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MICROCOMPUTER INTERFACES WITH U.S. MARINE CORPS TACTICAL COMMUNICATIONS SYSTEMS

1 APRIL 1991

Submitted to
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Thesis. The United States Marine Corps (USMC) has the ability to interface personal computers (PCs), local area networks (LANs), and wide area networks (WANs) with organic tactical communications systems; however, there is not a comprehensive USMC Command, Control, Communications, and Computers (C4) operational policy that documents these C4 interfaces.

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INTRODUCTION

Fleet Marine Force (FMF) units are utilizing organic tactical communications and Automatic Data Processing (ADP) systems to successfully establish data communications networks. These networks are meeting current FMF command, control, communications, and computers (C4) interface requirements; however, they are usually locally configured and unique to individual units. The lack of a comprehensive single source operational policy is the weak point in the United States Marine Corps (USMC) C4 system.

Currently, the only C4 operational policy disseminated to the FMF is Fleet Marine Force Reference Publication (FMFRP) 3-32, (TRI-MEF Standard Operating Procedures (SOP) for Communications and Computer Systems, Nov 89). FMFRP 3-32's purpose was to establish an SOP for Marine Expeditionary Force (MEF) level data communications. Our research determined that FMFRP 3-32 does not address all of the C4 interface requirements of the FMF.

Additionally, Central Design and Programming Activity (CDPA), Quantico, a division of HQMC, C4I2, is developing a Command and Control (C2) Manual. The development of the C2

Manual is independent of FMFRP 3-32. The C2 Manual documents, in much greater detail, C4 interfaces and operational procedures. It lists communications and computer equipment in the Marine Corps inventory that is typically used to configure microcomputer telecommunications networks. Additionally, it gives step-by-step procedures for connecting C4 equipment and troubleshooting common C4 network problems.

FMFRP 3-32 and the C2 Manual are the only USMC-wide documents that cover data communications systems. The lack of a Marine Corps Order (MCO) designating either of these as the official source for establishing networks has led to the proliferation of locally generated user manuals. This allows the unit using these local SOPs to get the job done, but it creates confusion when disparate units try to establish data communications systems interfaces. This shortfall was identified during compositing in Operation Desert Shield/Storm. A single source document would alleviate many of these problems and should be the cornerstone for all Marine Corps tactical data communications systems.

SCOPE OF RESEARCH

The main focus of our research was to determine the adequacy of existing USMC communications systems, ADP systems, and C4 operational policies available to FMF units.

In conducting our research, we focused on three areas of C4. Those areas were organic tactical communications systems, ADP systems, and C4 operational policies. We surveyed FMF units, down to the Marine Expeditionary Unit (MEU) level, FMF C4 staffs, and USMC C4 supporting establishment organizations. A sample of the survey form can be found in Appendix 1. Additionally, we interviewed several FMF C4 staffs and key decision makers in the USMC C4 supporting establishment.

Because the surveys were distributed after most FMF units deployed in support of Operation Desert Shield, there was not a 100 percent response from all of the FMF units surveyed. We did receive input from each of the four elements -- Ground Combat Element (GCE), Air Combat Element (ACE), Combat Service Support Element (CSSE), and Command Element (CE) of a Marine Air Ground Task Force (MAGTF) -- of the three active MEFs as well as input from 4th Marine Division-Wing Team (4th DWT).

Our research was limited to how tactical FMF units interfaced ADP systems, LANs, and WANs with organic tactical communications systems internal to the MAGTF. Joint and Combined C4 interfaces are developed and maintained by the Joint Tactical Command, Control, Communications Agency (JTC3A), Fort Monmouth, New Jersey, and are beyond the scope of this project.

Dist. A per telecon Maj. Tritchler
Dep. Dir. Marine Corps
Commissioned Officer School

8/27/91 CG

STANDARDS

The USMC standards for communications and ADP hardware systems interfaces are contained in a variety of publications. The Information Resource Management (IRM) Technical Publication series contains the majority of the communications systems hardware standards while Marine Corps Order (MCO) P5233.1 (Marine Corps ADP Management Standards Manual) contains the ADP systems standards. MCO P5233.1 details mainframe procedures governing supporting establishment operations but contains nothing on microcomputers or tactical data communications. Additional communications and ADP systems capabilities are contained in Field Manuals (FMs), Technical Manuals (TMs) and FMFRP 3-32.

