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THESIS

ANALYSIS OF MARINE CORPS EFFORTS IN THE PURSUIT OF THE JOINT BLUE FORCE SITUATIONAL AWARENESS CAPABILITY

by

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March 2013

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BLUE FORCE SITUATIONAL AWARENESS CAPABILITY

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LIST OF ACRONYMS AND ABBREVIATIONS

AAO	Approved Acquisition Objective
AEC	Army Evaluation Center
APS	Army Pre-Positioned Stocks
ATEC	Army Test and Evaluation Command
ATO	Approval to Operate
BC	Battle Command
BCT	Brigade Combat Team
BFT	Blue Force Tracker
BMC	Brigade Modernization Command
C2	Command and Control
C2PC	Command and Control Personal Computer
CCIR	Commanders' Critical Information Requirements
CCJO	Capstone Concepts for Joint Operations
CD&I	Combat Development and Integration
CFLCC	Coalition Forces Land Component Command
CM	Configuration Manager
COC	Combat Operations Center
COE	Concept of Employment
COCOM	Combatant Command
CONUS	Continental United States
COP	Common Operating Picture
CS	Capability Sets
CSTF	Central Testing Support Facility
CT	Customer Test
DAA	Designated Approval Authority
DACT	Data Automated Communication Terminal
DAGR	Defense Advanced Global Positioning System Receiver
DC	Deputy Commandant
D-DACT	Dismounted Data Automated Communication Terminal
DFSA	Digital Fires Situational Awareness
DIACAP	DoD Information Assurance Certification and Accreditation Process
DIP	DIACAP Implementation Plan
DoD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
DOTMLPF	Doctrine, Organization, Training, Material, Leadership, Education, Personnel, and Facilities
DREN	Defense and Research Engineering Network
DT	Developmental Test

EPLRS	Enhanced Position Location Reporting System
FBCB2-BFT	Force XXI Battle Command Brigade and Below Blue Force Tracker
FoS	Family of Systems
FSR	Field Service Representative
FT	Field Test
FUE	Field User Evaluation
FY	Fiscal Year
GCCS-A	Global Command and Control System-Army
GCCS-J	Joint Global Command and Control System
GWOT	Global War on Terrorism
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HPC	High-Performance Computing
IA	Information Assurance
IATO	Interim Approval to Operate
ICEP	Interoperability Certification Evaluation Plan
ID	Infantry Division
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IOW	Intelligence and Operations Workstation
ISO	In Support Of
ISP	Information Support Plan
JBC-P	Joint Battle Command-Platform
JBFSA	Joint Blue Force Situational Awareness
JCR	Joint Capability Release
JITC	Joint Interoperability Test Center
JTA	Joint Technical Architecture
JTCW	Joint Tactical COP Workstation
JROC	Joint Requirements Oversight Council
JROCM	Joint Requirements Oversight Council Memorandum
KPP	Key Performance Parameters
LAN	Local Area Network
LOC	Letter of Clarification
LOS	Line of Sight
LUT	Limited User Test
M-CSL	Maneuver Control System-Light
M-DACT	Vehicle-Mounted Data Automated Communication Terminal

MCNOSC	Marine Corps Network Operations and Security Center
MCT	Message Conformance Test
MDL	Mission Data Loader
MAGTF	Marine Air-Ground Task Force
MARCENT	Marine Corps Central Command
MARCORSYSCOM	Marine Corps Systems Command
MAW	Marine Aircraft Wing
MCB	Marine Corps Base
MCOTEA	Marine Corps Operational Test and Evaluation Activity
MCTSSA	Marine Corps Tactical Systems Support Activity
MEF	Marine Expeditionary Force
MOA	Memorandum of Agreement
MROC DM	Marine Requirements Oversight Council Decision Memorandum
MTX	Miniature Transmitter
NIE	Network Integration Event
NOC	Network Operations Center
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
ORD	Operational Requirements Document
OT	Operational Test
OT&E	Operational Test and Evaluation
PEO C3T	Program Executive Office Command Control and Communications Tactical
PDA	Program Decision Authority
PIED	Programmable In-Line Encryption Device
PLI	Position/Location Information
PMO	Program Management Office
POA&M	Plan of Action and Milestones
POA	Plan of Action
POR	Program of Record
RF	Radio Frequency
RRE	Risk Reduction Event
SA	Situational Awareness
SA/C2	Situational Awareness/Command and Control
SAR	System Assessment Report
SCR	Software Change Request
SDSA	Self-Descriptive Situational Awareness
SED	Software Engineering Directorate
SEP	System Evaluation Plan
SER	System Evaluation Report

SIP	System Identification Profile
SIPRNET	Secret Internet Protocol Router Network
SoSI	System of Systems Integration
SPAWAR	Space and Naval Warfare Systems Center
SRR	Systems Requirement Review
SSAT	System Subsystem Acceptance Testing
SW	Software
T&E	Test and Evaluation
TACC	Tactical Air Command Center
TDCN	Tactical Data Communications Network
TDN	Tactical Data Network
TEIPT	Test and Evaluation Integrated Product Team
TEMP	Test and Evaluation Master Plan
TIGR	Tactical Ground Reporting
TOC	Tactical Operations Center
TTP	Tactics, Techniques, and Procedures
USMC	U.S. Marine Corps
USSOCOM	United States Special Operations Command
UTO	Unit Task Organization
UUNS	Urgent Universal Needs Statement
VMF	Variable Message Format
WIPT	Working Integrated Product Team

I. INTRODUCTION

A. JOINT FORCE FUNDAMENTALS OF THE UNITED STATES ARMED FORCES

Joint Publication 1 (Joint Chiefs of Staff, 2007) is the keystone document that establishes doctrine for joint operations. The document describes the present-day battlefield as ever changing and the United States military's adaptability to counter its adversaries. The document describes the modern-day battlefield as "extremely fluid with changing alliances and new threats. The United States military is designed to operate seamlessly in that environment, addressing a variety of challenges, both traditional and irregular" (Joint Chiefs of Staff, 2007, p. i). The fundamental concept in maintaining the advantage against all challengers is fighting as a unified force. The ultimate goal of the unified force is to increase the effectiveness and lethality of available military might. The Goldwater-Nichols Act of 1986 was instrumental in improving several critical areas within the Department of Defense (DoD). One area was focusing the Services from independent operations to joint interest operations. One of the key objectives was to provide for more efficient use of the DoD's resources (Goldwater-Nichols Department of Defense Reorganization Act, 1986, p. 4). Joint Publication 1 (Joint Chiefs of Staff, 2007) describes joint operations as "team warfare." Consequently, "the synergy that results from the operations of joint forces maximizes the capability of the force. The advantage of a joint team extends beyond the battlefield and across the range of military operations" (Joint Chiefs of Staff, 2007, p. 1–2).

