analysis Directorate (SLAD) Bradley Fire Support Team Vehicle (BFIST) system leader (SL) determined that an Information Operations Vulnerability/Survivability Assessment (IOVSA) needed to be performed on the vehicle. Phase 1 of the IOVSA (system familiarization), sponsored by the SLAD ground systems mission area, was initiated in fiscal year (FY) 1999. The SLAD BFIST SL contacted the SLAD Non-Command, Control, Communications, Computers, and Intelligence (C4I) systems IO team leader, who jointly planned the effort. The SLAD Non-C4I systems IO team leader contracted with the Nuclear, Biological, Chemical (NBC) Effects Branch within SLAD for the performance of the initial phase of the IOVSA (documented in this report). This effort provides the preliminary groundwork needed to answer the question:

> *Does the Bradley Fire Support Team Vehicle (BFIST) have any IO susceptibilities of concern, and, if so, what can be done to protect the BFIST platform from the IO threat?*

The IOVSA process involves a sequence of analytical phases that are applied to networked automated Information Systems (INFOSYS) of military interest. Within the context of this report, INFOSYS are defined in accordance with Joint Publication 6-0 [1], and Field Manual (FM) 100-6 [2].

- **INFOSYS as Defined in Joint Pub 6-0:** The entire infrastructure, organization, personnel, and components that collect, process, store, transmit, display, disseminate, and act on information.

- **INFOSYS as Defined in FM 100-6:** INFOSYS allows the commander to view and understand his battle space, communicate his intent, lead his forces, and disseminate his pertinent information throughout his chain of command and his area of operation. Effective military and nonmilitary INFOSYS help the staff get the right information to

the right location in time to allow commanders to make quality decisions and take appropriate actions.

The IOVSA focuses primarily on the INFOSYS survivability as defined in VAL-CE-TR-92-22 [3].

- **Information System Survivability as Defined in VAL-CE-TR-92-22:** The ability of a computer-communication system-based application to continue satisfying its requirements (for example, requirements for security, reliability, real-time responsiveness, and correctness) in adverse conditions.

1.2 Background.

1.2.1 The IOVSA Process [4]. The IOVSA process is structured in five phases, as shown in Table 1. Each of these five phases encompasses a unique set of procedures and is connected to the following phases through particular products. The flow, interconnection, and products passing through these five phases are shown in Figure 1.

Figure 1 presents a process flow diagram that depicts the interconnections of the phases of an IOVSA. The boxes inside the larger boxes represent products of that particular phase of the analysis. This process flow can be envisioned as a directed graph (or digraph), where the products produced during one analytical phase form the basis for the execution of the following phase. The process flow depicted in Figure 1 is actually a simplified representation of the entire analytical process; subdigraphs also exist within the process which represent feedback loops. In the current analysis, the initial system familiarization phase with its related system description and system architecture products is executed.

1.2.2 Threat. The threats addressed within this analysis are information warfare (IW) threats and the associated susceptibility of BFIST information systems to these threats.

Table 1. The Five Phases of an IOVSA [4]

Phase Number	Phase Title
1	System Familiarization
2	System Design Analysis
3	Threat Definition and Susceptibility Assessment
4	Vulnerability Risk Assessment
5	Protection Assessment and Recommendations

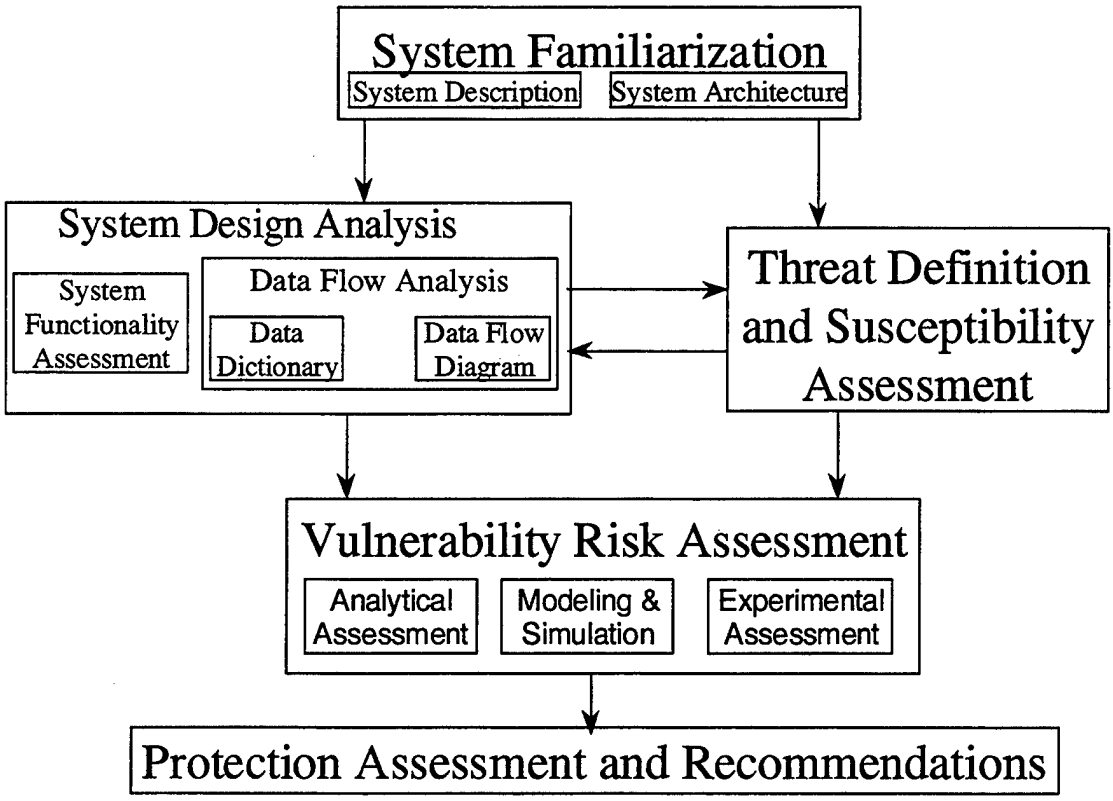


Figure 1. Schematic of the Methodology Flow of an IOVSA [4].

1.3 Scope. The information gateway components (and associated software) that connect the BFIST platform with the digital battlefield form the primary focus of this analysis; these components include the Single Channel Ground and Airborne Radio System (SINCGARS) radio,

the lightweight computer unit (LCU), the handheld terminal unit (HTU), the tactical communication interface modules (TCIM), the Enhanced Position Location Reporting System (EPLRS) data radio, the internet controller (INC), and the Appliqué+ computer. This set of components also comprises the primary point of ingress into the system used by radio frequency (RF) and network-based IW threats. Thus, the current system familiarization phase of the BFIST IOVSA addresses the identification and high-level connectivity of all information systems within the platform with primary focus on the communication systems. In this work, communication components, software, and associated interconnectivity are described in detail; elements requiring a future high resolution IOVSA are highlighted.

2. System Description

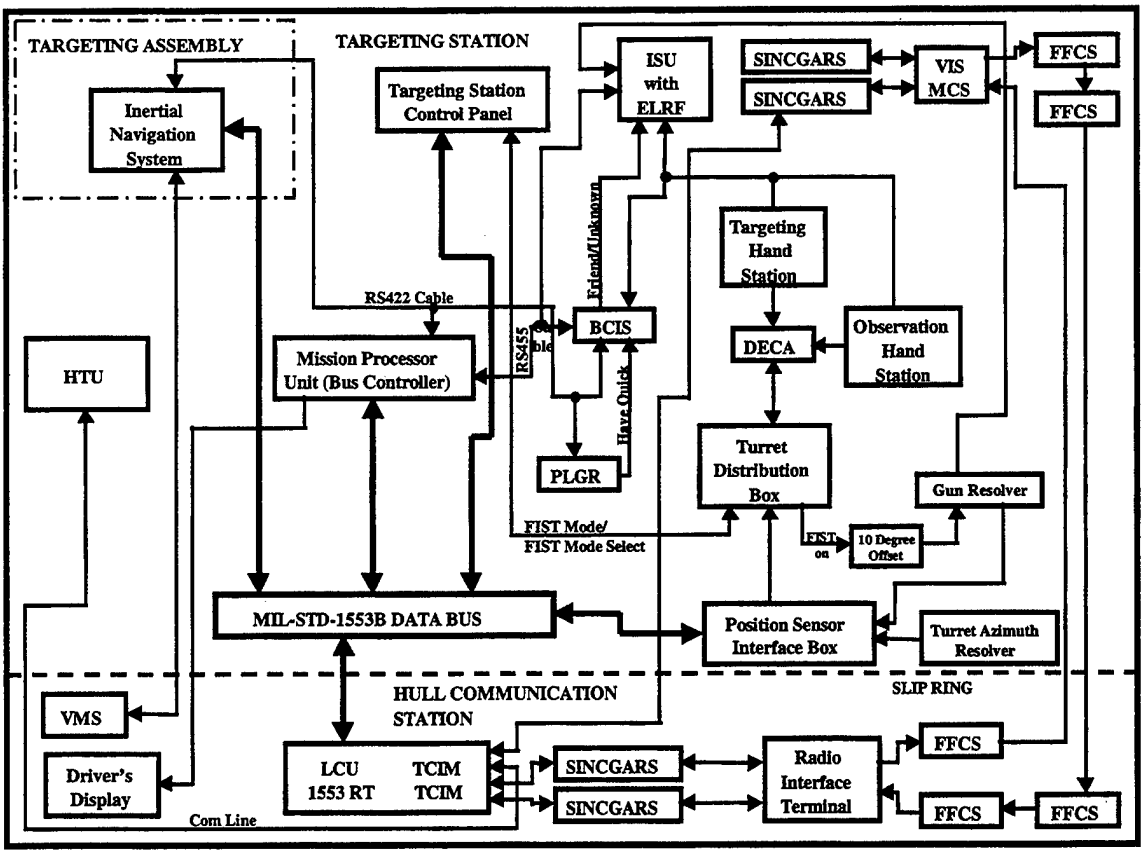
The BFIST serves as the carrier for the fire support team (FIST), replacing the M981 vehicle in some first-to-fight units. The FIST is the primary means for planning fire support of various types for the maneuver force. In conducting this mission, proximity to the supported unit is essential. The BFIST system provides the FIST with the capability to automate command and control (C2) functions required to perform joint fire support planning, directing, controlling and cross-functional area coordinating, as well as providing combat identification. The BFIST consists of two models: XM7 and XM7A1. Both versions of the BFIST have the same mobility, survivability, signature, and night vision capability as the maneuver force they support and will utilize Bradley common repair parts. In this report, only the XM7 model is addressed.

The XM7 model integrates the FIST mission equipment package (MEP) with an M3A2 Operation Desert Storm (ODS) chassis. It maintains the existing Bradley signature and significantly improves reliability/availability/maintainability, mobility, and survivability. The major subsystems include an Inertial Navigation System (INS), an eyesafe laser range finder (ELRF), four SINCGARS radios, a precision lightweight Global Positioning System (GPS) receiver (PLGR), a Battlefield Combat Identification System (BCIS), a mission processor unit (MPU), an HTU, and an LCU. A ground/vehicle laser locator designator (G/VLLD), once included as an additional major subsystem in the XM7 architecture, has since been deleted.

3. System Architecture

3.1 BFIST M7 MEP.

3.1.1 Overview. The BFIST MEP provides the forward observer with a base to accurately locate targets through the use of an ELRF, a GPS receiver, and an INS. The MPU provides the data gathering and distribution point and control element for the BFIST targeting station. The MPU interfaces with the targeting station control panel (TSCP), INS, BCIS, PLGR, LCU, turret distribution box (TDB), FIST distribution box (FDB), and the ELRF. Figure 2 illustrates the BFIST M7 MEP architecture.



Note: VMS = Vehicle Motion Sensor.
ISU = Integrated Sight Unit.

Figure 2. BFIST M7 MEP Architecture.

The MPU replaces the targeting station electronics unit (TSEU) of the engineering/manufacturing/development (EMD) XM7 systems. The function of the MPU is identical to that of the TSEU with the MPU also assuming the responsibility of the MIL-STD-1553 [5] bus controller for the MEP and adding enhanced built-in test (BIT) capability.

3.1.2 External Communication.

3.1.2.1 LCU. The LCU and its associated fire-support software, Forward Observer Systems (FOS), implements the BFIST's basic capability as a node on the fire support C2 network. It replaces the functionality of the digital message device (DMD) in the M981 FIST vehicle, and contains new functionality in the baseline design. The communications station operator uses the LCU as a data-handling terminal in conducting fire support planning and execution mission functions.

The AN/GYK-37 LCU is an IBM-compatible computer equipped with a 200-MHz Intel Pentium processor, which runs under Santa Cruz Operations (SCO) UNIX (Version 5.02) [6] and various hardware interface drivers controlling standard serial, parallel, small computer system interface (SCSI)-II, and floppy interfaces as well as an Institute of Electrical and Electronic Engineers (IEEE) 802.3 local area network (LAN) interface. Applications are loaded automatically on power-up using UNIX scripts. Additionally, the LCU provides hardware support (resources) in the form of a keyboard, external display, RS-232C serial port, removable hard disk, memory, and radio communications interface through multiple TCIM.

3.1.2.2 TCIM. The TCIM is a front-end communications processor that supports joint tactical communications. A TCIM can support over 26 protocols developed by the joint services, including MIL-STD-188-220A [7], and can also support communications interoperability by dynamically switching between these protocols. Each TCIM is configured to support two digital channels, where each channel is dynamically configured via FOS software downloads from the host LCU random-access memory (RAM) (see sections 4.2.6 and 4.2.7). The LCU interfaces with two TCIM units: an internal TCIM which fits into an expansion slot of the LCU, and an additional TCIM that connects to the LCU via an external interface. This provides the LCU with access to four different digital channels.