COMMUNICATIONS SYSTEMS

Communications hardware standards are uniform, adequate, and widely distributed throughout the USMC in systems TMs, as well as TM-2000 (Principal Technical Characteristics of USMC Communications-Electronics Equipment). None of the units responding to the survey indicated any problems with communications systems hardware standards.

ADP SYSTEMS

The only published standard relating to microcomputers is FMF End User Computing Equipment (EUCE) Automated

Information System (AIS) Guidelines, IRM 5230-01. There are no published standards for modems or cryptographic equipment as they relate to data communications.

USMC C4 policy makers have proposed ENABLE OA as the primary software standard for all telecommunications requirements. When the ENABLE OA software package cannot support unit requirements, requests for a waiver from the primary standard must be justified by the user, and a request to use a secondary telecommunications standard submitted to the supporting Information System Management Office (ISMO) for validation. Final approval for use of the secondary standard rests at the Commanding General Fleet Marine Force Pacific (FMFPAC) and Commanding General Fleet Marine Force Atlantic (FMFLANT) level for FMF units; for non-FMF units, the Commanding General has approval authority. Headquarters Marine Corps (HQMC), Code CCIR, is the approval authority for all other units not covered above.

OPERATIONAL POLICIES

Operational policies for interfacing communications and ADP systems are contained in FMFRP 3-32 and local directives. All three MEFs have made advances in tactical data communications which are not reflected in the current FMFRP 3-32.

CDPA, Quantico, has compiled a C2 Manual that is being staffed to all three MEF G-6s. This C2 Manual is being designed as a "cookbook" to assist FMF units in establishing data communications systems. FMFRP 3-32 and the C2 Manual are the only USMC source documents on data communications systems.

FINDINGS

Initial results of the survey indicated that there is not much divergence from authorized hardware and software standards for USMC data communications systems; however, a review of operational policies revealed significant differences from one unit to the next. Follow-on interviews confirmed survey results and identified the lack of a single source document for data communications systems as the reason for such diversity at the FMF unit level.

COMMUNICATIONS SYSTEMS

The procurement and configuration management of organic tactical communications systems is well established and supports current as well as projected FMF data communications requirements. Communications systems being used by the FMF to accomplish data communications include troposcatter, line-of-sight, multichannel and satellite radios; tactical switches; secure telephones; and commercial modems; as well as inventory cryptographic equipment. For

server to server communications, PARADYN, MICROCOM, RACAL-VADIC, and Zenith modems are used with TSEC/KG-84A/84C, MRC-135, GRC-201, and TSC-85/93 terminals. It is important to note that the FMF reported that the Packrat PK-232 modem is unreliable when used with encryption devices, such as the TSEC/KY-57, and the TSEC/KG-84A/84C. However, Communication Officers School (COS) and Computer Science School (CSS) successfully use the PK-232 modem for encrypted VHF data communications during inter-school Military Occupational Specialty (MOS) training. The cause for this unreliability has not yet been isolated and further discussion is beyond the scope of this paper.

The majority of LAN/WAN connectivity is being accomplished using multi-channel links. The majority of the burden is being handled by the MRC-135 and encrypted by the TSEC/KG-84A and STU-III secure telephone. LAN/WAN connectivity has also been achieved using the AN/TSC-85/93 in the HUB-SPOKE and point-to-point configurations.

There is no standard cable to connect modems to tactical communications gear or encryption devices. Units achieving such connectivity are doing so using locally produced cables.

As previously noted, we did not receive a 100 percent response to our survey (Appendix 1) of FMF units; however, representative results are discussed below.

A typical microcomputer-to-microcomputer link over nonsecure High Frequency (HF) radio is depicted in Figure 1. This configuration uses the AN/PRC-104 radio, the PK-232 modem, and the AN/UYK-83/85A microcomputer.