B. PROBLEM STATEMENT

The United States military maximizes its combat power by fighting as a joint force. However, within the shared battlespace the Services operate stovepipe systems to provide tactical situational awareness of their units. These systems are not interoperable, which significantly increase the potential for fratricide occurrences. The Marine Corps initiated efforts to comply with the Joint Requirements Oversight Council (JROC, 2004) convergence directive by altering the fielding strategy of the Data Automated Communication Terminal (DACT) variants, which was its primary digital situational

awareness/command and control (SA/C2) system. Additionally, in order to communicate with Army units sharing the battlespace in support of the Global War on Terrorism (GWOT), the Marine Corps rapidly procured and fielded the Army's SA/C2 solution, Force XX1 Battle Command Brigade and Below—Blue Force Tracker (FBCB2-BFT). Consequently, the Marine Corps relies on the Army's infrastructure and resources to operate the systems. The Army maintains the L-Band satellite network, architecture, and resources required to operate FBCB2-BFT within the current Global War on Terrorism (GWOT) region. However, the resources are limited outside that region and may be unavailable for Marine forces conducting traditional expeditionary missions. Moreover, the planned upgrade to the FBCB2 system, designated as Joint Capability Release (JCR), represents Increment I towards interoperability, but its software and hardware capabilities have not proven fully capable of meeting Marine Corps operational requirements. Additionally, reasonable concerns exist in developing, testing, and concept of employment (COE) for Increment II, Joint Battle Command-Platform (JBC-P). Both enhanced capabilities are essentially designed towards the Army Battle Command System (ABCS). They mandate an overly complex architecture that is dependent on organic ABCS resources that do not reside within the Marine Air-Ground Task Force (MAGTF) architecture. Furthermore, testing revealed an overarching lack of a reliable network for SA/C2.

C.   PURPOSE

The purpose of the thesis is to provide an analysis of Marine Corps efforts to comply with the JROC convergence directive for a Joint Blue Force Situational Awareness (JBFSA) capability for ground forces. The Army's FBCB2-BFT solution was first fielded to Marine Corps units during preparation for Operation Iraqi Freedom. Since that time, the system has been widely fielded throughout the Marine Corps. The system has clearly been a force multiplier in the combat zone and as a result the Marine Corps SA program of record, DACT, has been deemed obsolete by leadership.

This research provides insight into the actions taken by the Marine Corps towards convergence. This research highlights complexities of this joint effort, to include

imbalance in resources, priorities, and capabilities between the Army and Marine Corps. Additionally, this research provides some considerations and recommendations for further study.

D.   RESEARCH QUESTION

The primary intent of the JROC is to reduce redundancy and increase commonality between the Services. This research will address the primary question; why are the current convergence efforts not as favorable towards Marine Corps implementation as the Army? In addition, how important is it for all players to have equal influential power and resources on joint efforts?

E.   METHODOLOGY

The Marine Corps and Army have separate requirements documents for their respective digital SA/C2 systems. These requirements and corresponding parameters were used to evaluate the initial new capability, which proved to be impractical. An endeavor was undertaken to develop a joint Capabilities Development Document (CDD) for the objective solution. The research methodology focuses on evaluating the directive to develop and field a JBFSA capability at all echelons. This was accomplished through a quantitative content analysis of program-related materials. Data collection was achieved via confidential in-person interviews with personnel from the Army and Marine Corps program offices. The interviews were conducted at the individual program office site and were recorded, transcribed, and then analyzed for relevance and accuracy. The participants interviewed provided adequate factual information on the history and ongoing efforts, but opinions were not solicited. Additional data was collected through analysis of test reports, Joint Capabilities Integration and Development System documents, and other related program documents for amplifying information.

F.   ORGANIZATION OF THE THESIS

Chapter II, Background, provides a brief history of the Services' specific digital SA capabilities, oversight council directives that initiated Marine Corps involvement with the Army's platform and dismounted SA solution, and the Marine Corps' Blue Force Tracker Family of Systems program.

Chapter III examines the incremental approach to reach SA convergence. It also provides analysis of each increment's capabilities and test and evaluation efforts.

Chapter IV provides considerations from the analysis of Increment I and Increment II.

Chapter V provides recommendations for further research to better determine Increment II feasibility of fielding to the Marine Corps and analysis of Blue Force Tracker use in Marine Corps expeditionary operations other than war.

II. BACKGROUND

This chapter provides a brief history of the Services' specific digital SA capabilities, the oversight council directives that initiated Marine Corps involvement with the Army's platform and dismounted SA solution, and the Marine Corps' Blue Force Tracker Family of Systems program.

The U.S. Marine Corps and Army have traditionally employed diverse, friendly force tracking capabilities to enhance their respective battlefield situational awareness. At the onset of Operation Iraqi Freedom (OIF), a number of stovepipe systems were operated by each Service. The various systems were extremely reliable and effective but not interoperable. Each system transmitted its respective form of position/location information (PLI) data to the joint task force level, via the Joint Global Command and Control System (GCCS-J) server, which then populated the higher echelon common operating picture (COP). At the lower echelon, the Marine Corps used Command and Control Personal Computer (C2PC) and the Army used Maneuver Control System-Light (MCS-L) 1 to display the COP (Stengrim, 2005, p. 4). The systems were incapable of sharing information directly due to different architectures (Stengrim, 2005, p. 4).

A. MARINE CORPS DIGITAL SITUATIONAL AWARENESS AND COMMAND AND CONTROL CAPABILITIES

At the initial stage of OIF, DACT and the Miniature Transmitter (MTX) were the primary digital SA/C2 tactical systems employed by Marine forces.

The DACT is the Marine Corps' program of record for tactical Blue Force tracking and situational awareness. DACT provides a two-way path (send and receive) for PLI, messaging, and chat. The DACT operates on the Enhanced Position Location Reporting System (EPLRS) classified network that is limited to line-of-sight (LOS) terrestrial transmission. The DACT capability was fielded as vehicle-mounted (M-DACT) and hand-held dismounted (D-DACT) variants. The following are excerpts from the *DACT Operational Requirements Document (ORD) Change 3* (Marine Corps Combat

Development Command, 2001), signed January 8, 2001, that explains the requirements,

key performance parameters (KPP), and related operational parameters for the system.