3.1.2.3 HTU. The HTU is a small, lightweight computer that is functionally redundant with the LCU. The HTU is equipped with an 80586 133-MHz Pentium-class processor, 16 MB (expandable to 64 MB) of RAM, either a 260-MB or a 520-MB hard drive, an embedded two-button mouse, two RS-232C serial ports, a Centronics parallel port, and a TCIM-compatible dual channel modem. As with the LCU, the HTU operates under SCO UNIX (Version 5.02) [6] and also runs the FOS software. Although they both can operate independently, there is data flow communication between the HTU and the LCU via a half-duplex (two conductor path) system cable referred to as "Com Line" in Figure 2; one of the four available TCIM channels is used to establish HTU/LCU intercommunication. The principal function of the HTU is to display the same data that appears on the LCU to a second crew member; the HTU can also be utilized for dismount operations in conjunction with a tripod-mounted sensor.

3.1.2.4 SINCGARS. SINCGARS is a family of very high frequency (VHF), frequency-modulated, combat net radio (CNR) sets designed for tactical communications in the 30–87.975-MHz frequency range. It is designed for simple and quick operation using a 16-element keypad for push-button tuning. SINCGARS is capable of both short-range (200–400 m) and long-range (10–40 km) operation for voice and/or data communications. It can be used for single-channel operation or in a jam-resistant, frequency-hopping mode which can be changed as needed. Inherent in the SINCGARS radio are significant security features in terms of complex low probability of intercept (LPI) transmission techniques, data-coding techniques, and data encryption. The SINCGARS radio system for vehicular installations includes the RT-1523C/D receiver/transmitter (RT) and the AM-7239C/D vehicular amplifier adapter (VAA). The BFIST M7 MEP includes four RT-1523 integrated communication security (COMSEC) (ICOM) SINCGARS radios with 50 W peak RF output power and peak data transmission rates of 16 kbps, 4800 bps, and 600–2400 bps at ranges of 3 to 10 km, 5 to 22 km, and 5 to 25 km, respectively.

3.2 FBCB2 Interface Upgrade. An option exists for upgrading the BFIST M7 enabling it to interface with the Force XXI Battle Command Brigade-and-Below (FBCB2) "system of systems," which is the Army's principal effort to digitize the battlefield. The FBCB2 visually displays situational awareness (SA) information; processes and displays information provided by

weapon systems, sensors, and support platforms; prepares and distributes C2 orders and graphics; and receives, develops, and distributes information and data based on a common battlefield picture. The FBCB2 also provides the Army the architecture for the tactical internet (TI) which is the communication infrastructure that provides the connectivity between the platforms and provides the medium to exchange digital information. The FBCB2 incorporates situation understanding, which includes the capability to react to data received (whether from the user, sensors, TI, or other sources) based on rules and knowledge which are role- and echelon-dependent. Examples include "smart" displays, alerts triggered by computer analysis of the evolving real-time situation, tailoring of functionality by role, tailoring connectivity and bandwidth allocation by role, and other adaptive measures in which the FBCB2 takes action (or suggests actions to the user) based on its understanding of the situation in which its individual user is to operate.

The FBCB2, as a key component of the Army Battle Command System (ABCS), seamlessly interfaces with the component of the Army Tactical Command and Control System (ATCCS) at the battalion level. The FBCB2 supports SA down to the soldier/platform level across all battlefield functional areas (BFAs) and echelons. The FBCB2 also allows brigade and battalion commanders to command when away from their tactical operations centers (TOC) and when interoperating with subordinate commanders and leaders also using the FBCB2.

The following components are the building blocks of the FBCB2 system:

- Software for embedded air and ground platforms,
- Hardware and software for nonembedded air and ground platforms,
- Platform interfaces, and
- Supporting communications systems.

Interfacing the BFIST M7 with the FBCB2 system would involve the following modifications to the MEP architecture:

- Addition of an EPLRS data radio,
- Addition of an Appliqué+ bolt-on computer loaded with FBCB2 software,
- Addition of an INC router, and
- Removal of the HTU and associated communication line with the LCU due to space limitations.

Figure 3 illustrates the BFIST M7 MEP architecture modifications that would result from the FBCB2 interface upgrade. The following sections address the FBCB2 upgrade hardware in detail.

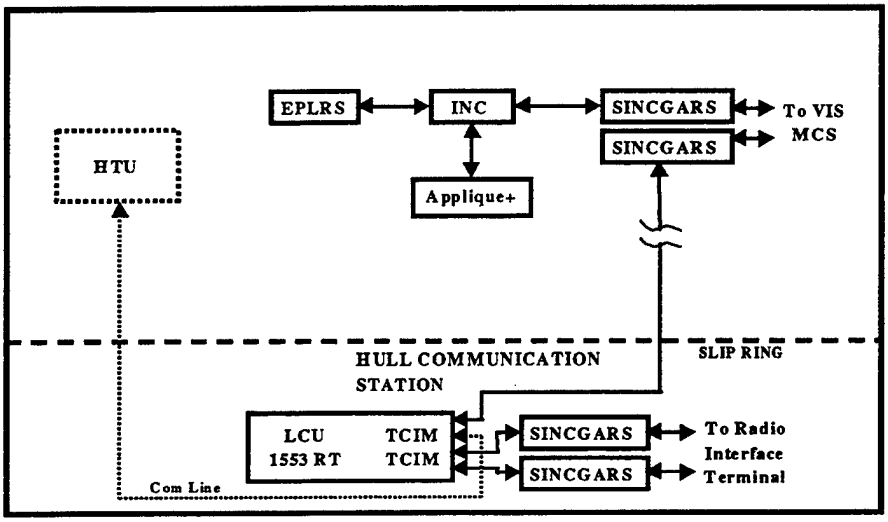


Figure 3. Modifications to BFIST M7 MEP Architecture Resultant From an FBCB2 Upgrade.

3.2.1 SINCGARS SIP Radio. The SINCGARS System Improvement Program (SIP) radio replaces the current ICOM version as part of the FBCB2 upgrade. The SINCGARS SIP radio is a modified version of the SINCGARS ICOM radio, where modifications include new RF waveforms with significantly improved data performance, voice/data channel access

performance improvements, and host-selectable automatic position reporting features. The SINCGARS SIP also provides for regulated power, a radio control interface, and provisions for incorporation of the INC router (see section 3.2.4).

3.2.2 EPLRS Data Radio. The very high-speed integrated circuit (VHSIC) EPLRS radio provides data-only communication capability in the form of platform position information, network coordination, and data communication. Inherent in the EPLRS data radio are significant security features in terms of complex LPI transmission techniques, data coding techniques, and data encryption. The primary components of an EPLRS network are the network control station (NCS) and the EPLRS user units (EPUUs). The NCS is the centralized control element used for system initialization and dynamic monitoring and control of the EPLRS network. The EPUU is the radio RT provided to the users of EPLRS. The EPUU interfaces to the INC in accordance with the Army Data Distribution System Interface (ADDSI) [8]. The FBCB2 system architecture utilizes EPLRS radios to provide wide area network (WAN) connectivity between SINCGARS SIP radio networks from the platoon to brigade level. EPLRS utilizes the ADDSI to flow data to/from the INC. The ADDSI is primarily based on the International Consultative Committee for Telegraphy and Telephony (CCITT) Recommendation X.25 [9], which allows access to a secured public packet switched network. Different EPLRS needline types (virtual circuits which are established between radios based on host data requirements) are used to support the various types of message traffic. An EPLRS network provides a communication resource of eight frequencies, each with eight logical time slots (LTS) in its time division multiple access (TDMA) architecture. Once enabled by the NCS, the needlines are automatically maintained by the EPLRS radios without operator or NCS intervention. These needline types are discussed in the following sections.

3.2.2.1 Full-Duplex Needline. The full-duplex needline (also called a permanent virtual circuit [PVC]), is a point-to-point bi-directional communications path between EPUUs. This needline type is used to support forward area air defense (FAAD) command, control, and intelligence (C2I) hierarchical transfer of battle management messages and the distribution of EPLRS-derived data from the NCS to the NCS multisource group (MSG) position server radio set (RS).

3.2.2.2 Simplex Needline. The simplex needline is a unidirectional communications path from one EPUU to many EPUUs. It is generally used for community-wide distribution of EPLRS position data, such as situation awareness data link (SADL) forward air controller (FAC) to aircraft.

3.2.2.3 CSMA Needline. The carrier-sense multiple-access (CSMA) needline is a multisource, multidestination communications path among EPUUs, on which a CSMA protocol is used by all members to gain authority to transmit, and all members are able to receive. This needline type is used to broadcast SA and C2 Joint Variable Message Format (JVMF) messages within organizational boundaries such as battalions. There are up to two CSMA needlines per radio which are used to transmit and receive data: one for battalion-area SA, and one for battalion-area C2.

3.2.2.4 MSG Needline. The MSG needline is a multisource, multidestination communication path among EPUUs, on which up to 16 active EPUUs are assigned shares of the MSG transmit resource, and which all MSG participants are able to receive. Each MSG participant is assigned a source index of 1–120 or 127, a priority, and preassigned shares of the transmit resource.

Only EPUUs with a source index of 120 or less are eligible to transmit or can act as relays. EPUUs with a source index of 127 are only capable of receiving. All preassigned shares are always claimed during initialization. EPUUs with a priority of 1 or 2 never release their shares. Once the host has no more data to transmit, an EPUU with a priority of 3 or greater releases its shares within two epochs (128 s).

Unclaimed shares are available for any eligible radio to claim that has data to transmit and a source index of 120 or less. The highest priority EPUUs claim the available shares first. The EPUUs periodically transmit information on the shares they have claimed; consequently, if a radio that has claimed shares becomes disabled, all eligible radios become aware that those shares are available.

This wide-area MSG needline type allows contention-free access and is used to broadcast SA JVMF position reports from SA position servers located in each battalion and the brigade-area CSMA communities to all EPLRS-equipped platforms. An interbrigade server transmits onto the wide-area MSG needline position data received from the division area and other brigades. Furthermore, NCS-derived SA position data is transmitted over the wide-area MSG needline via an application layer gateway. Additionally, a separate brigade-wide MSG needline enables transmission of multicast C2 messages across the brigade. A gateway router is selected from each battalion and the brigade area to the MSG by means of Request for Comments (RFC) 1256+ [10], gateway selection. All EPUU in the brigade receive messages transmitted onto the brigade-wide MSG. Separate from the wide-area MSG SA needline, the FAAD C2I distributes air tracks from the sensor C2 to the fire units on an MSG sensor broadcast needline.

3.2.3 Appliqué+ Computer. The Appliqué+ computer is the primary FBCB2 host that interfaces to the INC router via an RS-423 cable at the physical layer; Point-to-Point Protocol (PPP) at the link layer; Internet Protocol (IP), Internet Control Message Protocol (ICMP), and Internet Group Management Protocol (IGMP) at the network layer; and Challenge Handshake Authentication Protocol (CHAP) and Simple Network Management Protocol (SNMP) at the application layer. The Appliqué+ computer provides the host with the capability to display SA and C2 data received via the FBCB2 software JVMF application layer, and Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) transport layer interfaces to the INC.

There are two versions of the Appliqué+ computer bolt-on-kit (B-Kit): the Appliqué+ B-Kit and the V2 Enhanced B-Kit. In both versions, the "Year 2000 Problem" is correctly supported by the basic input/output system (BIOS) software and computer hardware as measured by the National Software Testing Laboratories YMark2000 program (2000.exe) [11]. The Appliqué+ and V2 Enhanced B-Kit versions are described in sections 3.2.3.1 and 3.2.3.2, respectively, while the display unit interface and serial input/output (I/O) ports (the same for both B-Kit versions) are described in sections 3.2.3.3 and 3.2.3.4, respectively.

3.2.3.1 Appliqué+ B-Kit. The Appliqué+ B-Kit is ruggedized and is intended for use in military operational environments. Power for the Appliqué+ is supplied by the host platform

with the Appliqué+ responsible for providing protection against power ripples, surges, and spike voltage conditions. The Appliqué+ is composed of the following units: (1) a central processing unit (CPU), (2) a flat-panel color display unit with touch-screen input capability and tethered-remote operating capability up to 25 ft, and (3) a backlit keyboard which connects to the display unit. The processor unit is comprised of a 90-MHz Pentium processor board with 16 MB of RAM and a 510-MB hard disk drive. The display unit is available in three variations: (1) a 12-in display version; (2) a 10.4-in display with bezel keys, and (3) a 10.4-in display without bezel keys. All variations have five serial interface ports, a universal serial bus (USB) interface port (currently not used by the FBCB2), a parallel interface port, and a super video graphics array (SVGA) interface port. The Appliqué+ also includes an analog resistive touchscreen panel overlaying the liquid crystal display (LCD) that provides pointing device functionality using a supplied nonmetallic stylus. A Sound Blaster-compatible audio controller device is provided by the Appliqué+ to interoperate with the vehicle intercommunications system (VIS). Finally, the current operating system running on the Appliqué+ is Solaris X86 (UNIX) Version 2.5 [12], which, in turn, hosts the FBCB2 application software (FBCB2 Versions 2–4).

3.2.3.2 V2 Enhanced B-Kit. The V2 Enhanced B-Kit, is an upgraded Version 1 (Ruggedized) Appliqué computer that was originally produced for use in the Task Force XXI Army Warfighting Experiment (AWE) and was improved by additional memory, a larger hard disk drive, and (in some instances) a faster processor for use in FBCB2-related activities. The V2 Enhanced B-Kit includes the computer, interconnecting cables, and an installation kit appropriate to the host vehicle type. There are two configurations of the V2 Enhanced B-Kit. The first configuration retained the original 90-MHz Pentium processor board, whereas the second configuration replaced the original board with a 200-MHz processor board. Both configurations were upgraded to include 80 MB of RAM and a 4-GB hard disk drive. Both V2 Enhanced B-Kit configurations include a processor unit, a transmissive active matrix LCD with a remote operating capability up to 25 ft, a keyboard, and a built-in trackball. Similar to the Appliqué+, power for the V2 Enhanced B-Kit is supplied by the host platform with the V2 responsible for providing protection against power ripples, surges, and spike voltage conditions. The V2 Enhanced B-kit provides a number of interface ports including a flat panel display (FPD) port, an external monitor port, a SCSI-II port; a LAN port, a parallel printer port, and dual serial

ports. In addition, the V2 Enhanced B-Kit provides an instruction set architecture (ISA)/personal computer interface (PCI) expansion slot and floppy disk drive interface. The V2 computer also provides a speaker output port to interface with the VIS for the output of warning and alert tones.