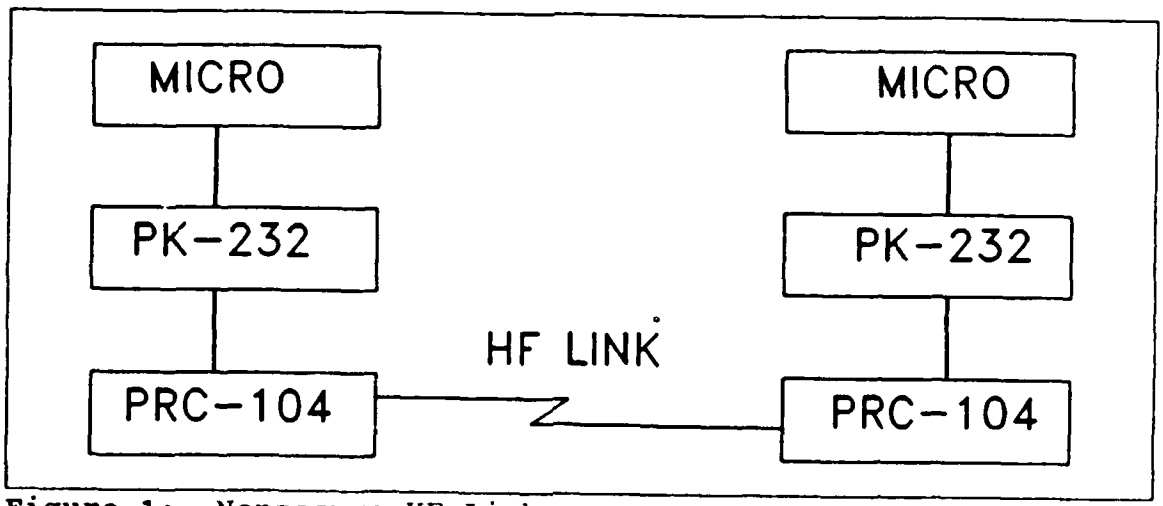

Figure 1: Nonsecure HF Link

For secure line-of-sight (LOS) LAN data communications, units are utilizing the configuration shown in Figure 2.

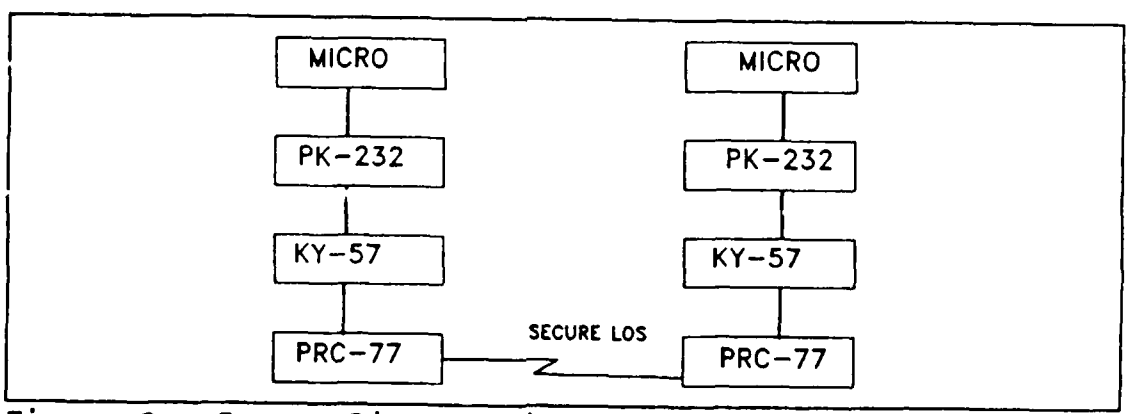

Figure 2: Secure Line-of-Sight

The standard AN/PRC-77 radio facilitates short range secure data communications in this network when linked to

the TSEC/KY-57 encryption device, PK-232 modem, and the AN/UYK-83/85 microcomputer.

Figure 3 depicts a typical WAN configuration. The WAN servers, connected to the Z-248 microcomputers, are linked via a troposcatter radio shot provided by USMC inventory AN/GRC-201 radios.