> The DACT shall provide automated communications support for commanders in tactical operations. This automation expedites existing manual decision-making and executing processes, in addition to the processes associated with planning, processing combat information, and the exercise of tactical direction. The DACT will be used to transmit, receive, store, retrieve, create, modify, and display map overlays and commanders' critical information requirements (CCIRs). The DACT will exchange this information with other users of the Tactical Data Network (TDN). Other units' positions, coordinates of user-designated points, pre-formatted messages and free-text information are CCIRs managed by the DACT. Tactical communications such as radio network and local area networks (LANs) will be the systems that enable DACT generated data to be transmitted between users. Using global positioning information, and digital maps resident on the removable disk, the DACT will provide a screen display of its own position location. (p. 1) …

> The KPPs for the DACT consist of the ability to display a map with GPS derived position location information (PLI) [Interoperability KPP] represented on the map, the ability to transmit PLI generated by the DACT to a C2PC Gateway and receive PLI from a C2PC Gateway, and transmit and receive those messages in Appendix D. The dismounted DACT shall be interoperable with UHF, VHF and HF voice/data radios that are man-portable and mounted in tactical/armored vehicles. This maintains the requirement to exchange preformatted and free text messages on point-to-point and netted doctrinal radio nets. (Marine Corps Combat Development Command, 2001, p. 3)

The DACT-generated PLI data is transmitted to GCCS-J by the Intelligence and

Operations Workstation (IOW) functioning as a C2PC Gateway located in the

commander's Combat Operations Center (COC). Figure 1 depicts the DACT System

Interface Diagram.
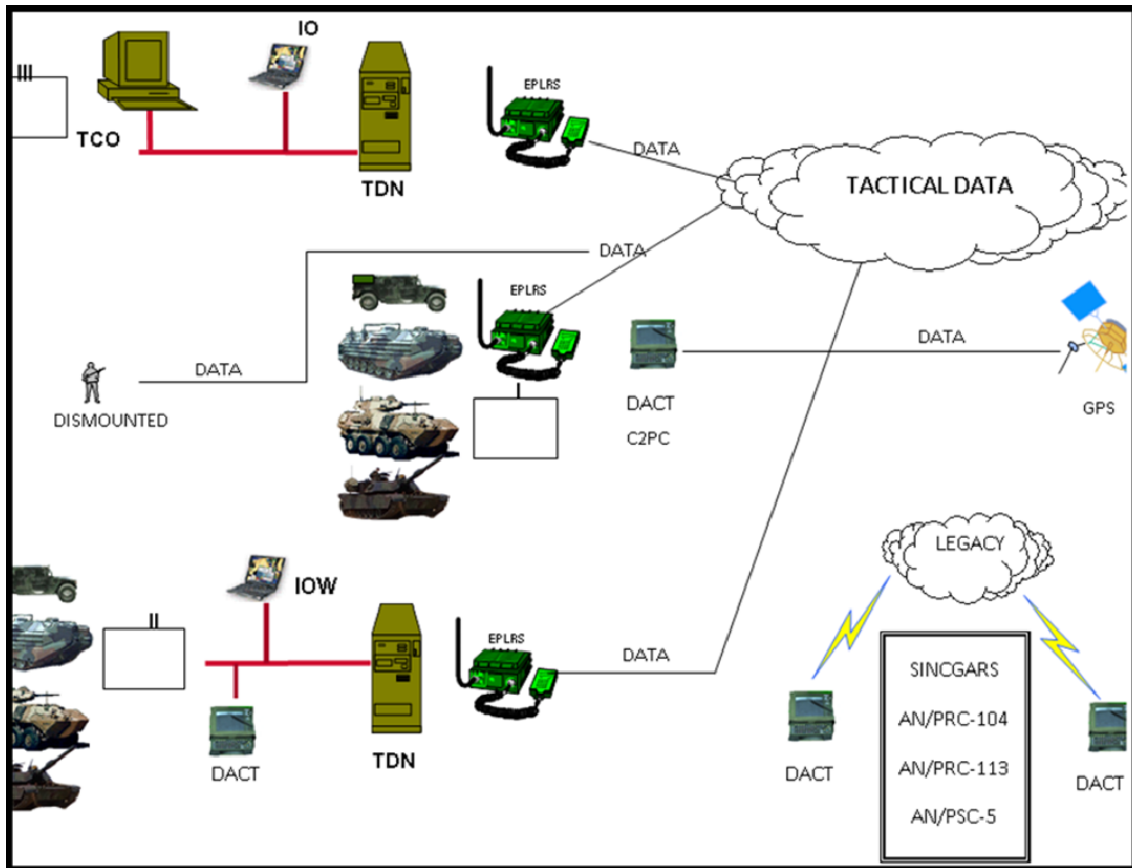
Figure 1.   DACT System Interface Diagram (From Marine Corps Combat Development Command, 2001, p. 34)

The MTX is a beacon limited to one-way communication that provides the capability to identify position and track progress (Stengrim, 2005, p. 5). The MTX primarily supported Marine Corps Special Operations Command ground forces. However, a limited number of devices were provided to the Marine Aircraft Wing (MAW) to support rotary platforms operating in the theater of operations. The device transmits PLI only; it has no messaging function. The position information generated by devices mounted on air assets was pushed to the Marine Tactical Air Command Center (TACC) via C2PC. The MAW operated the MTX as a short-term solution until the Aviation BFT fielding.

The DACT and MTX limitations disqualified both systems as viable solutions towards JBFSA. Only a limited number of Marine Corps forces had either capability at the onset of OIF. Figure 2 depicts M-DACT, D-DACT, and MTX systems.

Figure 2.   M-DACT, D-DACT, and MTX Systems (From Product Manager, Digital Fires Situational Awareness [DFSA], 2010)

B.   U.S. ARMY FBCB2-BFT

The Army's program of record for digital Blue Force tracking and situational awareness is FBCB2. FBCB2 provides a two-way (send/receive) path for PLI and is messaging and chat capable. FBCB2 was developed in two different versions to utilize

available EPLRS and L-Band satellite networks, FBCB2-EPLRS and FBCB2-BFT, respectively. The L-Band network enables flexible and beyond-line-of-sight communications. The satellite network utilizes commercial encryption. Consequently, FBCB2 has a National Security Agency–approved classification of sensitive but unclassified. The FBCB2 Program Management Office (PMO) is a component of the Program Executive Office Command Control and Communications Tactical (PEO C3T). FBCB2-BFT is a multi-Service, Army Acquisition Category 1C, post-Milestone C program.

The remainder of this section relies heavily on Conatser and Grizio's (2005) Master of Business Administration professional report. The report provides a comprehensive analysis on the genesis, history, and employment of FBCB2 within the Army.

The FBCB2 capabilities had a modest beginning.

In 2000, the Balkan Digitization Initiative effort in both Bosnia and Kosovo was the genesis for BFT. About 600 systems had been used with the commercial Fieldworks/Kontron and Ku Band using a reduced functionality FBCB2 software Version 3.1. The maturity level of FBCB2 software provided an effective Graphic User Interface (GUI), a variety of functional command and control messaging capabilities, a robust mapping capability, graphic control measure development and symbology. Finally, hardware development under the FBCB2 program baseline and procurement under Low Rate Initial Production (LRIP) provided a partial hardware solution to install. The ability to leverage L-Band transceivers from a pre-existing Movement Tracking System contract was the final hardware component required to complete the system. (p. 35)

The FBCB2 system was battle tested, which led to follow-on deployment in support of Global War on Terrorism.