3.2.3.3 Display Unit Interface. The display unit interface video/graphics output is compatible with National Semiconductor's flat panel display (FPD) link interface using low-voltage differential-signaling (LVDS) technology. The display unit interface utilizes the PC-compatible communications (COM)-1 serial port to communicate with the display unit's touchscreen controller, with design support for a future transition to the USB-based human interface devices (such as touchscreen, keyboard, bezel buttons, etc.). The display unit interface also supports tethered-remote operation of the display unit through an interface cable with a MIL-C-38999 [13], Type III, 55-pin connector.

3.2.3.4 Serial I/O Port. The CPU provides external serial data port interfaces configured as described in the following paragraphs.

COM-B is an Electronics Industries Association-232 (EIA-232), asynchronous interface connected to the COM2 serial port. Four serial ports (COM-C, COM-D, COM-E, and COM-F) function as asynchronous interfaces supporting EIA-422 and EIA-423 signaling levels dependent upon wiring of the external interface harness. Serial ports COM-B, and COM-C through COM-F, are compatible with the industry standard 16550 universal asynchronous receiver/transmitter (UART) [14] which is operable at data rates up to 115.2 KBaud.

A single, factory-programmable, processor interrupt is used for serial ports COM-C through COM-F. All of these ports have their I/O addresses in a contiguous block of 32 addresses such that the hexadecimal value of the factory-programmable starting address ends in a zero; the first eight addresses are associated with COM-C, the next eight with COM-D, etc.

The processor interrupt also has a status register which indicates which ports, if any, are causing the interrupt. The status register indicates a bit value of one if the corresponding ports have an interrupt request pending, and a zero, otherwise. The least significant data bit of the register represents the status of COM-C, the next bit COM-D, etc. Data bits of the status register

which are not associated with ports are output as zero. The status register is located at an offset of 40 hexadecimal above the starting address of the I/O block.

The serial I/O port connector is a MIL-C-38999 [13], Type III, 37-pin connector. Signal assignments on the serial I/O port connector are normally configured as follows:

- COM-B: INC router,
- COM-C: GPS receiver,
- COM-D: BCIS,
- COM-E: Sensor Link Protocol device, or
- COM-F: JVMF device.

*3.2.4 **INC Router.*** The INC is the primary data router in the TI and provides data subscriber, intranet relay, and internet routing. The INC is a five-port data router, where two ports are for operation with SINCGARS SIP radios; one port is for operation with a host computer; one port is for operation with either an EPUU, TOC router, or a second host computer; and one last port supports an Ethernet connection in lieu of the second host/EPUU port.

The INC router processes both SA and C2 data types. However, SA data is handled differently in the TI network than is C2 message traffic. Since there is no guarantee of where a particular host is located in the TI, C2 traffic has to be routed through normal IP routing mechanisms to the final destination. SA data, on the other hand, is not sent to a specific individual but to a physical network. Because of this, the TI network can use SA agents to reduce the size of the message and thereby reduce the load on the TI. The FBCB2 host, in some cases, replaces the MIL-STD-2045-47001 [15] header on SA messages, again, to help reduce the data load on the TI.

In the following sections, INC router processing of both SA and C2 data types is described in more detail.

3.2.4.1 C2 Data Processing Through the INC Router. As depicted in Figures 4, 5, and 6, C2 traffic is handled the same in each case. The host wraps the JVMF data with MIL-STD-2045-47001 TCP or UDP, IP, and PPP headers and sends the message to the INC router. The IP header contains the destination IP address of the recipient. Multicast traffic uses a UDP header, while unicast traffic uses a TCP header. The INC router receives the packet, strips off the PPP header, and sends it up the protocol stack to the IP layer. The IP layer, using the current routing table, routes the message to the SINCGARS SIP interface or to an EPLRS interface. As a C2 message traverses the TI, only the link layer header is affected until the destination host receives the message.

3.2.4.2 SA Data Processing Through the INC Router. The first step in SA data processing is for the host to determine if the SA data is being sent to the EPLRS CSMA network. If so, the host replaces the MIL-STD-2045-47001 header with two bits to indicate either friendly position or entity data messages. In all other cases, a full 47001 [15] header is used. The host then wraps the data and 47001 header in UDP, IP, and PPP headers and sends the message to the INC router. The IP header contains the destination IP address of the directly attached INC. The UDP header contains a UDP port number to indicate to which SA agent the message is to be sent. There are three SA agent types: (1) SINCGARS (Figure 4), (2) EPLRS CSMA (Figure 5), and (3) EPLRS MSG (Figure 6). The INC router receives the message, strips off the PPP header, and determines that the message is addressed to the router and strips off the IP header. The INC then looks at the UDP header for the port number and passes the message to the appropriate SA agent.

3.2.4.3 SA Agents. SA agents are utilized by the INC router to efficiently disseminate SA data via EPLRS and SINCGARS SIP radios. For EPLRS, the SA agent is used for SA data collected by the local area or CSMA position servers to be disseminated onto the battalion/brigade area CSMA needline or the brigade MSG needline. When the INC receives an SA IP packet from the host via the EPLRS CSMA or MSG SA UDP port, the INC strips off the IP and UDP headers and broadcasts the data onto the respective needline, CSMA, or MSG. INC routers receiving SA data via the CSMA or MSG needline builds an IP/UDP header which uses

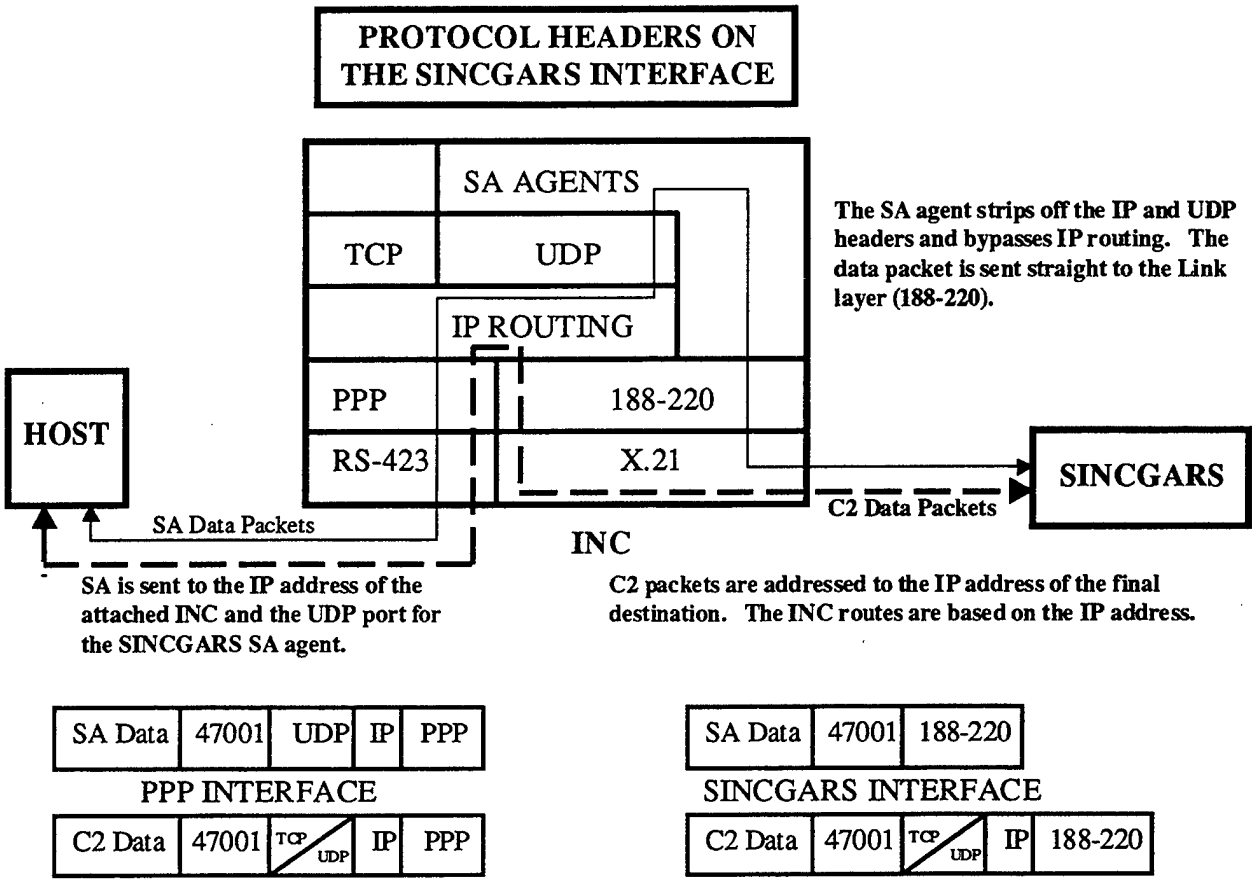


Figure 4. SINCGARS SA Agent and C2 Message Processing.

its attached host as the destination IP address. The INC encapsulates the SA data into an IP packet and then sends the IP packet to the host using the UDP port address which corresponds to the host computer.

For SINCGARS SIP radios, when an INC router receives an SA IP packet via a SINCGARS SA UDP port, the INC first determines if the destination SINCGARS interface is operational and then silently discards the packet if the interface is unavailable. If the destination SINCGARS interface is operational, the INC strips off the IP and UDP headers and transmits the packet onto the SINCGARS net using the link layer broadcast address. When the INC router receives a link

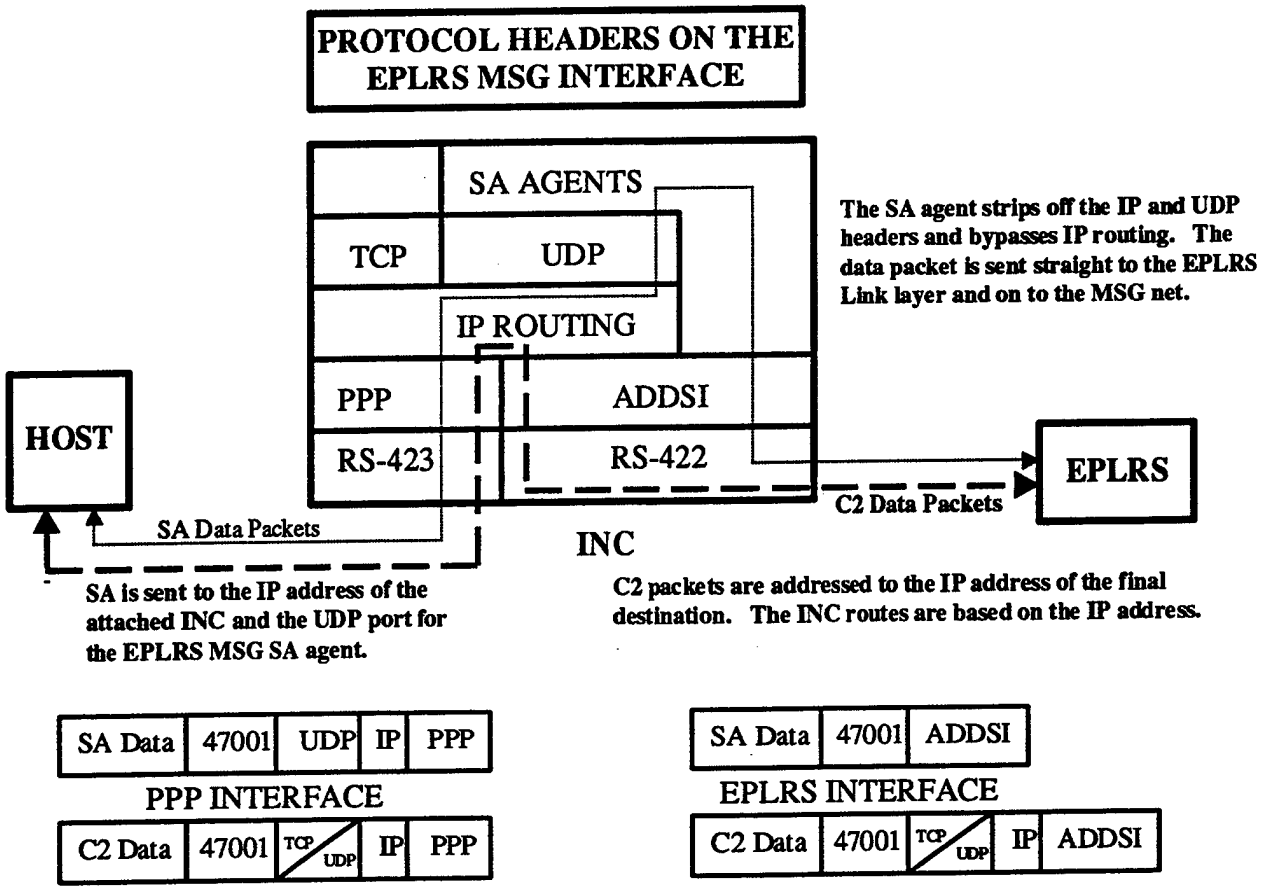


Figure 5. EPLRS CSMA SA Agent and C2 Message Processing.

layer SA packet on the local SINCGARS net, it builds an IP/UDP header which uses its attached host as the destination IP address, encapsulates the SA data from the link layer frame into the IP packet, and then sends this IP packet to the host using the UDP port address which corresponds to the host computer.