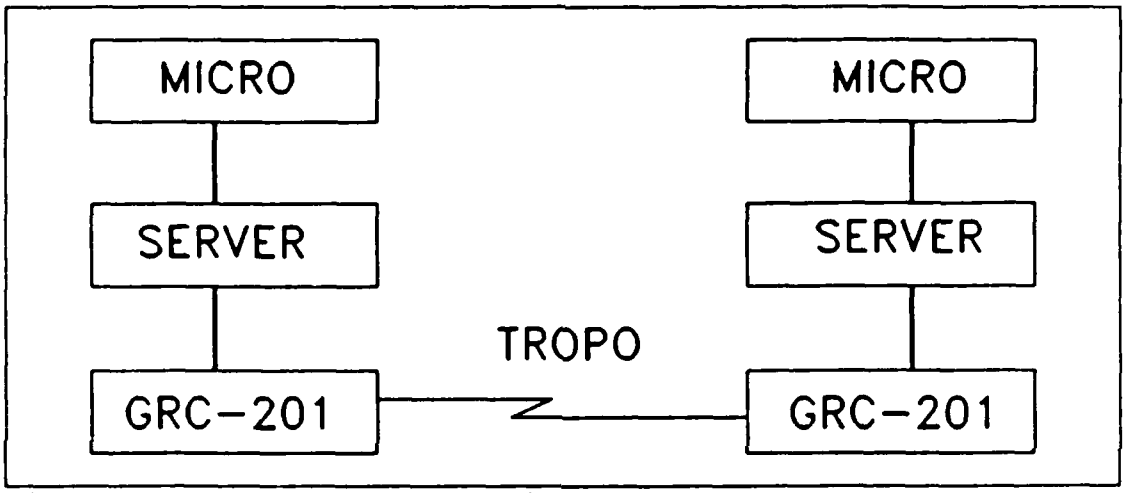

Figure 3: Typical WAN Configuration

Single channel Ultra High Frequency (UHF) satellite terminals enable units to have long range data communications. Figure 4 illustrates how the Z-248 microcomputer, Hadron modem, TSEC/KY-57 encryption device, and AN/PSC-3 satellite radio provide this long range data communications link.

Tactical switches also enable data communications links to be established by FMF units. Figure 5 shows a data communications network utilizing the AN/SB-3614 tactical switchboard, Zenith modem, and a microcomputer. The

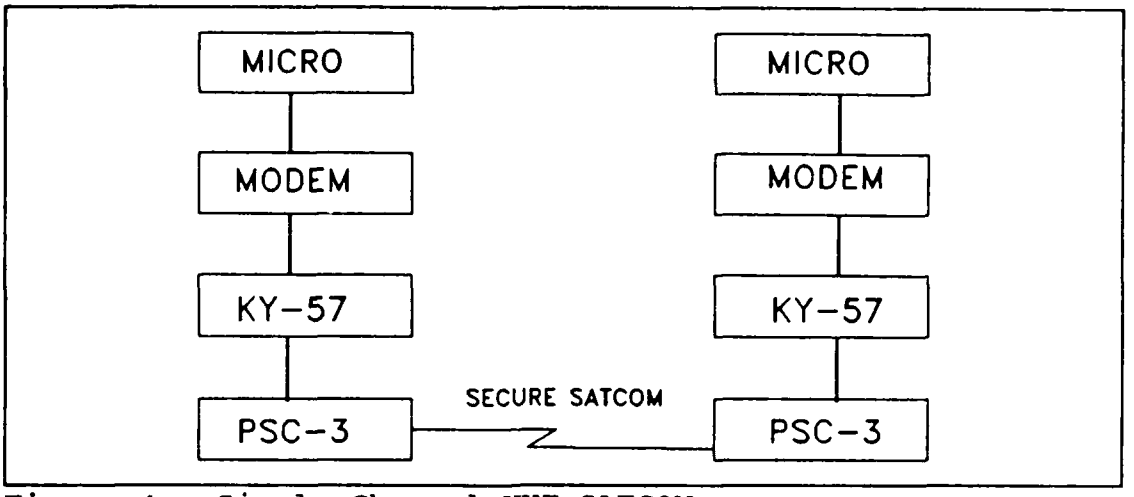

Figure 4: Single Channel UHF SATCOM

addition of the AN/MRC-135 multichannel radio to this network, Figure 6, permits units not physically co-located to establish a data communications network.