The initiative that culminated with the development and fielding of the FBCB2-BFT system actually evolved over time and was one of three technical initiatives to increase command and control in the theater of operations. The broad effort to support United States Central Command (CENTCOM) began in February 2002, and was threefold, as follows: 1) Correct current communications and network problems within the theater of operations, 2) Design and build a command center for the integration of

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all fielded ABCS Systems, and 3) Field 200 "tracking systems" within the Afghanistan theater of operations. (Conatser & Grizio, 2005, p. 33)

System fielding to combat units in support of Global War on Terrorism operations was expedited. Leadership realized it was vital for some level of commonality between the multinational force to increase SA and reduce the occurrences of friendly fire. Additionally, FBCB2 increased combat efficiency.

> The 2d Brigade Combat Team (BCT), 3d Infantry Division (ID) was deployed to Kuwait in September and October 2002 for Operation Desert Spring (formerly Intrinsic Action) and was the first unit to receive FBCB2-BFT. What followed was an unprecedented fielding of FBCB2-BFT systems in Army Pre-positioned Stocks (APS) and unit platforms in theater, as well as on unit platforms at home station prior to their deployment. This resulted in simultaneous installation of more than 1,000 systems on three continents, spanning six countries, including 20 states within the United States, and involving more than a dozen Army, Joint, and Coalition formations. Throughout this process, over 4,000 soldiers were trained. The system was provided to the 3d ID (M); 1st Armored Division; 101st Air Assault Division; 82d Airborne Division; 2d Light Cavalry Regiment; 3d Armored Cavalry Regiment; 173d Airborne Brigade; 3d Brigade, 4th ID (M); 75th Exploitation Task Force; 11th Aviation Brigade; 12th Aviation Brigade; 1st Marine Expeditionary Force (MEF); and the 1st United Kingdom Armored Division, as well as selected V Corps and Coalition Forces Land Component Command (CFLCC) platforms and command posts. (p. 38) …

> FBCB2-BFT provided Operation Enduring Freedom and Iraqi Freedom commanders and units a remarkable capability that greatly enhanced their combat effectiveness. FBCB2-BFT enabled the ability to navigate under limited visibility conditions, to move rapidly over great distances and synchronize unit movement, and to communicate both vertically and horizontally over extended distances. Unit Commanders' initial confidence in the system varied. It is difficult to embrace a new system and discard tried and true practices with which they and their units were familiar and confident. In some cases, units were forced to accept, and came to rely on, FBCB2-BFT when traditional equipment and accepted practices proved insufficient during the campaign. During Operations Enduring Freedom and Iraqi Freedom, the level of FBCB2-BFT's effectiveness and individual unit "digital learning curves" varied after receiving the system. Units that quickly embraced the new technology and placed command emphasis on its training and employment, benefited early on in the campaign. Others that either received the capability late in the

fielding process or did not quickly embrace it, were forced to adjust during the conflict. (Conatser & Grizio, 2005, p. 41)

The Army strategically fielded the FBCB2-BFT variant, as compared to the EPLRS variant, in greater numbers among its tactical combat units in Iraqi and Afghanistan. Army senior leadership understood the scope of the operating area and the nature of the environment in which GWOT operations would predominantly take place. Combat operations would be conducted in austere, restricted, and vast areas where combat units would exceed the LOS limits of the EPLRS network. Satellite communications are not limited to the same restrictions of the EPLRS network. Both FBCB2 variants were mounted exclusively on High Mobility Multipurpose Wheeled Vehicle (HMMWV) platforms.

1.   FBCB2 Architecture

The Network Operations Center (NOC) is the central point in the FBCB2 network. FBCB2-generated digital data is pushed to the NOC via L-Band Satellite and ground station. The NOC integrates and disseminates to all active BFT systems via reverse path.   FBCB2 uses commercial type encryption. Consequently, the network is a one-way feed to the joint environment. FBCB2 PLI is transmitted to GCCS-J through a radiant mercury guard located at the NOC.   Marine Corps COC pull data from GCCS-J via JTCW. Marine Corps PLI is classified and cannot transmit to FBCB2. The radiant mercury guard is there to prohibit secret information from passing to the network. Figure 3 depicts the FBCB2 data flow.
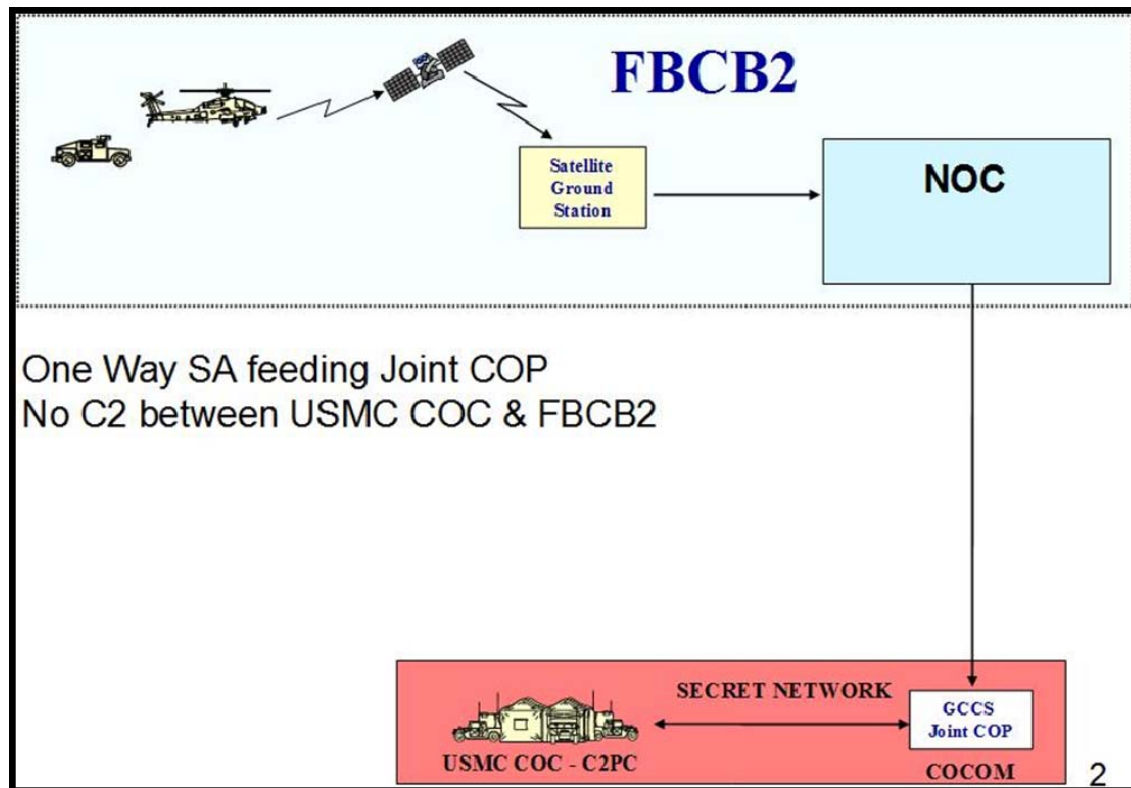
Figure 3.   FBCB2 Data Flow (From Product Manager, DFSA, 2010)