4. Software

4.1 TCIM Resident Software. The TCIM resident software provides communications protocol capabilities that are independent of the host operating system. The host resident portable operating system interface (POSIX) software architecture, which interfaces with the

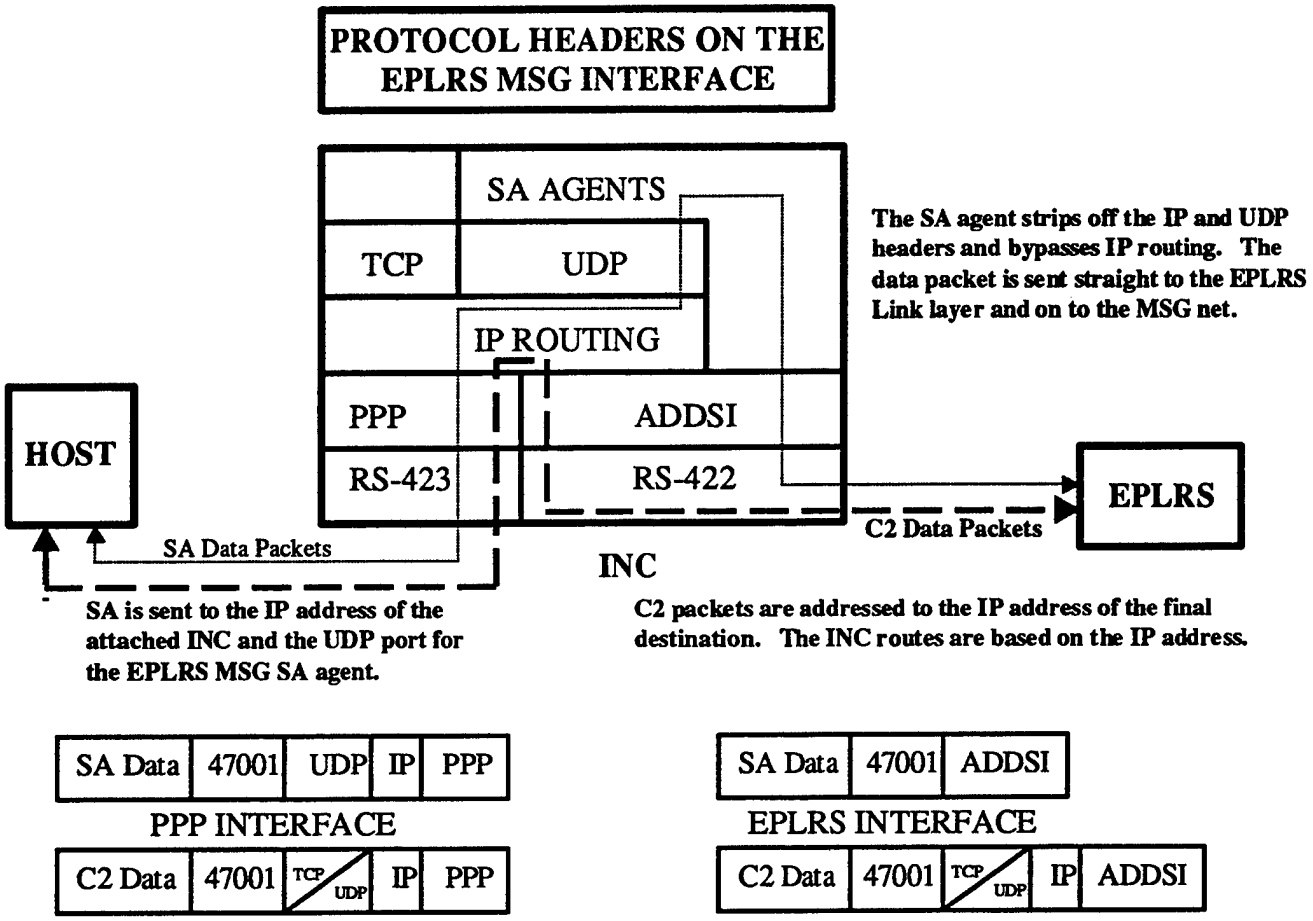


Figure 6. EPLRS MSG SA Agent and C2 Message Processing.

SCO UNIX operating system running on the LCU, is implemented through the use of STREAMS technology. The TCIM configuration and diagnostics application (TC&D) tool provides full manual access for TCIM operational configuration through an X-Windows interface. Finally, the TCIM software provides the following:

- *Load module independence.* Each TCIM channel is loaded independently, allowing for continuous operation of one channel while loading the other.

- *Channel protocol commonality.* The same source code is used for both TCIM channels.

- *Open System Information (OSI) architecture.* TCIMs are designed to support higher OSI layer software.

- *Programming language interface.* C- and Ada-language bindings are available for integration with application software.

- *Built-in test (BIT) capability.*

4.2 FOS Software. The FOS (Version 11.0) Computer Software Configuration Item (CSCI), when installed on the HTU or the LCU, provides automated digital message and data processing, data storage and recall, and communications capabilities to field artillery (FA) fire support personnel, FA commanders, and FA survey personnel, which enables them to more efficiently accomplish their mission. The FOS software requires the availability of a minimum of 4 MB of RAM in the host computer system. Figure 7 illustrates the external fire support systems that interoperate with the FOS software.

The FOS CSCI can be initialized in one of three operational modes: (1) Forward Observer (FO)/ FIST, (2) Fire Support Officer (FSO)/Commander (CDR), or (3) Survey. Each of these operational modes provides specific functionality in support of the applicable mission of the operator. The following paragraphs outline the major operational capabilities of each of the three modes in the FOS CSCI, as well as the capabilities common to all modes.

4.2.1 FO/FIST Operational Mode. When initialized in the FO/FIST mode, FOS enables the operator to compose, edit, transmit, receive, display, and/or store applicable messages and data pertinent to FO/FIST operations. In support of this mission, FOS provides the operator with the capability to conduct/monitor a wide range of fire missions, to report targeting information and enemy shelling information, to receive operation order (OPORD) documents from higher echelons, and to develop company-level fire support plans. In the area of fire missions, FOS allows for the conducting of fire missions on stationary or moving targets using a variety of munitions, including Copperhead and Hellfire. In addition, the operator may also request

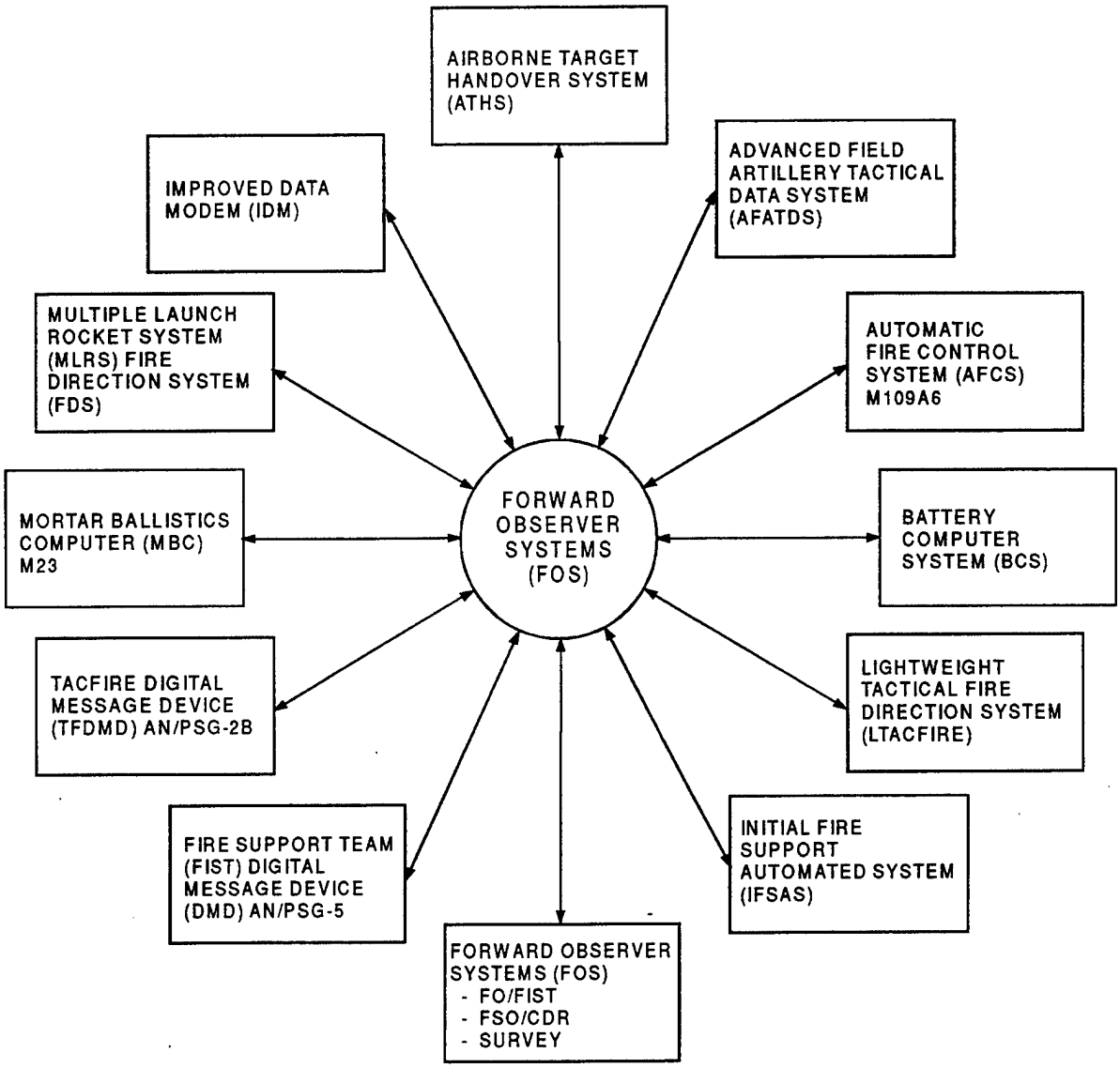


Figure 7. FOS External Interface Diagram.

engagement of a target by employment of close air support (CAS) or the enhanced fiber-optic guided missile (EFOG-M).

4.2.2 FSO/CDR Operational Mode. When initialized in the FSO/CDR mode, FOS enables the operator to compose, edit, transmit, receive, display, and/or store applicable messages and data pertinent to the command and control of fire support operations. In support of this mission,

FOS provides the operator with the capability to monitor/control external fire missions of interest or conduct local fire missions (as with the FO/FIST mode); to conduct deliberate and quick fire planning; to receive OPORD documents from higher echelons or generate original OPORD documents and exchange them with other agencies; to receive and transmit survey point information; and to store and display decision graphics information.

4.2.3 Survey Operational Mode. When initialized in the Survey mode, FOS enables the operator to compose, edit, transmit, receive, display, and/or store applicable messages and data pertinent to survey operations. In support of this mission, FOS provides the operator with the capability to perform various survey calculations and datum-to-datum coordinate conversions; to maintain a survey point database for use by external fire support agencies; to print standard survey forms; and to generate, transmit, and receive OPORD documents. In addition, a limited FO capability is provided to allow the surveyor to conduct basic fire missions and to report targeting information.

4.2.4 Capabilities Common to All Operational Modes. For all operational modes, FOS provides the operator with the following common capabilities:

- A capability to request medical evacuation of friendly/enemy casualties;

- A graphics capability which enables the exchange of battlefield geometry and unit/equipment information used to display pertinent tactical military symbols on a graphics map display;

- A print capability which enables the printing of the current screen display or the contents of selected files to an external printer;

- Two-way digital communications using various communications protocols over standard Army tactical communications equipment, including wire (both 2 and 4 wire), combat net radio (CNR), EPLRS data radio, and mobile subscriber equipment (MSE); and

- A capability to save the current database and deactivate the keyboard when battery power is low or completely lost; functionality is restored when the battery is replaced or an acceptable alternate power source is used (applies only to HTU-mounted operation).

4.2.5 Limitations of FOS Capabilities. The capabilities implemented in the FOS CSCI are known to exhibit the following limitations:

- The fire planning capability does not provide for the automatic generation of a fire plan schedule; nor does it provide for the automatic execution of the fire plan.

- The decision graphics capability does not provide for any automatic updating of files from mission messages.

- On selection of a database purge, the database files are not actually erased. Instead, the database is overwritten three times, alternating with ones and zeroes, and then restored to default parameters.

4.2.6 FOS Initialization Sequence. The FOS initialization sequence presents the operator with a series of system configuration displays used to initialize the FOS software. On several displays, one or more fields require operator input prior to proceeding to the next display; attempting to move forward to the next display without providing input to those fields results in the cursor being placed on the required field and opening the edit window instead of advancing to the next display. The required displays include the FOS setup display, net status display, member data display, and map modification data display. Once all required displays have been entered, pressing the <MODE> key displays the applicable mode menu for the current operational mode (see section 4.2.8.2). The sequence of displays, including the required and conditional fields for each display, are listed in Table 2. In this table, net *n* refers to one of four possible communication nets (see section 4.2.7).

4.2.7 External Net Configuration. The function of the net configuration process is to activate and deactivate communication data nets according to operator-supplied parameters contained in the net status file, member file, and setup file. There are four different net types that

Table 2. Required Fields for FOS Initialization Sequence

Display	Required Fields	Comments
Setup	Observer Number, Address, Date Set, Time Set, Time Zone, URN and Unit	—
Net Status List	None	Net *n* must be present. Net *n* may not exist if internal TCIM is BAD, so Net Status List could be blank, in which case Net Data will not be displayed.
Net Data	Connection	For Net *n*.
Member Data Summary	None	Data for at least one member must be entered.
Member Data	Address, Device, URN, and Unit	Data for at least one member must be entered.
	Logical Channel Number	Logical Channel Number is required when the member is assigned for a net with a Connection field in the Net Status File set to EPLRS.
	Phone Number	Phone Number is required when the member is assigned for a net with a Connection field in the Net Status File set to DSVT or DNVT.
	Area Code	Area Code is required when the member is assigned for a net with a Connection field in the Net Status File set to DSVT or DNVT and the Net Service field is set to NATO or OUT-OF-AREA for the member.
	NATO Code	NATO Code is required when the member is assigned for a net with a Connection field in the Net Status File set to DSVT or DNVT and the Net Service field is set to NATO for the member.
	Observer Number	Observer Number is required when Device is set to ATHS, FIST DMD, FOS FO/FIST, FOS FSO/CDR, FOS SURVEY, IDM, TFDMD, UNKNOWN, or USER DEFINED.
	Net Number	Net Number is required when Relay Type is set to NONE or TACFIRE.
	Relay Thru	Relay Thru is required when Relay Type is set to VMF. FOR is required when Relay Type is set to TACFIRE.
	Station Rank	Station Rank is required when the Protocol for the member's Net Number in the Net Status File is set to 188-220A.

Note: DSVT = Digital Subscriber Voice Terminal; DNVT = Digital Nonsecure Voice Telephone; NATO = North Atlantic Treaty Organization; VMF = Variable Message Format.