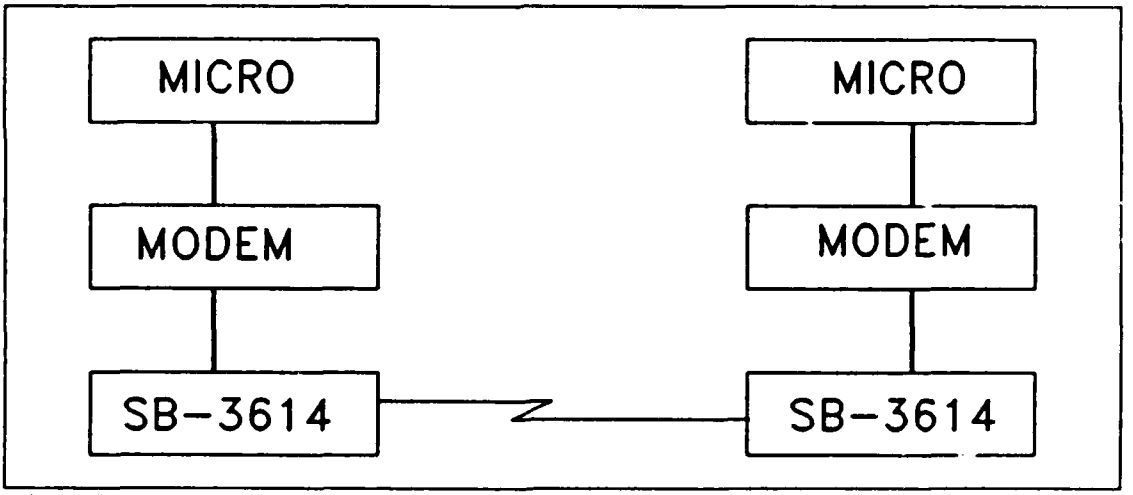

Figure 5: Tactical Switch Setup

We realize that this listing of data communications networks is not all inclusive; however, these configurations are representative of the responses we received from FMF units.

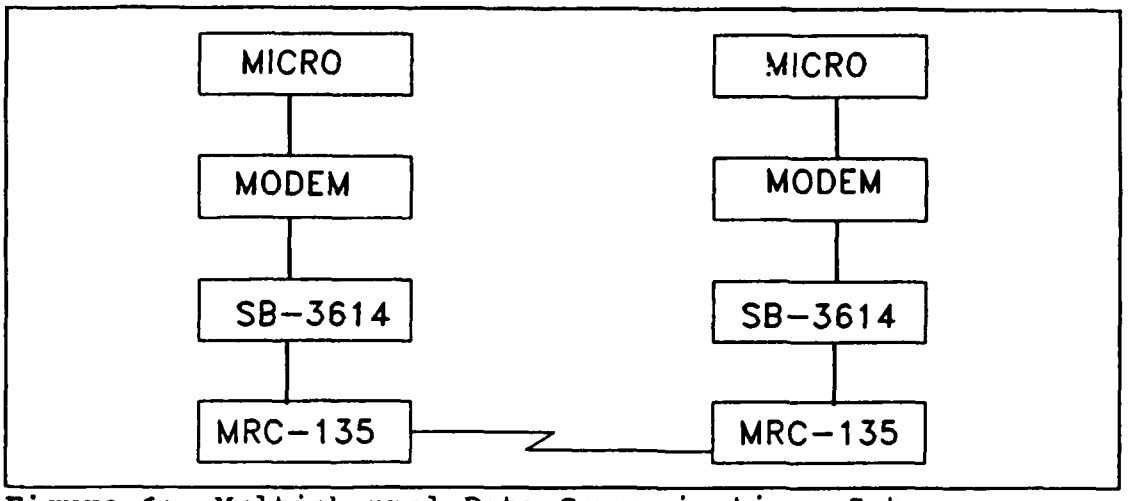

Figure 6: Multichannel Data Communications Setup

ADP SYSTEMS

One of the most commonly used methods of data communications is the PC to PC file transfer using STU-IIIs and ENABLE OA telecommunications software. Also used, with increasing frequency, is the AN/UYK-83A server to server communications using the BANYAN VINES network operating system. ADP hardware complies with defacto and established standards. Wherever FMF-EUCE devices do not fulfill tactical requirements, units are using whatever ADP systems are locally available.

ENABLE OA, PROCOMM, PROCOMM PLUS, and BANYAN VINES are the most common software applications being used for data communications. Some units indicate that they prefer PROCOMM PLUS over the proposed standard, ENABLE OA. Most FMF units indicate difficulty in using PROCOMM and ENABLE OA over Ground Mobile Forces Satellite Communications (GMF SATCOM) links, because of the delay in satellite

transmission. Other units indicate that PROCOMM PLUS has been successful over GMF SATCOM links for bulk data transfer and server to server connections.