C.   OVERSIGHT COUNCIL DIRECTIVES

Fratricide has always existed on the battlefield. Studies have shown that technological advances have significantly reduced occurrences. In the initial stages of OIF, fratricide accounted for about 11% of United States battlefield deaths, as compared to 24% during Desert Storm over a decade earlier (Cahlink, 2004). It was widely understood that the lack of battlefield SA was a major factor for the occurrences. In June 2003, the JROC ordered the development of the framework to enhance combat effectiveness and improve interoperability between the ground forces (JROC, 2003). JROC Memorandum (JROCM) 161–03 (JROC, 2003) requested the Army and USMC provide an integrated briefing to the JROC discussing the way ahead towards converging efforts for achieving a single Joint capability. In 2004, to ensure interoperability between the Army and USMC, JROCM 163–04 (JROC, 2004) approved the Marine Corps and Army convergence plan to adapt a single capability. The JROC approved the plan to make FBCB2 the capability baseline, assigned the U.S. Army as the lead Service to

develop the JBFSA capability, and directed the Marine Corps to adopt FBCB2-BFT for its platform and dismounted applications (JROC, 2004). Marine Requirements Oversight Council (MROC) Decision Memorandum (DM) 41–2004 (MROC, 2004), dated June 2, 2004, establishes the MROC concurrence with the recommendation to migrate to the FBCB2 baseline as the Marine Corps refreshes its dismounted and mounted devices. However, the MROC desired for the Marine Corps to "remain independent and maintain its own communication architecture" (MROC, 2004).

D.   MARINE CORPS AND FBCB2-BFT

In late 2002, Marine Corps and Army tactical units had limited methods to readily communicate with each other. To prepare for OIF, I Marine Expeditionary Force submitted an Urgent Universal Needs Statement (UUNS) to acquire 50 vehicle-mounted FBCB2-BFT systems to communicate with Army ground units sharing the battlespace. The units immediately recognized the advantages of the FBCB2-BFT capability as a force multiplier. Marine forces' operational requirement for FBCB2-BFT rose significantly after the onset of the GWOT. The system provided maneuver forces with the ability to communicate and exchange critical combat information and messages with adjacent units utilizing same system. Subsequent to the initial UUNS, MARCORSYSCOM responded to multiple UUNS and initiatives requesting FBCB2-BFTs for deployed units.

- March 2003, UUNS requested 267 systems to support convoy operations.
- January 2004, UUNS requested 100 systems to directly support combat operations.
- September 2004, UUNS requested 26 systems to directly support combat operations.
- FY05 Supplemental Initiative, to procure 2600 systems to mitigate shortfalls of forces supporting GWOT.
- FY05 Marine Corps Forces Central Command (MARCENT) requirement, requested 1826 systems as part of a multisystem integrated effort for M1114 HMMWVs supporting OIF.

In November 2008, representatives from the BFT PMO and support contractors deployed to locations in Kuwait and Afghanistan to conduct a field assessment of the Marine Corps' BFT effort in support of Operation Enduring Freedom (OEF) ramp up. The objective of the trip was to improve the logistical and operational support to Marine forces. The assessment concluded that the Marine Corps was a burden on the Army's in-theater contracted logistical support network and continued support was unsustainable for the long term. A Marine Corps BFT Service Center was established in Kuwait to support MARCENT combat requirements for both the Iraq and Afghanistan theaters. Additionally, all BFT-equipped vehicles transitioning from Iraq to Afghanistan were refurbished at the service center in order to upgrade the combat strained systems. Moreover, plans were coordinated with stakeholders, including Marine Corps Logistic Command, to establish BFT Field Service Representative (FSR) sites onboard Camp Kandahar, Camp Leatherneck, and follow-on forward operating bases.

At the height of combat operations, the Marine Corps had 19 dedicated BFT FSRs. The FSRs were strategically positioned aboard each major Marine Corps operating base within theater and in the continental United States (CONUS). The FSR conducted maintenance, installations, and over-the-shoulder training to all Marine Corps units utilizing BFT systems.

1. Memorandum of Agreement with Stakeholders

A Department of the Army memorandum of agreement (MOA; Department of the Army, Program Executive Office Command, Control, and Communications Tactical [PEO C3T], 2004) between the Army, the Marine Corps, and the United States Special Operations Command (USSOCOM) "established an enduring partnership among the Services and solidified the roles directed by the JROC for achieving a single, joint capability" (p. 2). Additionally, the MOA recognized program Manager (PM), FBCB2 as servicing agency and allowed the Marine Corps access to existing Army contracts to procure and support FBCB2-BFT. The Army was able to economically procure FBCB2-BFT systems and services by combining the requirements of all Services and subsequently purchasing in economically advantageous quantities. The result was a

decrease in the per-unit cost and substantial savings to the government, savings that could not have been realized through smaller purchases made independently. Both the Army and the Marine Corps realized cost avoidance by combining their respective FBCB2-BFT system requirements, enabling both Services to benefit from the quantity discounts provided in Army contracts. Moreover, each saved additional funds by conducting joint system integration and testing and combining logistical services support, thereby avoiding the cost duplication that inevitably occurs when like items are procured separately. More important, utilizing already established Army contract vehicles enabled the Marine Corp to efficiently and expeditiously meet its FBCB2-BFT requirements in support of home station training and overseas contingency operations.