Table 2. Required Fields for FOS Initialization Sequence (Continued)

Display	Required Fields	Comments
Member Data	IP Address	IP Address is required when connection for the member's Net number in the Net Status File is set to MSE J-1077 and Namer Server is NO or when Protocol for the member's Net Number in the Net Status File is set to 188-220A.
Map Modification Data	Minimum Easting, Minimum Northing, Maximum Easting, Maximum Northing, Grid Zone, Ellipsoid, and Datum	—
Member Monitor	None	—
Auto Target Numbering	None	Auto Target Numbering is applicable only for FO/FIST and FSO/CDR operational modes.
URN File Summary	None	—
FOS Location	None	—
Survey Form Header Data	None	Survey Form Header Data is applicable only for the Survey operational mode.
Message Legality Table Setup	None	—

Note: DSVT = Digital Subscriber Voice Terminal; DNVT = Digital Nonsecure Voice Telephone; NATO = North Atlantic Treaty Organization; VMF = Variable Message Format.

can be configured: (1) TACFIRE, (2) 188-200A, (3) MSE/X.25, and (4) EPLRS. While a net is being configured, the net status file state entry for the net is changed to "LOADING." Once the net is successfully configured and enabled for use, the net status file state entry is changed to "READY." If the net is not successfully configured for any reason, the net status file state entry is changed to "FAILED." A warning message is added to the status queue, if the net status file, member file, or setup file data required for the net are modified; the net status file state entry is "READY," and the net has not been reactivated within one minute of the time the data was modified. If the net has not been reactivated within five minutes after data modification, the net will be automatically reactivated. To deactivate a net, the net status file state entry is changed to "OFF."

According to its operational requirements document (ORD), the BFIST must maintain the capability to simultaneously monitor four different digital nets through the use of the LCU and

associated TCIM channels and SINCGARS radios. Since the probability of simultaneous data flow activity over all four nets is very remote, the system is thus configured for a maximum of three digital nets available for simultaneous access. Although the FOS software running on the LCU will support a maximum of four nets (one net per TCIM channel), one of the TCIM channels is currently committed to establishing an HTU/LCU interface (see section 3.1.2.3). Each of the three remaining TCIM channels utilizes a SINCGARS radio for net interfacing (the fourth SINCGARS radio is reserved for voice-only communications).

4.2.8 FOS Function Keys. The function keys on the FOS keyboard provide the operator with the capability to display, edit, delete, save, and transmit message data. The HTU and LCU function key definitions are summarized in Table 3.

4.2.8.1 Transmit Key. The <XMIT> (transmit) key is enabled when a message is being displayed, with the exception of message copies or monitored messages.

4.2.8.2 Mode Key. The <MODE> key is enabled at all times except when priority displays are active, when the initialization sequence is ongoing, or when a confirmation message is displayed. When the <MODE> key is pressed, the mode menu is displayed unless the FOS initialization sequence is ongoing. The operational mode determines the specific capabilities available to the operator from the mode menu.

4.2.8.3 Message Key. The <MSG> (message) key is enabled at all times except when Copperhead or Airborne Mission Command priority displays are active, when the initialization sequence is ongoing, or when a confirmation message is displayed. When the <MSG> key is pressed and any of the received message indicators (message bell sounding or clock display in reverse video) are on indicating that a message has been received, the indicators are subsequently turned off. When the <MSG> key is pressed and the received message indicators are off, the received message function is accessed and the index to the receive queue is displayed. FOS provides the operator the capability to review, edit, transmit, save, delete, or update the database with received messages with the exception that monitored messages cannot be transmitted.

Table 3. FOS Function Key Definitions for the HTU and the LCU

HTU Key	LCU Key	FOS Function
F1	F1	XMIT
F2	F2	MODE
F3	F3	MSG
F4	F4	SAVE
F5	F5	MAP
F6	F6	FM[a]
F7	F7	PREV
F8	F8	NEXT
F9	F9	CALCULATOR
F10	F10	PRINT
F11, FNC[b] and PGUP	F11, PGUP	PGUP
F12, FNC and PGDN	F12, PGDN	PGDN

[a]FM = Fire Mission
[b]FNC = Function

4.2.8.4 Save Key. The <SAVE> key is enabled at all times except when Copperhead or Airborne Mission Command priority displays are active, when the initialization sequence is ongoing, or when a confirmation message is displayed. When the <SAVE> key is selected, the index to the save queue is displayed. FOS provides the operator the capability to update the database or review, edit, transmit, and delete saved messages with the exception that monitored messages can not be transmitted. The save message function is accessed through the <SAVE> key or saved message function.

4.2.8.5 Map Key. The <MAP> key is enabled at all times except when Copperhead or Airborne Mission Command priority displays are active, when the initialization sequence is ongoing, or when a confirmation message is displayed. When the <MAP> key is selected, the graphics mode is accessed. The FOS graphics capability allows the operator to display graphical maneuver and fire support information. The graphics display uses a subset of the symbols from FM 101-5-1 [16].

4.2.8.6 Fire Mission Key. The <FIRE MISSION> key is enabled at all times except when Copperhead or Airborne Mission Command priority displays are active, when the initialization

sequence is ongoing, or when a confirmation message is displayed. If the <FIRE MISSION> key is selected, the following requirements are applicable:

- If buffer one or two is empty, then the fire request message "FR GRID" is placed in the empty buffer.

- If buffers one and two contain active missions, then they are checked for a fire mission with a target number. If a target number is found, then the mission is moved to the first empty buffer of buffers three through nine and the FR GRID message is stored in buffer one or two.

- If buffer one or two contains only a composed message, then that message is moved to the first available buffer of buffers three through nine and the FR GRID message is stored in buffer one or two. Otherwise, the FR GRID message is placed in the first empty buffer of buffers three through nine.

- If there is no empty buffer, then a search is made to find the first buffer containing only a composed message, which is then overwritten with the FR GRID message.

- If all buffers are busy, then a warning message is displayed indicating that all buffers are busy.

4.2.8.7 Previous Key. The <PREV> (previous) key is enabled when the current display is a sublevel of another display except when a confirmation message is displayed or the initialization sequence is ongoing. When the <PREV> key is selected, the previous level of display is displayed.

4.2.8.8 Next Key. The <NEXT> key is enabled at all times except when a confirmation message is displayed. If the <NEXT> key is selected, the following requirements are applicable.

- ***Status Line Message Displayed.*** The <NEXT> key clears the status line message that is displayed from the status line. If there is another status line message in the status queue, then the next message in the queue is displayed. When the status queue is full and there is a new status line message to be placed in the queue, the displayed status line message is automatically replaced with the status line message next in the queue using reverse video, and the new status line message is added to the queue. In addition, if the message bell volume is turned on in the FOS status file, an audible alarm sounds during the display of status line messages and can be silenced only when the last status line message is cleared from the status queue. The status line message alarm uses a unique audio frequency to distinguish it from the audible alarm which sounds when messages are placed in the receive queue. If the status line message alarm is sounding when a message is placed in the receive queue, the received message alarm takes precedence over the status line message alarm.

- ***Receive Queue Summary.*** When the status message queue is empty, a two-line summary of the contents of the receive queue and number of active missions is displayed on the status line. If any categories of the summary are in reverse video, pressing the <NEXT> key sets those fields back to normal video. The receive queue summary consists of the following categories:

  (1) FO/FIST and FSO/CDR operational modes:

  (a) MSN = Active Missions (local and nonlocal missions)
  (b) FR = Fire Requests
  (c) INFO = Information messages
  (d) GEOM = Geometry messages
  (e) FP = Fire planning messages
  (f) CKF = Check fire messages
  (g) ERR = Messages with errors

(2) Survey operational mode:

(a) MSN = Active Missions (local missions)
(b) FR = Fire Requests
(c) INFO = Information messages
(d) GEOM = Geometry messages
(e) SP = Survey point messages
(f) CKF = Check fire messages
(g) ERR = Messages with errors

MSN Category. If the current FOS operational mode is FO/FIST or FSO/CDR, the MSN category of the receive queue summary consists of the total count of active missions in the nonlocal and local mission files. If the current FOS operational mode is Survey, the MSN category consists of the total count of active missions in the local mission file.

FR Category. The FR category of the receive queue summary consists of the total count of all fire request messages in the receive queue. Fire request messages include FR GRID, FR POLAR, FR SHIFT, FR LASER, FR MOV1, FR MOV2, IMMED FIRES, TACAIR REQST, and AIR FIRE. In addition, if FR QUICK, RDR REG, MTO, or HB/MPI messages are used to initiate a mission, then these messages are also included.

INFO Category. The INFO category of the receive queue summary consists of the total count of all information messages in the receive queue. Information messages include FL TRACE, SHELREP, ATI GRID, ATI POLAR, OBSR LOC, MEDEVAC, and FREETEXT. If FR QUICK, RDR REG, MTO, or HB/MPI messages are not used to initiate a mission, then these messages are included. If the FOS operational mode is FO/FIST or FSO/CDR, then SURV PNT, SURV SRCH, and SURV LIST messages are also included. Finally, if the FOS operational mode is Survey, then ATI TGT, PLAN SCHD, PLAN DESC, PLAN INST, and FIREPLAN messages are included.

GEOM Category. The GEOM category of the receive queue summary consists of the total count of all geometry messages in the receive queue. Geometry messages include SPRT UNIT, SPRT PNT, SPRT GEOM, and SPRT ACA.

FP Category. The FP category of the receive queue summary consists of the total count of all fire planning messages in the receive queue. Fire planning messages include ATI TGT, PLAN SCHD, PLAN DESC, PLAN INST, and FIREPLAN.

SP Category. The SP category of the receive queue summary consists of the total count of all survey point messages in the receive queue. Survey point messages include SURV PNT, SURV SRCH, and SURV LIST.

CKF Category. The CKF category of the receive queue summary consists of the total count of all check fire messages in the receive queue. Check fire messages include the following:

- AIR COMD message with the mission command field set to either "CHECK" (Check Firing) or "CANCFR" (Cancel Check Fire).

- FO CMD message with the fire info field set to either "CHECK FIRE" (Check Firing), "CHECK FIRE ALL" (Check Firing All), "CANCFR" (Cancel Check Fire), or "CANCFR ALL" (Cancel Check Fire All).

ERR Category. The ERR category of the receive queue summary consists of the total count of all messages in the receive queue that are flagged with an error.

4.2.8.9 Enter Key. The <ENTER> key provides the operator the capability to toggle between the review mode and the edit mode. If the operator is in the edit mode, FOS provides the capability of windowing. The <ENTER> key is pressed to toggle the window on and off. The window displays either legal ranges or a selection table for the field indicated by the current cursor location. If a selection table has only one selection, FOS automatically makes that selection and moves to the next field for editing. FOS displays a character entered by the

operator only if the entry is within the legal range for the field or unless the operator is in overstrike mode. Otherwise, the input is ignored and FOS makes a check to determine if the illegal entry bell is "OFF." If the illegal entry bell volume in the FOS status file is not "OFF," a bell is sounded to audibly notify the operator of the invalid keystroke. For all data field types, FOS indicates the data entry sequence by moving the prompt and reversing the video for the data field of the display to be edited.

4.2.8.10 Page Up Key. The <PGUP> (page up) key is enabled whenever the current display or edit window has multiple segments. If the edit window is open, the <PGUP> key is active for the edit window. Otherwise, the <PGUP> key is active for the current display. When the <PGUP> key is selected, the previous segment is displayed. If the message segment is the first segment, then the last segment is displayed.

4.2.8.11 Page Down Key. The <PGDN> (page down) key is enabled whenever the current display or edit window has multiple segments. If the edit window is open, the <PGDN> key is active for the edit window. Otherwise, the <PGDN> key is active for the current display. When the <PGDN> key is selected, the next segment is displayed. If the message segment is the last segment, then the first segment is displayed.

4.2.8.12 Print Screen Key. The <F10> key or <FNC> key followed by the <P> key provides the operator the capability to print the current display on the screen except when a confirmation message is displayed or the initialization sequence is ongoing. The print banner window is displayed to prompt the operator for the appropriate classification banner to be centered on the top and bottom of the printed page. The serial status file is checked to determine if the printer capability is on. If the printer capability is not on, then a warning message is displayed. If all available print buffers are allocated, an error message is displayed, indicating that the print queue is full. If the print request is accepted, the current display is printed after all previous print requests have been printed.

4.2.8.13 Print File Key. The <FNC> key followed by the <Q> key provides the operator the capability to print the contents of the file when the current screen is a file list display, except

when the initialization sequence is ongoing. The print banner window is displayed to prompt the operator for the appropriate classification banner to be centered on the top and bottom of the printed page. The serial status file is checked to determine if the print capability is on. If the printer is not on, then a warning message is displayed. If the queue is full, an error message is displayed indicating that the queue is full. If the queue is not full, each record in the file to be printed is queued up and printed after all previous print requests have been printed. If the current screen is not a file list display, then no print action is taken.

4.2.8.14 Print Abort Key. The <FNC> key followed by the <A> key allows the operator to abort the current print job and all the print jobs in the print queue, except when a confirmation message is displayed or the initialization sequence is ongoing.

4.2.8.15 View Transmit Status Block Key. If the operator presses a valid key for that display during the transmission of a message, the transmit status block is removed from the display. To view the transmit status block for the current message, the operator presses the <?> key and the current transmit status is displayed.

4.2.8.16 Survey Calculator Key. The <CALCULATOR> <F9> key provides the operator access to the survey calculator. The <CALCULATOR> key is enabled in the Survey operational mode when the current display is the survey mode menu or a survey calculation display. The survey calculator consists of the survey calculator display and the survey formula calculator display. The operator has the capability to use the <PGUP> and <PGDN> keys to change between the displays. The survey calculator provides normal calculator functions: addition, subtraction, multiplication, division, SIN, COS, TAN, ASIN, ACOS, ATAN, square root, exponential log, and natural log. The calculator has a memory location to store one value. The operator has the ability to clear the memory, add to the memory, and recall the value stored in memory. In addition, specialized survey algorithms are provided from the survey formula calculator display. The calculator allows the operator to move the calculated value to the field of the survey calculation display from which the calculator was invoked. If the value cannot be moved because of legal range limitations or the calculator was invoked from the survey mode menu, then an error message is displayed. For all calculator functions, "ERROR" is displayed in

the value field when all required fields are not present, when the calculated result is too large for the value field, or when a mathematical error is encountered (e.g., when operator attempts to divide by 0).

*4.2.9 **Outputs.*** FOS provides the operator with the following output options:

- Save Queue,
- Transmit Queue,
- Print Queue, and
- Operator output via the FOS screen.