OPERATIONAL POLICIES

FMFRP 3-32's purpose was to establish standard operating procedures for tactical communications and computer systems at the MEF level. As such, it covers planning considerations, concepts of operations, and guidelines for command and control; however, it is deficient in several key areas. Although it details AIS's and their incorporation into LAN's and WAN's, it does not sufficiently cover the integration of microcomputers into data communications systems. Specifically, FMFRP 3-32 describes how to request GMF SATCOM support, yet it does not document GMF SATCOM data communications interfaces. The lack of any discussion of HF data communications interfaces is another shortfall of the document.

FMF units indicated that those data communications systems described in FMFRP 3-32 do not contain the level of detail they require to successfully install and operate those systems. This shortfall has resulted in C4 systems being designed, tested, and informally documented by local users at the lowest level of command without benefit of a comprehensive C4 operational policy. The C2 Manual contains useful information on single channel, multi-channel and

satellite systems, as well as local area networks. It lists step-by-step procedures for establishing data communications systems and details specific trouble shooting steps for common problem areas in those configurations. However, the C2 Manual and FMFRP 3-32 were independently developed along parallel lines which resulted in redundancy in some areas.

During the final stages of Operation Desert Storm, HQMC task organized a team of over 50 people from various USMC C4 systems organizations to travel to Southwest Asia (SWA) and document the USMC SWA C4 systems architecture. Unfortunately, that documentation was not available for our project.

CONCLUSIONS

Existing organic tactical communications systems and ADP systems are meeting FMF requirements for data communications. Individual units and commands are capable of interfacing PCs, LANs, and WANs over organic tactical communications systems throughout all three MEFs and 4th DWT; however, a comprehensive USMC C4 operational policy is not available. Units are compensating for this lack of a comprehensive C4 operational policy by locally designing, testing and informally documenting C4 systems. These locally designed C4 systems are not based upon a master C4 architecture and may not be interoperable with other USMC systems.

There are no guidelines for hardware-software or their integration with organic tactical communications systems published at the HQMC level. Several of the data communications configurations being used by the FMF are not addressed in FMFRP 3-32. Since many of the data communications configurations being used by the different MEFs are not listed in FMFRP 3-32, units from one MEF do not have a document that illustrates how other MEFs data communications networks are configured. This lack of a widely disseminated USMC C4 operational policy increases the degree of coordination required by units of different MEFs to establish data communications links.

RECOMMENDATIONS

Based upon our research, the two areas that require improvement are C4 data communications operational policies and telecommunications software. Communications and ADP systems hardware meet current FMF telecommunications requirements.

COMMUNICATIONS SYSTEMS

Communications hardware standards are uniform, adequate, and widely distributed throughout the USMC in system TMs, as well as TM-2000 (Principal Technical Characteristics of USMC Communications-Electronics Equipment). None of the units responding to the survey

indicated any problems with communications systems hardware standards or documentation. FMF data communications requirements are being met by existing communications systems; therefore, we have no recommendations for this area.

ADP SYSTEMS

All microcomputers should contain standard RS-232 Input/Output (I/O) ports. Modems should have at least one RS-232 connection and two-wire connectors where RJ-11 two-wire feeders can be connected. The Marine Corps should produce technical specifications for a cable that connects the audio input jack on tactical radios to an RJ-11 connection compatible with standard modem specifications, or purchase such a cable to keep units from having to produce the cables locally.

A single telecommunications software package should be universally distributed. The consensus of FMF users is that ENABLE OA works over switched and direct connections but it is unreliable over satellite connections or encrypted circuits. PROCOMM PLUS has proven reliable over all connections; therefore, we recommend it as the telecommunications software standard. Additionally, because PROCOMM PLUS is shareware, it is available at low or no cost. We recommend that proper testing for viruses be

conducted, and a step-by-step user manual be written before PROCOMM PLUS is issued to Marine Corps units.

Modern data communications no longer requires manipulation of data in order to achieve successful transfer. The file format has no effect on the protocols' ability to successfully transfer the data; therefore, recommendations for file creation software will not be presented.

OPERATIONAL POLICIES

The results of current efforts by HQMC to document the USMC C4 systems that are operational in SWA should be used to update FMFRP 3-32 since over two-thirds of the USMC's deployable forces, representing all three MEFs and the 4th DWT, have established data communications systems in theater. Any FMF data communications requirements that are not being met should be turned over to the Warfighting Center (Code WF-11) for resolution.