2. Marine Corps BFT Program Management Office

For the Marine Corps, the FBCB2-BFT capabilities are referred to as the BFT Family of Systems (FoS). The BFT FoS is a product line within the JBC-P FoS portfolio. The JBC-P FoS is defined as a weapon system program with a product line made up of systems and products associated with the BFT FoS (Increment I) and JBC-P (Increment II). The PMO resides within MARCORSYSCOM. The BFT FoS is the primary digitized battlefield COP component of the Marine Air-Ground Task Force (MAGTF) C2 infrastructure for echelons below the battalion level. The BFT FoS is comprised of the vehicle-mounted BFT, the dismounted Tactical Operations Center (TOC) Kit, and FBCB2 software. In addition to the systems procured and delivered in support of GWOT, to date the BFT PMO has procured 4,000 FBCB2-BFT systems. Supporting combat zone requirements is a priority, but the PMO made the BFT FoS readily available to all Marine Corps units in CONUS, Hawaii, and Okinawa. The systems supported home station readiness and pre-deployment training requirements. Figure 4 depicts the BFT FoS systems.
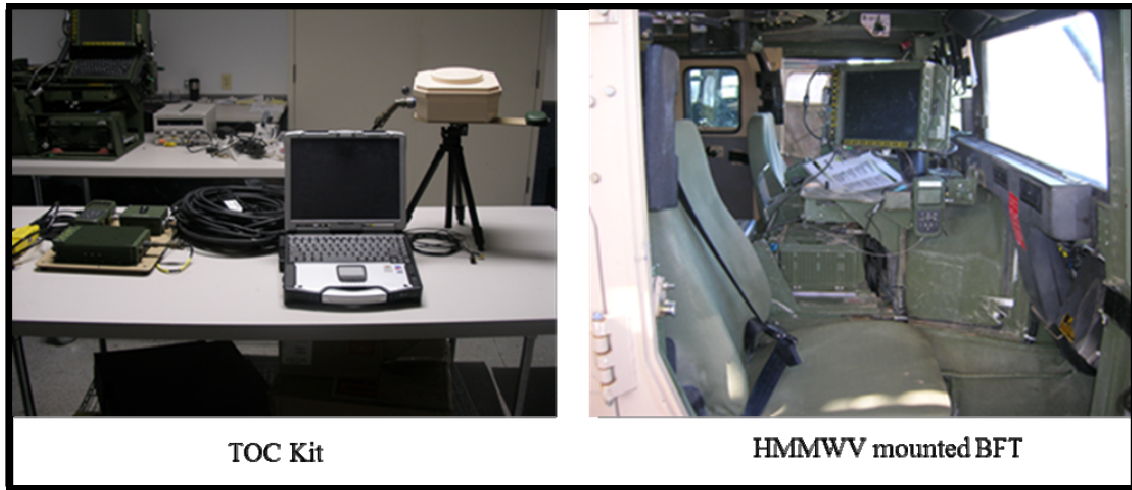
Figure 4.   TOC Kit and HMMWV Mounted BFT (From Product Manager, DFSA, 2008

a.   Blue Force Tracker

The BFT system consists of the JV-5 computer, 12-inch display, interconnecting cables, MT-2011 series L-Band satellite transceiver, a Defense Advanced Global Positioning System Receiver (DAGR), and an installation kit appropriate to the host vehicle type. The Deputy Commandant (DC), Combat Development and Integration (CD&I; 2007) *Letter of Clarification* (*LOC*) established the interim procurement BFT objective at 8,549. The objective was based on emerging requirements and to support the Marine Corps' convergence strategy (CD&I, 2007). In both OIF and OEF theaters, BFT systems were installed on various platforms, including the HMMWW family of vehicles (FoV), Light Armored Vehicle FoV, Medium Tactical Vehicle Replacement, Logistics Vehicle System Replacement, and M88 Recovery Vehicle. Figure 5 depicts the BFT core components.

Figure 5.   BFT Core Components (From Product Manager, DFSA, 2008)

b.   Tactical Operations Center Kit

The TOC Kit is the BFT variant that brings blue force SA capability into the MAGTF COC. The TOC Kit consists of a CF-30 laptop, MT-2011, DAGR, and interconnecting cables. The DC, CD&I *LOC* (2007) established the interim procurement TOC Kit objective at 562.

c.   FBCB2 Software

The FBCB2 software is the initial baseline software that enables ground units to exchange large volumes of C2, SA, and PLI. Additionally, the software enables operators to send and receive C2 messages and overlays. The current fielded version is FBCB2 6.5.

E. SUMMARY

This chapter provided the reader with background information on Marine Corps and Army specific digital SA capabilities and the oversight council directives that mandated convergence.

III. INCREMENTAL APPROACH

This chapter will describe the incremental approach strategy to achieve SA convergence. Additionally, it will provide an analysis of each increment's capabilities and test and evaluation efforts.

A. INCREMENT I—JOINT CAPABILITIES RELEASE

1. Overview

JCR is the upgrade to the FBCB2 system. The software developer is Northrop Grumman, in Carson, CA. Initial fielding of FBCB2 occurred over a decade ago, but this rugged system still remains the primary digital battlefield tactical SA/C2 solution. JCR brings enhanced capabilities that are force multipliers to the warfighter: Two of these capabilities address critical issues that exist in the current system; latency and information security. The improved capabilities include a new transceiver to support a high-speed satellite communications network and a programmable in-line encryption device that supports Type 1 data encryption. The PM FBCB2 JCR Test and Evaluation Strategy briefing (U.S. Army Office of the Program Manager, FBCB2 [PM FBCB2], 2010) states that the software's primary purpose is to "allow forces to simultaneously mount, execute, and recover from operations and synchronize all of the operating systems" (p. 8). Additionally, the briefing states JCR improves C2 "while on the move by receiving and updating the situation awareness via net-centric linkages between Tactical Operational Centers (TOCs) and net-centric links between mounted and future JBC-P systems" (PM FBCB2, 2010, p. 8). In fiscal year (FY) 2011, the Army began fielding JCR to operational units in CONUS and in the Republic of Korea. The Marine Corps will begin fielding to units during their pre-deployment training, in the third quarter of FY2013. The JCR software version 1.3.1.4 is the official Marine Corps' fielding candidate. Moreover, JCR represents the interim solution (Increment I) towards JROC-directed SA convergence.

2. Capabilities

a. BFT 2 Network/Transceiver

The new faster satellite network is known as BFT 2. The current system is plagued with latency and its transceiver is half-duplexed. Consequently, friendly position updates take minutes and send/receive messages are limited to single transmission (one way at a time). The BFT 2 network provides 10 times the bandwidth as compared to the existing network. The new transceiver is full-duplex and enables simultaneous send/receive transmissions. With its enhanced capabilities, the system is capable of updating friendly positions and transmits messages in seconds. Therefore, the warfighter will be able to share more vital battlefield information to more users and do it faster. Additionally, the increased data capacity improves the accuracy of friendly SA and the depiction of reported enemy locations, obstacles, and known battlefield hazards. The following excerpt is from the BFT 2 PowerPoint (PM FBCB2, 2011) brief that provides more details on BFT 2.