*4.2.10 **Operational Capabilities From Mode Menu.*** The operational capabilities available from the different mode menus (FO/FIST, FSO/CDR, and Survey) enable the operator to access various files and functions. The operator has the capability to select any local mission buffer for activation. If the active mission buffer contains a composed message, the message type is displayed with the mission buffer number. If the active mission buffer contains a mission other than a tactical air (TACAIR) mission with a target number, that target number is also displayed. Finally, if the active mission buffer contains a TACAIR mission with a request number, then the request number is displayed. Each mode menu provides the operator access to only those operational capabilities applicable to the specific system functionality.

*4.2.11 **Priority Processing.*** FOS provides the capability to display and process priority messages. Priority warning messages are displayed on the status line of the screen if space permits. If screen space does not allow for a status line, the priority warning messages are displayed on a full screen. FOS also provides the operator the capability to compose the next message in the logical sequence of messages.

*4.2.12 **Message Processing.*** The processing associated with each data message is dependent upon the origin/destination within the system. There are five main areas of processing to which a message may be subjected: (1) composition and transmission initiation, (2) prepare received message, (3) transmission continuation, (4) process monitored message, and (5) update key. In the paragraph specific to each message, there will be a subparagraph for each of these areas

which provides the necessary details. Processing common to more than one paragraph is contained in shared message processes and is referenced by the appropriate paragraph number. Processing specific to a paragraph is elaborated in detail in the paragraph specific to that message.

*4.2.13 **FOS Internal Interfaces.*** The internal interfaces between FOS capabilities is graphically depicted in the FOS system model (Figure 8) and the FOS system capabilities model (Figure 9). The FOS system model and FOS system capabilities model identify the flow of information between the system capabilities and internal FOS interfaces, which includes the interfaces between the FOS applications software and the common hardware software (CHS) components (which, in turn, include the LCU, HTU, TCIMs, and SINCGARS radios). Note that the G/VLLD interface and associated data flows (Figure 9) have been deleted from the BFIST M7 FOS application.

*4.2.14 **Security.*** The FOS CSCI was developed to the applicable security provisions as specified in AR 380-19, Information Systems Security [17], which includes standards for software, hardware, physical, procedural, personnel, and network security. The FOS software does not contain any classified information.

4.3 FBCB2 Software. To achieve systemic, force-wide, platform-to-platform, training, and life-cycle cost benefits, specific digitization capabilities must be implemented across all Army platforms. The FBCB2 CSCI provides these capabilities through implementation upon a participating platform's resident Appliqué+ computer. The capabilities implemented through the FBCB2 software are

- SA processing,
- TI network connectivity and management,
- JVMF message processing,
- C2 data management, and
- security.

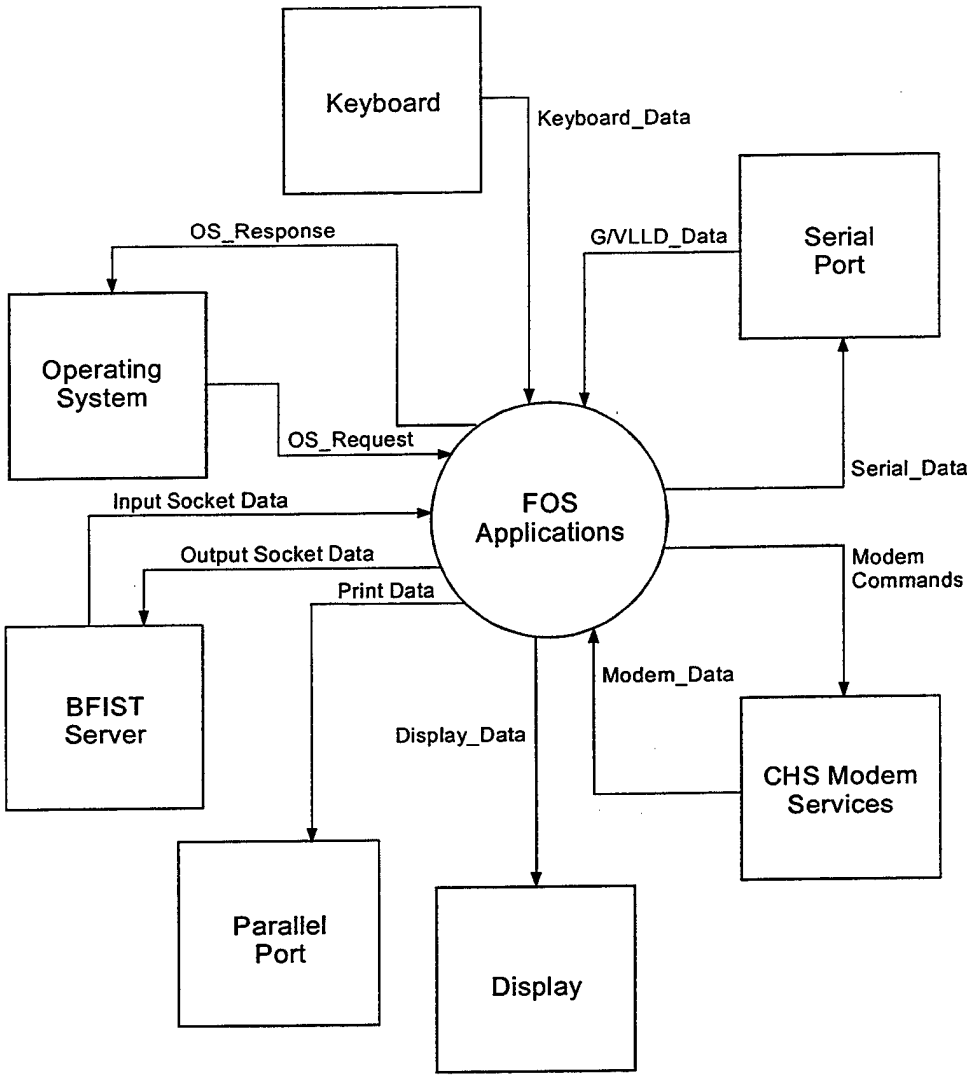


Figure 8. FOS System Model.

Figure 10 shows a structural block diagram illustrating the FBCB2 software flow from the session manager screen.

In the following sections, each of the above capabilities will be described in more detail.

4.3.1 SA Processing. One of the primary functions of the Appliqué+ and resident software is the receipt, maintenance, and dissemination of SA data. The SA database provides an accurate, "real-time," graphically enhanced awareness of the current battlefield situation to

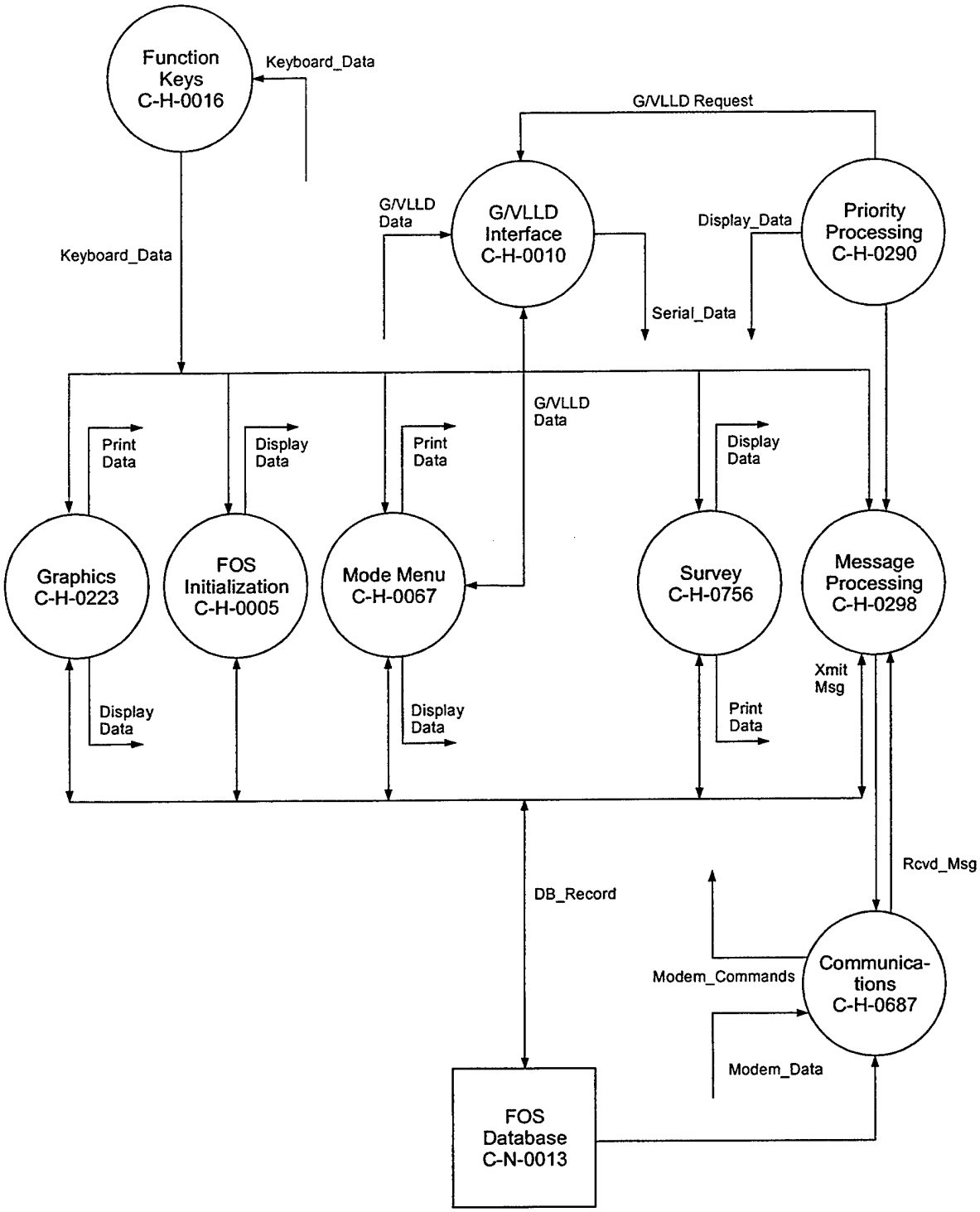


Figure 9. FOS System Capabilities Model.

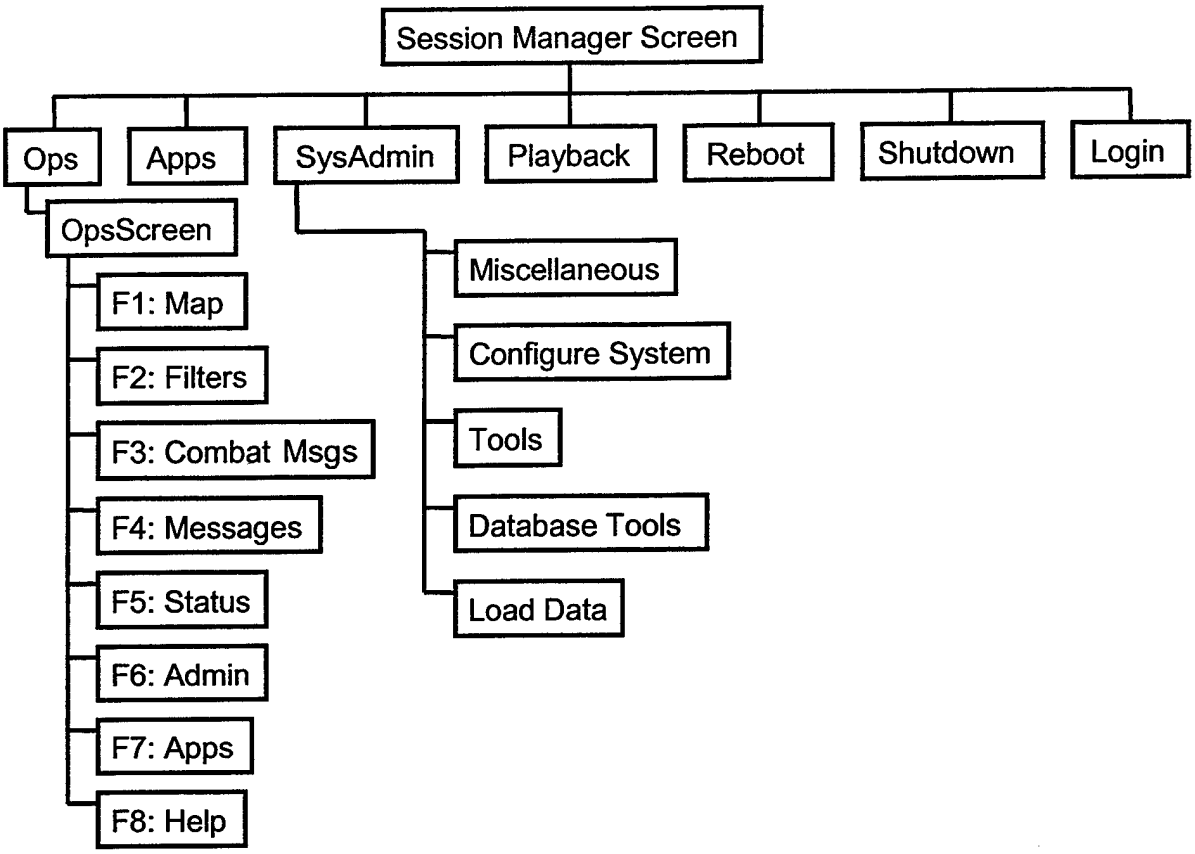


Figure 10. FBCB2 Software Flow From the Session Manager Screen.

all participating platforms. The SA database is built from a combination of near real-time and non-real-time data that is extracted from JVMF messages. The primary function of SA is the dissemination of near real-time data. Near real-time data changes rapidly, is transmitted often, is normally disseminated automatically, and is composed of the following elements:

- *Platform Data:* the FBCB2 software host platform's own position,
- *Friendly Data*: the positions of friendly units and platforms,
- *Enemy/Unknown Data* the positions of enemy and unidentified units, and

- *Georeference Data:* the positions and identifications of objects of military significance (e.g., mine fields, bridges; obstacles, NBC areas, etc).