The C4 systems interface documentation must be flexible enough to allow units to procure required ADP hardware and modems locally as long as the new hardware meets architecture constraints and can be supported by the integrated logistics support programs initiated or approved by Marine Corps Research Development Acquisition Command (MCRDAC) and CG FMFPAC/FMFLANT.

The C4 systems interfaces contained in FMFRP 3-32 should be reviewed annually by C4I2, the Warfighting Center, and all FMF units. The formal review should be preceded by a detailed analysis by all MEFs to determine which C4 requirements are not being met by the current version of FMFRP 3-32. These requirements should be developed into draft Required Operational Capabilities (ROCs). These draft ROCs should then be a main agenda item for the annual USMC G-6 conference. After review and discussion during the conference, valid ROCs would be submitted to the Warfighting Center for action. The solutions to draft ROCs identified during the conference should be included in the next revision of FMFRP 3-32.

Designating FMFPAC as the sponsor for revising FMFRP 3-32 is a step in the right direction. The FMFRP 3-32 revision should include any pertinent information from the C2 Manual. A single source document for C4 systems should be all inclusive and become the basis for establishing tactical C4 systems throughout the entire Marine Corps. The promulgation of this single source C4 systems manual should greatly reduce the proliferation of local user manuals.

SUMMARY

FMF data communications requirements are being met with organic tactical communications and ADP systems. The minor ADP software problems could be solved with the acquisition and fielding of PROCOMM PLUS. The largest deficiency in the USMC's C4 system is the lack of a comprehensive single source C4 operational policy. FMFPAC should incorporate the C2 Manual into FMFRP 3-32. FMFRP 3-32 should be updated after thorough review at the annual G-6 conference.

APPENDIX 1 - SAMPLE SURVEY

The sample survey and cover letter follow on pages 5-21A through 5-21C.

UNITED STATES MARINE CORPS
MARINE CORPS COMBAT DEVELOPMENT COMMAND
QUANTICO, VIRGINIA 22134-5001

IN REPLY REFER TO
1500
TU 533
15 OCT 1990

From: Director, Communication Officers School
To: Commanding General, First Marine Aircraft Wing, FMF, FPO San Francisco, CA 96603-8701

Subj: LOCAL AREA NETWORK/PERSONAL COMPUTER (LAN/PC) USE WITH USMC INVENTORY COMMUNICATIONS SYSTEMS

Encl: (1) Common Known Hardware/Software Configurations

1. Each year while attending the Communication Officers School's Command and Control Systems Course (CCSC) at Quantico, Virginia, officer students conduct research on issues submitted by USMC organizations. At the conclusion of the CCSC course, the research results are briefed to a panel of sixteen Colonels.

2. One of the issues submitted by the Fleet Marine Force was: "How are LAN's/PC's being used for communications in the MEF's? Recommend standards for hardware and software; and procedures in this area." Enclosure (1) indicates some known configurations. Evaluation by addressees of the configurations is requested.

3. Your forthright and thorough completion of the attached questionnaire will be appreciated. All responses will be kept strictly confidential and the results briefed generically (i.e., Unit A, Unit B, etc.).

4. Our goal is to recommend standards (hardware, software, and procedures) for the use of LAN's/PC's with USMC inventory communications systems.

5. Please forward the completed questionnaire by 15 November 1990 to my POC's (Captain Harrison, Captain Harber, Captain Miller and Captain Walker). They may be reached at AUTOVON 278-2315. ELMS replies are encouraged and may be sent to GGEC3G:MQG (Captain Harber).

T. M. EARLY

COMMON KNOWN HARDWARE/SOFTWARE CONFIGURATIONS

1. The following list of equipment comprises some basic configurations used within the USMC. If your equipment or configuration deviates from those listed, please state what equipment you are using, how your configuration differs, and why. Known suites are configured as follows:

Zenith-248 - PK-232 PakRatt Modem - KY-57 or KG-84 - PSC-3, PRC-77,
or Hadron Modem Crypto PRC-104

a. Is your command doing any communications using PC's?

b. Are you using any of the above equipment, and if so, in what combination/configuration?

c. Do you use a different configuration for joint operations, combined operations, or secure operations than you do for nonsecure, Intra-Marine Corps operations, and if so, please list the configuration and its technical specifications (i.e. baud rates, terminal settings, unique cables, etc.)?

d. If you are using any equipment not listed above, what brand is it, and what unique capabilities support your requirements.