> The BFT 2 upgrade program will enhance performance for BFT transceivers in both the ground and air domains. The next generation BFT 2 network provides near global coverage (70°N to 70°S) and operates over geosynchronous L-Band satellites (e.g., Inmarsat-3, Inmarsat-4, Artemis, and Thuraya). The BFT2 network consists of two active and one backup Satellite Network Control Centers (SNCC), up to eight (8) Satellite Ground Stations (SGS), and supports up to 200,000 remote Ground Vehicular Transceivers and Aviation Transceivers. Each SNCC connects with the SGSs through a redundant terrestrial/Very Small Aperture Terminals (VSAT) network. A SGS interoperates with BFT-2 Transceivers in a star topology. A BFT 2 air interface designed to meet capacity and latency requirements allows the SGS and BFT 2 Transceivers to exchange Joint Variable Message Format. (PM FBCB2, 2011, p. 3)

b. KGV-72 Encryption Device

The KGV-72 is a new programmable in-line encryption device (PIED) that encrypts BFT-generated data Type 1, under the classification "secret." The device resides between the system processor and GPS transceiver. The KGV-72 is the solution to provide the warfighter a seamless, classified network. Additionally, the KGV-72

abides by JROC policy for classified friendly battlefield information (JROCM 071–08) and National Security Agency Type 1 certification requirements.

c.   *Additional Capabilities*

JCR provides an abundance of additional capabilities to BFT operators. The following list of capabilities was gained from in-person interviews with PM FBCB2 senior leadership and a PowerPoint brief provided by the PMO (Program Office, FBCB2, 2010).

- Marine Corps EPLRS Interoperability—provides Marine Corps network with a terrestrial capability

- JCR Logistics (Log; C2/SA Interoperability)—allows exchange of C2/SA between JCR Log and JCR Vehicle

- C2 Repository (C2R)—server that allows use of the Address Book Database

- Self-Descriptive SA (SDSA)—removes requirement for large preplanned databases and allows users to log in and send an SDSA message with all necessary information (i.e., Unit Reference Number, Internet Protocol address) to update C2R. Allows BFT-equipped units to change task organizations in the field to meet new mission requirements

- Recognition of Combat Vehicles—allows recognition of combat vehicles training tool

- Graphical User Interface/Commercial Joint Mapping Toolkit—permits new map types

- Data Dissemination Service (DDS)—allows data flow to GCCS-J

- Secure Mission Data Loader (MDL)—provides encryption of data on MDL, connects to Windows and Linux

- Slew-to-cue—allows JCR operator to auto send message to Vehicle Commander for shoot/no shoot determination

- Open Office—allows writer, calculations and impress applications on system, compatible with Microsoft Office

- Personal File Folder—allows for easy file management

- Enhanced Imagery—allows images to be sent/received

- CENTCOM Regional Intelligence Exchange System International Security Assistance Force—allows exchange of data with coalition forces in Afghanistan

3. Architecture

The JCR network architecture is complex. The Network Operations Center (NOC) remains the backup node to data flow. Three NOCs are geographically segmented for redundancy. Redundancy is built in the network for seamless transition from one NOC to another, in the event one is degraded. Celestial JCR-generated PLI and messages are the same as the current FBCB2-BFT. Data are pushed to the NOC via L-Band Satellite and ground station. The NOC integrates and disseminates to all celestial JCR systems via reverse path. There are two new systems required with JCR, the DDS server, and C2R. C2R enables SDSA and DDS enables interoperability to the joint community. The DDS located in the NOC (NOC DDS) distributes to another DDS server located in the Combatant Command (COCOM) TOC. The DDS at the COCOM pushes to GCCS-A, which continues the path to GCCS-J, and then to the MAGTF architecture. The data flow reverses for terrestrial data generated via Marine Corps systems. The data flow is seamless with the new BFT 2 network and occurs in a matter of seconds. Figure 6 depicts the JCR data flow. Figure 7 depicts the JCR concept of employment.
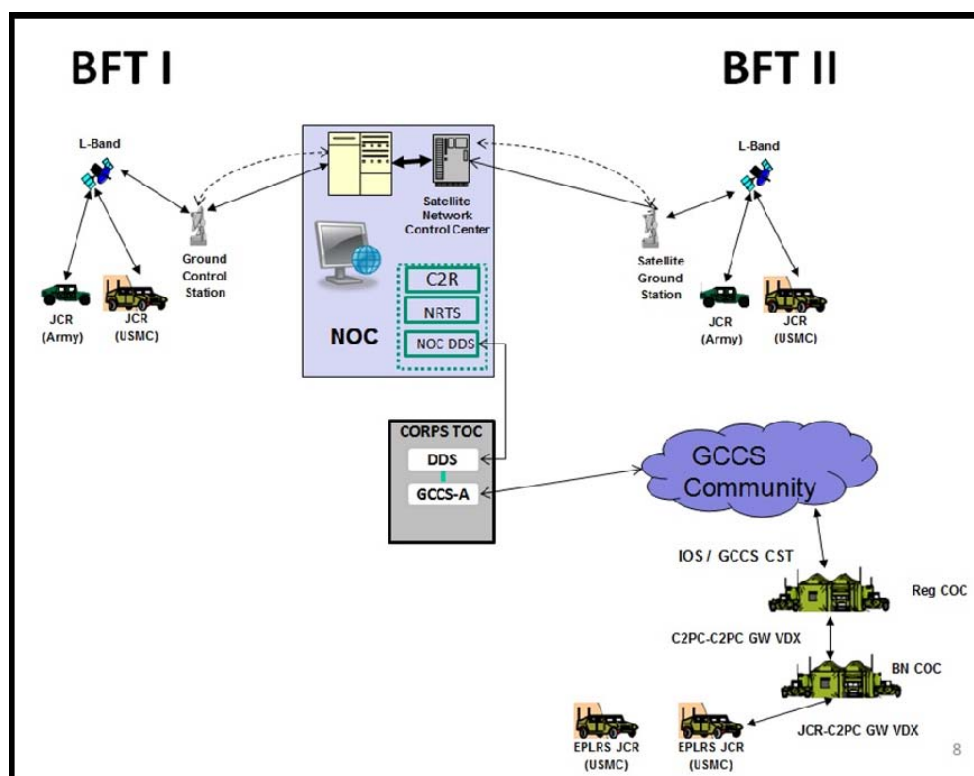
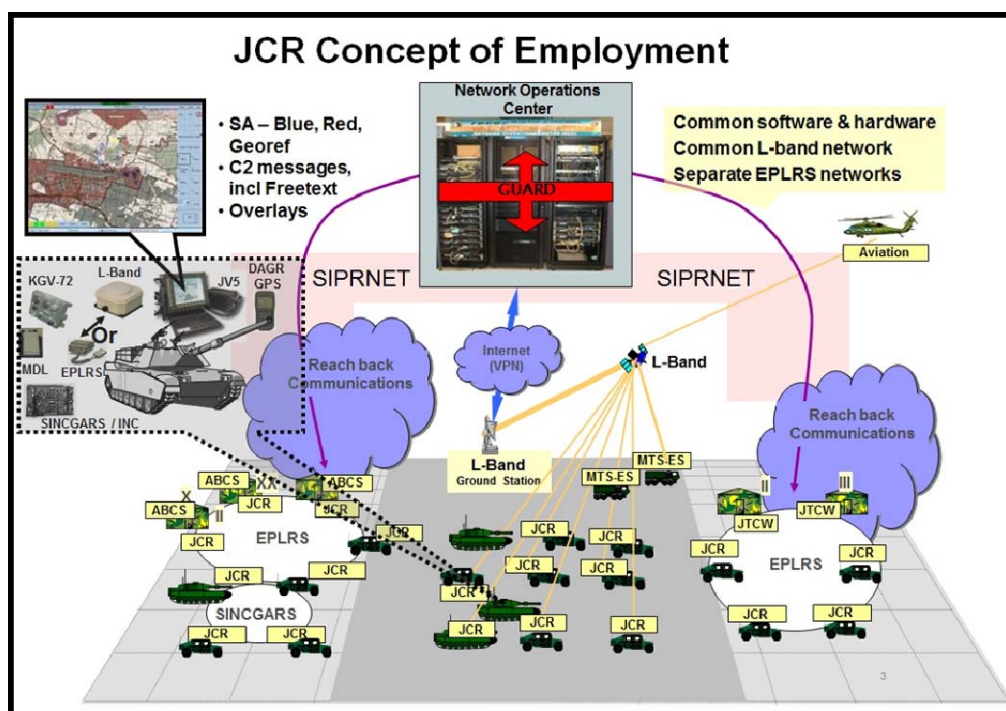Figure 6.   JCR Data Flow (From Product Manager, DFSA, 2010)