It is the platform's responsibility to provide all graphical presentation tools to display SA data to the user. Particular graphics that would use the SA database include digital maps, navigational aides, and overlays. Dissemination of SA data is controlled by a series of filters with settings designed to provide estimated accuracy of received data and to prevent overloading of the communications network. For example, while reporting the host platform's own position to the network, time and motion filters regulate the rate of reporting. Table 4 presents representative default time and motion filters by generic unit type. Geographic filters limit the volume of data sent to any subnet to that information which is directly applicable to the participant's immediate area of operation. Finally, the host client's position data may be received from any of the following sources: GPS, manual entry, EPLRS-VHSIC, or other onboard client subsystems.

Table 4. Representative Default Time and Motion Filters by Generic Unit Type

Unit Type	Time Filter	Motion Filter
Ground Vehicle	5 min	100 m
Air Vehicle	15 s	100 m
Dismounted	5 min	100 m

Figure 11 depicts the SA dissemination network architecture. The entire battlefield is provided with SA data through a hierarchy of servers responsible for implementing geographic filters. This figure identifies local area nets served by designated units (i.e., platoon leader), medium area nets by the battalion level, and wide area nets by the upper echelon.

The SA database is also filtered according to data currency. When new data is received about a unit already listed in the database, its time and quality are compared to the existing data, and the most accurate data is maintained. In order to provide maximum utility, data is classified

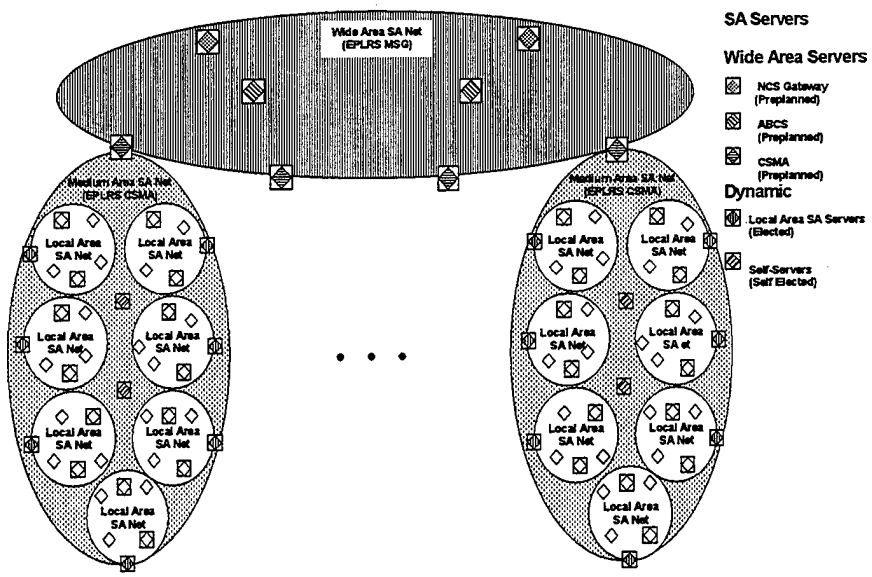


Figure 11. SA Dissemination Architecture.

in four levels of currency: (1) current, (2) stale, (3) old, and (4) purge. Current data is the latest available georeference position information. When data age exceeds the filter limit for stale time, and old time that data is marked as stale and old, respectively. When data age exceeds the filter limit for purge time, that data is deleted from the SA database. It is the platform's responsibility to provide any graphical representation of data age. Table 5 presents representative default data age filter limits.

Table 5. Representative Default Data Age Filter Limits

Unit Type	Stale	Old	Purge
Enemy Unit	20 min	40 min	12 hr
Ground Vehicle	20 min	40 min	8 hr
Air Vehicle	1 min	2 min	2.5 min
Dismounted	20 min	40 min	8 hr

4.3.2 TI Connectivity. The FBCB2 software provides TI connectivity and communications services by configuring, controlling, and employing the INC router to send and receive digital information across the EPLRS VHSIC and SINCGARS SIP radios.

4.3.3 JVMF Processing. JVMF messages are composed of two parts: header and body. The header format is governed by MIL-STD-2045-47001B [18]; body formats are governed by the Joint Interoperability of Tactical Command and Control Systems Variable Message Format Technical Interface Design Plan (Test Edition), Reissue 3 [19]. There will also be a "to be supplied" (TBS) set of critical, though not yet approved, interface change proposals (ICP) implemented. For inbound messages, the message header and message body are passed to the platform when the appropriate application programming interface (API) service is requested. For outbound messages, the platform provides the FBCB2 software the message type and message body; the software then creates the appropriate message header. Finally, the FBCB2 software uses the message type to determine appropriate default message addresses.

4.3.4 Security. System security procedures were developed to prevent enemy access to the digitized battlefield, in accordance with AR 380-19 [17]; and Department of Defense (DOD) 5200.28-STD, "Orange Book" [20] The FBCB2 software operates at a System High Mode, as defined in AR 380-19 and Program Executive Office (PEO) Command, Control, and Communications Systems Security Policy [21]. System High is a mode of operation wherein all users of the FBCB2 computer system possess the required security authorization, but not necessarily at a need-to-know level, for all data handled by the FBCB2 system. The FBCB2 software supports operation at either of two system (high) sensitivity levels. These levels include SENSITIVE BUT UNCLASSIFIED (SBU) and SECRET (S). The system sensitivity level controls message marking, message rejection, and screen marking functions. In addition to maintaining a system sensitivity level, the FBCB2 software exercises the principle of "least privileged." Specifically, the software limits the user to only those operational capabilities and data needed to perform the user's assignment in accordance with the user's mission. To accomplish this, the FBCB2 software identifies each user by a user access role. The software also associates one or more access privileges with each user access role. These privileges define

the user's access to FBCB2 functionality and data. From a security perspective, the FBCB2 software enforces a role-based method of access control.

4.3.5 Basic Operations. In this section, the basic operations available through the use of the FBCB2 software are described, where these operations consist of those procedures most often used by an operator. The basic operations procedures include the following options:

- *Select a Map*: allows the operator to retrieve a map from the database and then display that map.

- *Center on a Map*: allows the operator to adjust the map display to center the icon representing himself as the screen center.

- *Auto-Center*: allows the operator to redisplay the map automatically with the icon representing himself as the screen center.

- *Select Map Scale/Zoom*: allows the operator to change the scale of a map or to zoom in/zoom out on a displayed map.

- *Set Map 6, 8, 10 Digit Representation*: allows the operator to set the map grid pattern.

- *Turn Filters On/Off*: allows the operator to engage/disengage the system filters or select only those items that he wishes to display on the SA map.

- *Send Combat Message*: combat messages may be created and sent either by using the touchscreen button "Combat Msgs" on the display or the eight-button function bar (10.4-in display only) after setting up the appropriate transmission settings.

- *Default and Address Settings*: allows the operator to set up the defaults and the addresses for the eight-button function bar or for combat message destinations.

The operator initiates these procedures from the operations (OPS) screen.

5. Conclusions

In this report, an overview description of the information systems on the BFIST M7 model with a comprehensive focus on the communication system hardware and software components is provided. These latter components include the SINCGARS radios, the LCU, the HTU, the TCIM, the FOS CSCI, the EPLRS data radio, the INC router, the Appliqué+ computer, and the FBCB2 CSCI. In the execution of the IOVSA system familiarization phase, numerous contractor and government resources were utilized to ensure proper representation of the BFIST M7 configuration. In addition, supplemental information was obtained from various public-access DOD and commercial vendor web sites.

In documenting the BFIST M7 information system architecture during the current phase of this IOVSA, there are several indicators that survivability was considered during the information system design process. First, there is considerable redundancy in many of the hardware components (i.e., SINCGARS radios, full-function crew stations, TCIMs, LCU/HTU, and hand stations). Second, communication system processing is functionally separate from other system processing, so that loss of the MPU (for example) would not directly affect the BFIST's digital communication capability. Finally, both the FOS and FBCB2 software have been developed in accordance with AR 380-19 [17].

As a result of the current system familiarization phase of the BFIST M7 IOVSA process, which focused on communication system components, two information system components are recommended for future in-depth analysis. The first of these components is the FOS CSCI, which is the key for access to battlefield C2 systems such as the Advanced Field Artillery Tactical Data System (AFATDS) and the Initial Fire Support Automated System (IFSAS). If the BFIST were overrun and boarded by a hostile force during the course of a mission, the FOS software potentially could provide the enemy an avenue into numerous fire support communication nets. Also meriting further in-depth analysis is the FBCB2 CSCI, which could provide that same enemy even greater access into the Army's TI. This is of secondary concern relative to the FOS software, however, since the FBCB2 upgrade is tentatively set for in FY 2002 at the earliest.

In the next phase of the IOVSA process (system design analysis), both a system functionality assessment and a data flow analysis will be executed [4]. In the system functionality assessment process, a determination is made as to whether a system can achieve its specific requirements from a DOD Information Technology Security Certification and Accreditation Process (DITSCAP) perspective. In the data flow analysis, the detailed program specifications for an information flow model (IFM) are formulated, and provides an initial analytical measure of system performance as a function of configuration and scenario.

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7. U.S. Department of Defense. *Interoperability Standard for Digital Message Transfer Device Systems*. MIL-STD-188-220(A), Washington, DC, 28 March 1995.

8. U.S. Department of the Army. *Interface Specifications for the Army Data Distribution System Interface (ADDSI)*. ACCS-A3-407-008D, Washington, DC, 10 April 1990.

9. International Consultative Committee for Telegraphy and Telephony. "Interface Between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Dircuit." *Recommendation X.25*, Geneva, Switzerland, October 1996.

10. Deering, S. *Internet Control Message Protocol Router Discovery Messages*. RFC 1256+, Xerox Palo Alto Research Center, Palo Alto, CA, September 1991.

11. National Software Testing Laboratories. Ymark2000 (2000.exe). Conshohocken, PA, 1998.

12. Sun Microsystems, Inc. Solaris X86 (UNIX) Version 2.5. Palo Alto, CA 1997.

13. U.S. Department of Defense. *General Specification for Connectors, Electrical Circular, Miniature, High Density, Quick Disconnect (Bayonett, Threaded and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts.* MIL-C-38999, Washington, DC, 20 June 1990.

14. Anonymous. *Universal Asynchronous Receiver/Transmitter.* 16550 UART, 1994.

15. U.S. Department of Defense. *Connectionless Data Transfer Application Layer Standard.* MIL-STD-2045-47001, Washington, DC, 27 July 1995.

16. U.S. Department of the Army. *Operational Terms and Graphics.* FM 101-5-1, Washington, DC, 30 September 1997.

17. U.S. Department of the Army. *Information Systems Security.* AR 380-19, Washington, DC, 27 February 1998.

18. U.S. Department of Defense. *Interoperability Standard for Connectionless Data Transfer Application Layer Standard.* MIL-STD-2045-47001B, Washington, DC, 27 July 1995.

19. U.S. Department of Defense. *Joint Interoperability of Tactical Command and Controls Systems Variable Message Format Technical Interface Design Plan (Test Edition), Reissue 3.* Washington, DC, June 1996.

20. U.S. Department of Defense. *Department of Defense Trusted Computer System Evaluation Criteria.* DOD 5200.28-STD, Washington, DC, 26 December 1985.

21. U.S. Army Communication Electronics Command. *Program Executive Office Command, Control, and Communications Systems Policy.* Fort Monmouth, NJ, 24 May 1999.

Appendix:

Tactical Internet Protocols

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This appendix provides a description of all protocols used for system interfacing with the tactical internet (TI). Except for MIL-STD-188-220(A)[1] and the Army Data Distribution System Interface (ADDSI),[2] all TI protocols (i.e., requests for comment [RFC]) are commercially available. Some commercial protocols have been modified to support unique military environments. The Force XXI Battle Command Brigade and Below (FBCB2) host (Appliqué+ computer) protocol stack is shown in Figure A-1, and the INC router protocol stack is shown in Figure A-2.

Point-to-Point Protocol (PPP)[3]

PPP (RFC 1662) is used to connect the host computer to the internet controller (INC) router. This protocol will also support address resolution between the host and router.

Interoperability Standard for Digital Message Transfer Device Systems [MIL-STD-188-220(A)]

MIL-STD-188-220(A) is a communication protocol run across the Single Channel Ground and Airborne Receiver System (SINCGARS) nets to control data/voice access to the net and data delivery.

Army Data Distribution System Interface (ADDSI)

The ADDSI protocol is a variation of the X.25 Packet Switching Standard protocol,[4] and is used by Army host systems as the standard interface to transport data across the Enhanced Position Location Reporting System (EPLRS) data distribution network.

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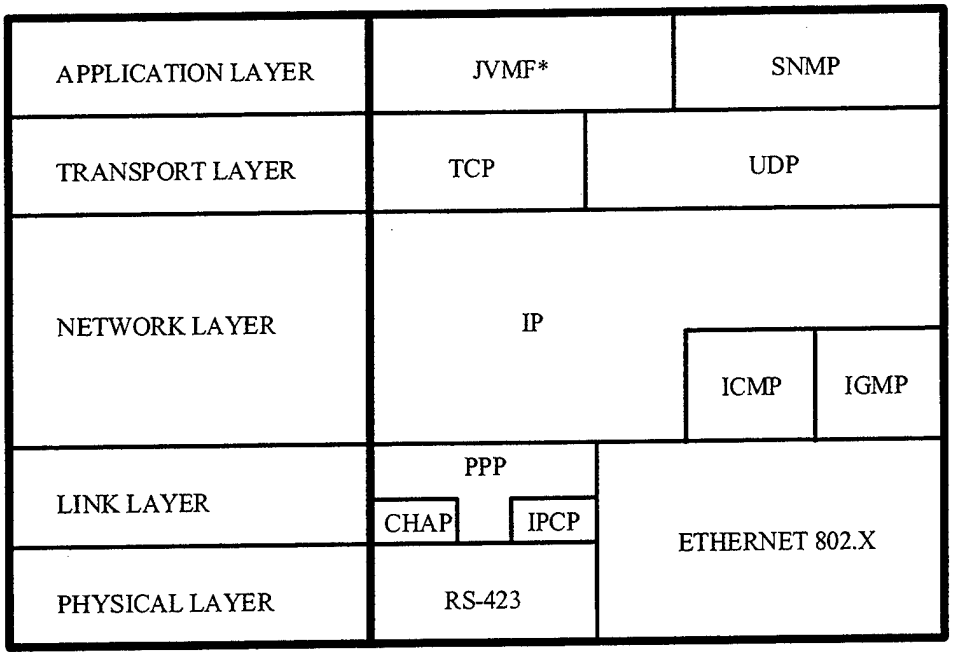
[1]U.S. Department of Defense. *Interoperability Standard for Digital Message Transfer Device Systems.* MIL-STD-188-220(A), Washington, DC, 28 March 1995.