2. The software being used most widely in the Marine Corps is PROCOMM.

a. If you are currently using PROCOMM, what parameters are you using, and what specific lessons learned have you encountered?

b. If you are using different software packages or additional software, please list them and state what functions they perform.

3. Information on which USMC and/or local SOP's, policies, orders, etc., are being used for technical, procedural guidance and instruction is requested.

a. Do you find MCO P.5233.1 useful?

b. Do you use the IRM publications to assist these operations, and if so, which ones do you find most valuable?

c. Do you have any local publications that provide guidance in this arena, and if so, what are their designators and titles?

d. Please indicate if there are any USMC or local references that you have found to be inadequate in supporting mission requirements?

4. What suggestions or recommendations would you make in standardizing:

a. Hardware

b. Software

c. Procedures

Please support any recommendations with technical capabilities that fulfill currently unfulfilled requirements.

APPENDIX 2 - ACRONYMS

4TH DWT	4th Marine Division-Wing Team
ACE	Air Combat Element
ADP	Automatic Data Processing
AIS	Automated Information System
C2	Command and Control
C4	Command, Control, Communications and Computers
CDPA	Central Design and Programming Activity
CE	Command Element
CG	Commanding General
COS	Communication Officer School
CSS	Computer Science School
CSSE	Combat Service Support Element
EUCE	End User Computing Equipment
FMF	Fleet Marine Force
FMFLANT	Fleet Marine Force Atlantic
FMFPAC	Fleet Marine Force Pacific
GCE	Ground Combat Element
GMF	Ground Mobile Forces
HF	High Frequency
HQMC	Headquarters Marine Corps
IRM	Information Resource Management
ISMO	Information Systems Management Office
JTC3A	Joint Tactical Command, Control, Communications Agency
LAN	Local Area Network
LOS	Line-of-Sight
MAGTF	Marine Air Ground Task Force
MCO	Marine Corps Order
MCRDAC	Marine Corps Research Development Acquisition Command
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MOS	Military Occupational Specialty
PC	Personal Computer
ROC	Required Operational Capability
SATCOM	Satellite Communications
SOP	Standing Operating Procedures
SWA	Southwest Asia
UHF	Ultra High Frequency
USMC	United States Marine Corps
VHF	Very High Frequency
WAN	Wide Area Network

APPENDIX 3 - GLOSSARY

Architecture: A series of configuration parameters that comprise a standard method and system of interfaces in order to make pieces of a system integrate as a whole.

Automatic Data Processing Systems: Any collection of hardware and software that passes, routes and processes data.

BANYAN VINES: The Network Operating System (NOS) adopted as the Marine Corps standard. A NOS controls all operations and clients on a LAN, as well as interfacing with external devices.

C4 Supporting Establishment: Those USMC organizations external to the FMF that are involved in C4 research, development, acquisition, and planning.

Data Communications: The passing and routing of data and its control parameters between two devices.

ENABLE OA: An integrated (word processing, database management, spreadsheet, telecommunications) propietary software package.

Encryption Devices: Communications security equipment used to protect C4 transmissions from being disclosed to unauthorized personnel.

FMF-EUCE: A family of Tempest certified, ruggedized, field microcomputers with specific Marine Corps requirement driven features.

Local Area Network: Two or more microcomputers connected to a central device known as a server which controls the flow of information and the sharing of devices.

Microcomputer: Any processing device centered around a processing chip which can accept input, manipulate data, and produce output.

Multichannel Radios: Communications systems that allow several single communications channels to be electronically combined and sent over a single transmission path.

Personal Computers: Any microcomputer that can be purchased on the open market. Normally used for low scale automation.

PROCOMM (PROCOMM PLUS): A propietary telecommunications software package.

Satellite Radio: Communication systems that use satellites orbiting in space to connect ground communications systems that are not physically co-located.

Tactical Switches: Communication systems that enable multiple users of a C4 system to communicate with other members of the C4 network.

Troposcatter Radios: A radio system which uses the tropospheric layer of the earth atmosphere as a radio frequency transmission path.

Line-of-Sight Radio: Radios that require transmission path that are within electronic line-of-sight of each system.

Wide Area Network: Two or more networks connected server to server.

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