[2]U.S. Department of the Army. *Interface Specification for the Army Data Distribution System Interface (ADDSI).* ACCS-A3-407-008D, Washington, DC, 10 April 1990.

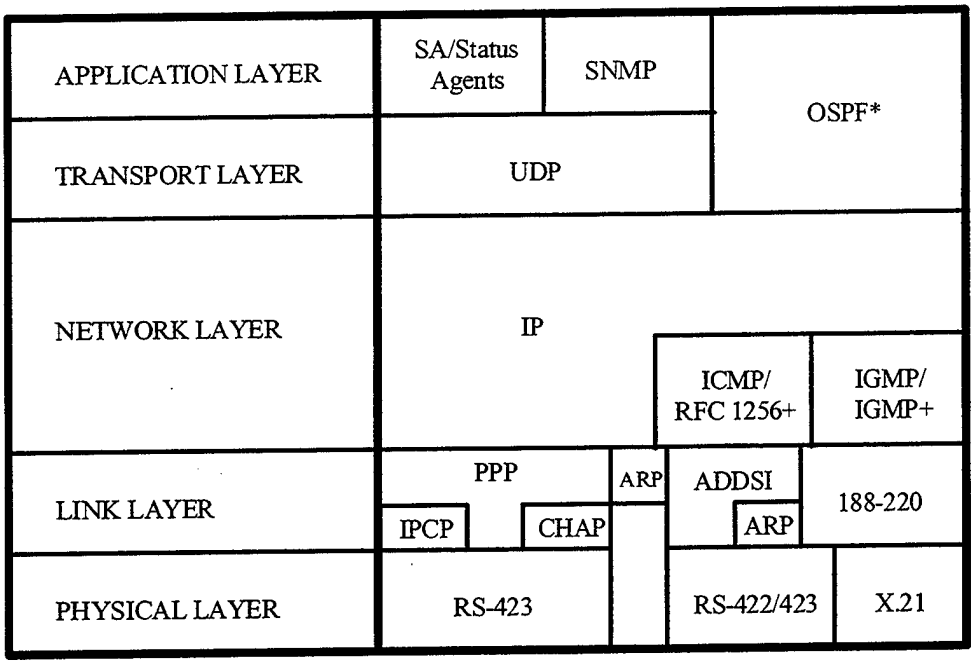
[3]Simpson, W. *Point-to-Point Protocol.* RFC 1662, DayDreamer Computer Systems Consulting Services, Madison Heights, MI, July 1994.

[4]International Consultative Committee for Telegraphy and Telephony. "Interface Between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit." *Recommendation X.25*, Geneva, Switzerland, October 1996.



*Messaging standard, not a protocol.

Figure A-1. FBCB2 Host Protocol Stack.



*Activated only at the TOC.
Note: ARP = Address Resolution Protocol.
OSPF = Open Shortest Path First.

Figure A-2. INC Protocol Stack.

Internet Protocol[5]/Internet Control Message Protocol[6] (IP/ICMP)

IP/ICMP (RFC 791 and 792) are used for the routing and delivery of all message types through the TI.

RFC 1256[7] and RFC 1256+[8]

RFC 1256 is used on the SINCGARS nets so that INC routers can advertise their exit gateway eligibility/priority. The primary function of RFC 1256+ is the same as RFC 1256; however, the RFC 1256+ also advertises the directly attached host IP address as well as the eligible router IP address. RFC 1256+ involves no changes to the RFC 1256 format but is used in a router-to-router mode instead of a host-to-router mode.

Transmission Control Protocol (TCP)[9]

TCP (RFC 793) is a protocol used between two hosts to provide acknowledged delivery of unicast messages. Large messages (greater than 576 B) are sent by serial unicast using TCP.

User Datagram Protocol (UDP)[10]

UDP (RFC 768) is used for a connectionless or nonacknowledged delivery of all SNMP messages and SA data sent between the FBCB2 host computer and the directly connected INC router. All multicast C2 messages are sent using UDP.

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[5]Postel, J. *Internet Protocol.* RFC 791, Information Sciences Institute, Marina del Rey, CA, September 1981.
[6]Postel, J. *Internet Control Message Protocol.* RFC 792, Information Sciences Institute, Marina del Rey, CA, September 1981.
[7]Deering, S. *Internet Control Message Protocol Router Discovery Messages.* RFC 1256+, Xerox Palo Alto Research Center, Palo Alto, CA, September 1991.
[8]Deering, S. *Internet Control Message Protocol Router Discovery Messages.* RFC 1256+, Xerox Palo Alto Research Center, Palo Alto, CA, September 1991.
[9]Postel, J. *Transmission Control Protocol.* RFC 793, Information Sciences Institute, Marina del Rey, CA, September 1981.
[10]Postel J. *User Datagram Protocol.* RFC 768, Information Sciences Institute, Marina del Rey, CA, August 1980.

Internet Group Management Protocol (IGMP and IGMP+)[11]

IGMP (RFC 1112) is used by the FBCB2 host computer to register for multicast services with the directly connected INC router. IGMP is used between the host and router to inform the router of the multicast groups from which the host wishes to receive traffic. IGMP+ is used from router to router (instead of from host to router) to allow a SINCGARS-only router to inform the gateway router of the multicast groups from which the host wishes to receive traffic.

Simple Network Management Protocol (SNMP)[12]

The INC routers will receive all necessary router initialization data or changes to router initialization data from their local host via their PPP interfaces using SNMP. The host also determines router and local radio interface status via SNMP.

PPP Challenge Handshake Authentication Protocol (CHAP)[13]

CHAP (RFC 1994) is used by the INC router to authenticate the directly connected host. Utilizing CHAP, the INC authenticates the host upon initial PPP link establishment and periodically thereafter. Authentication is accomplished by a three-way handshake between the INC and the host, whereby the INC verifies that the host possesses a valid password. Both the host and the router maintain the password as a shared secret. A one-way message digest 5 (MD5) hash function is applied to the password data so that the password is never exposed in the clear over the PPP link.

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[11]Deering, S. *Internet Group Management Protocol.* RFC 1112, Stanford University, Stanford, CA, August 1989.
[12]Case, J., M. Fedor, M. Schoffstall, and C. Davin. *Simple Network Management Protocol.* RFC 1098, University of Tennessee, Knoxville, TN, April 1989.
[13]Simpson, W. *Challenge Handshake Authentication Protocol.* RFC 1994, DayDreamer Computer Systems Consulting Services, Madison Heights, MI, August 1996.

Internet Protocol Control Protocol (IPCP)[14]

IPCP (RFC 1332) is a part of IP, and is responsible for configuring, enabling, and disabling the IP protocol modules on both ends of the INC router to host point-to-point link. The primary use of IPCP by the FBCB2 host computer is to enable router discovery in the event the host's INC is replaced.

[14]McGregor, G. *Internet Protocol Control Protocol.* RFC 1332, Merit Network, Inc., Ann Arbor, MI, May 1992.

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List of Abbreviations

ABCS	Army Battle Command System
ADDSI	Army Data Distribution System Interface
AFATDS	Advanced Field Artillery Tactical Data System
AFCS	Automatic Fire Control System
API	Application Programming Interface
AR	Army Regulation
ARL	U.S. Army Research Laboratory
ARP	Address Resolution Protocol
ATCCS	Army Tactical Command and Control System
ATHS	Airborne Target Handover System
AWE	Army Warfighting Experiment
B	Bytes
BCIS	Battlefield Combat Identification System
BCS	Battery Computer System
BFA	Battlefield Functional Area
BFIST	Bradley Fire Support Team Vehicle
BIOS	Basic Input/Output System
BIT	Built-In Test
B-Kit	Bolt-on Kit
bps	Bits per second
CAS	Close Air Support
C2	Command and Control
C2I	Command, Control, and Intelligence
CCITT	Consultative Committee for Telegraphy and Telephony
CDR	Commander
C4I	Command, Control, Communications, Computers, and Intelligence
CHAP	Challenge Handshake Authentication Protocol
CHS	Common Hardware Software
CNR	Combat Net Radio
COM	Communications
COMSEC	Communication Security
CPU	Central Processing Unit
CSCI	Computer Software Configuration Item
CSMA	Carrier Sense Multiple Access
DECA	Digital Electronics Control Assembly
DITSCAP	DOD Information Technology Security Certification and Accreditation Process
DMD	Digital Message Device
DNVT	Digital Nonsecure Voice Telephone
DOD	Department of Defense
DSVT	Digital Subscriber Voice Terminal
EFOG-M	Enhanced Fiber Optic Guided Missile
EIA	Electronics Industries Association
ELRF	Eyesafe Laser Range Finder
EMD	Engineering/Manufacturing/Development

EPLRS	Enhanced Position Location Reporting System
EPUU	EPLRS User Unit
FA	Field Artillery
FAAD	Forward Area Air Defense
FAC	Forward Air Controller
FBCB2	Force XXI Battle Command Brigade-and-Below
FDB	FIST Distribution Box
FDS	Fire Direction System
FFCS	Full Function Crew Station
FIST	Fire Support Team
FM	Field Manual, Fire Mission
FNC	Function
FO	Forward Observer
FOS	Forward Observer Systems
FPD	Flat Panel Display
FR	Fire Request
FSO	Fire Support Officer
FY	Fiscal Year
Gb	Gigabyte
GFE	Government Furnished Equipment
GPS	Global Positioning System
G/VLLD	Ground/Vehicle Laser Locator Designator
HTU	Handheld Terminal Unit
ICMP	Internet Control Message Protocol
ICOM	Integrated Communication Security
ICP	Interface Change Proposal
IDM	Improved Data Modem
IEEE	Institute of Electrical and Electronic Engineers
IFM	Information Flow Model
IFSAS	Initial Fire Support Automated System
IGMP	Internet Group Management Protocol
INC	Internet Controller
INFOSYS	Information System
INS	Inertial Navigation System
IO	Information Operations
I/O	Input/Output
IO/IW	Information Operations/Information Warfare
IOVSA	Information Operations Vulnerability/Survivability Assessment
IP	Internet Protocol
IPCP	Internet Protocol Control Protocol
IP/ICMP	Internet Protocol/Internet Control Message Protocol
ISA	Instruction Set Architecture
IW	Information Warfare
JVMF	Joint Variable Message Format
IW	Information Warfare
kb	Kilobyte
kbps	Kilobytes per second

LAN	Local Area Network
LCD	Liquid Crystal Display
LCU	Lightweight Computer Unit
LPI	Low Probability of Intercept
LTACFIRE	Lightweight Tactical Fire Direction System
LTS	Logical Time Slot
LVDS	Low Voltage Differential Signaling
MB	Megabyte (1 million bytes)
MBC	Mortar Ballistics Computer
MD5	Message Digest 5
MEP	Mission Equipment Package
MHz	Megahertz
MIL-C	Military Circular
MIL-STD	Military Standard
MLRS	Multiple Launch Rocket System
MPU	Mission Processor Unit (replacement for TSEU)
MSE	Mobile Subscriber Equipment
MSG	Multisource Group
NBC	Nuclear, Biological, Chemical
NATO	North Atlantic Treaty Organization
NCS	Network Control Station
ODS	Operation Desert Storm
OPORD	Operation Order
OPSEC	Operations Security
ORD	Operational requirements Document
OSI	Open System Information
OSPF	Open Shortest Path First
PC	Personal Computer
PCI	Personal Computer Interface
PEO	Program Executive Office
PLGR	Precision Lightweight GPS Receiver
POSIX	Portable Operating System Interface
PPP	Point-to-Point Protocol
PVC	Permanent Virtual Circuit
RAM	Random-Access Memory
RF	Radio Frequency
RFC	Request for Comment
RS	Radio Set
RT	Receiver/Transmitter
S	SECRET
SA	Situational Awareness
SADL	Situation Awareness Data Link
SBU	SENSITIVE BUT UNCLASSIFIED
SCO	Santa Cruz Operations
SCSI	Small Computer Serial Interface
SINCGARS	Single Channel Ground and Airborne Receiver System
SIP	System Improvement Program

SL	System Leader
SLAD	Survivability/Lethality Analysis Directorate
SNMP	Simple Network Management Protocol
SVGA	Super Video Graphics Array
TACAIR	Tactical Air
TACFIRE	Tactical Fire Direction System
TBS	To Be Supplied
TC&D	TCIM Configuration and Diagnostics Application
TCIM	Tactical Communications Interface Module
TCP	Transmission Control Protocol
TDB	Turret Distribution Box
TDMA	Time Division Multiple Access
TEMP	Test and Evaluation Master Plan
TFDMD	TACFIRE Digital Message Device
TI	Tactical Internet
TOC	Tactical Operations Center
TSCP	Targeting Station Control Panel
TSEU	Targeting Station Electronics Unit
UART	Universal Asynchronous Receiver/Transmitter
UDP	User Datagram Protocol
URN	Unit Reference Number
USB	Universal Serial Bus
VAA	Vehicular Amplifier Adapter
VHF	Very High Frequency
VHSIC	Very High Speed Integrated Circuit
VIS	Vehicle Intercommunications System
VMF	Variable Message Format
WAN	Wide Area Network

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The Information Operations Vulnerability/Survivability Assessment (IOVSA) process, developed by the Survivability/Lethality Analysis Directorate (SLAD) of the U.S. Army Research Laboratory (ARL) for the purpose of conducting an analysis of the effects of information operations/information warfare (IO/IW) threats on battlefield information systems was applied to the M7 model of the Bradley Fire Support Team Vehicle (BFIST). The IOVSA process consists of five distinct phases which must be completed for a complete analysis of IO/IW threat impact on weapon system capability: (1) system familiarization, (2) system design analysis, (3) threat definition and susceptibility assessment, (4) vulnerability risk assessment, and (5) protection assessment and recommendations. This report documents the IOVSA system familiarization phase for the M7 BFIST with particular focus on those critical information systems relating to battlefield communications.

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