Figure 7.   JCR Concept of Employment (From Product Manager, DFSA, 2010)

4. Test and Evaluation

This section relies heavily on in-person interviews with the JBC-P FoS PMO leadership and SPAWAR test result documents.

The Marine Corps joined the Army's JCR test paradigm in FY2005. Since that time, JCR underwent an intensive test and evaluation (T&E) process. The Marine Corps' test strategy is aligned with the Army's. Joint test events are conducted to maximize resources and better assess mutual requirements. When necessary, the Marine Corps team conducts independent testing for specific Marine Corps requirements. The JBC-P FoS PMO established three mutually supported sites with dedicated personnel to assess each JCR software build. A limited Initial Test Team (ITT) augmented the Army's test team, which was collocated with the software developer Northrop Grumman. This ITT's primary mission was to test Marine Corps specific requirements in each software release. More comprehensive teams are located in Charleston, SC, within the Space and Naval Warfare Systems Center (SPAWAR) Atlantic and aboard Marine Corps Base (MCB) Camp Pendleton, CA, within the Marine Corps Tactical Systems Support Activity (MCTSSA). The SPAWAR facility is the Marine Corps' JBC-P FoS Increment I Configuration Manager (CM). MCTSSA is a component of MARCORSYSCOM. The MARCORSYSCOM webpage identifies MCTSSA as the Marine Corps "organization for integration, interoperability, and technical support for tactical Command, Control, Communication, Computer, and Intelligence (C4I) systems" (marcorsyscom.marines.mil). Both sites are tasked with conducting all Increment I and Increment II development testing efforts.

a. Requirements

The *DACT Operational Requirements Document* (ORD; Marine Corps Combat Development Command, 2001) and direction from DC, CD&I were the basis for the requirements and parameters used to evaluate JCR:

- System shall display 100% SA (PLI) accuracy within a 15-minute window (based on refresh rate);
- System shall send/receive messages within 5 minutes;

- Systems will demonstrate the ability to display a map with GPS-derived PLI represented;

- System must transmit/receive PLI data with C2PC Gateway (shows interoperability with Joint Tactical COP Workstation [JTCW]); and

- System must transmit and receive preform Variable Message Format (VMF) messages.

b. Events

Each software version and subsequent release underwent identical series of joint test events. System Subsystem Acceptance Testing (SSAT) is the first in the test series. SSAT is a formal lab acceptance test of the software. SSAT is conducted to verify the ability of the software to meet system requirements and readiness for formal testing (PM FBCB2, 2011). The developer formally delivered to the government each JCR software release to the ITT. The ITT conducted all SSATs within controlled spaces at the developer facility. After successful completion of the SSAT, the software build was sent to the Central Testing Support Facility (CSTF), Fort Hood, TX. The CTSF then built the Marine Corps' hard disk, referred to as the gold brick. The gold brick was then sent to the SPAWAR facility.

Risk Reduction Event (RRE) is second in the test series. The purpose of the RRE was to verify and validate the JCR capabilities' functionality in the planned Marine Corps/Army architecture. The RREs were conducted at both comprehensive test sites. The Army tested out of the CSTF. The RREs were executed in four phases, in numerical order. Phases I and II were performed at SPAWAR. When the initial phases were completed, multiple hard disks were duplicated and sent to MCTSSA for subsequent testing. Phases III and IV were simultaneously executed by both test sites and the CTSF, utilizing the Defense and Research Engineering Network (DREN). The DREN supports DoD-wide research, development, testing, and evaluation activities. The vast majority of DT events were completed on the DREN. During each phase, data were collected on the interactions between the architectures, overall system performance, and compliance with the DACT ORD requirements. In addition, Phase I, II, and III tests are completed to check hardware functions, system configuration, and standalone operations. Moreover,

Phase III and IV tests are performed to verify the system can accurately transmit and receive data throughout a Marine Corps representative network. All phases were performed on the BFT FoS loaded with JCR software, to verify the software satisfied the testable software requirements set forth in the *DACT ORD* (Marine Corps Combat Development Command, 2001). Test cases were developed using specific *DACT ORD* requirements to evaluate the system to support each test phase. Each test case was completed and assessed with *pass, pass with exception*, or *fail* (SPAWAR, Atlantic, 2011, p. 3). Only after successful completion of each RRE would the software move to a formal field test (FT) or field user evaluation (FUE).

Appendix A is an excerpt of RRE test cases from the SPAWAR RRE 9 Test Report (SPAWAR, Atlantic, 2011). Included is the attribute support for the specific DACT ORD Capability and the criteria used to assess each attribute.

At the completion of each test day, a meeting, referred to as a hotwash, was conducted with all test participants. The hotwash discussed issues encountered including test case discrepancies and other software and system deficiencies. A consolidated list was generated, evaluated, and prioritized based on severity. The list was provided to the software developer as a Software Change Request (SCR). The developer normally would release a software patch to adjudicate the SCRs. SCR fixes that could not be resolved with a patch would be included in a follow-on software release, engineered to address the deferred SCR fixes.

Third on the test series, and more often accomplished concurrently and throughout DT, were the Joint Interoperability Test Command (JITC) certification (combined Army and USMC certification) and risk assessment. The JTIC certification process was accomplished by representatives from the Defense Information Systems Agency (DISA). The certification not only included an evaluation of information exchanges and the interfaces used to support those exchanges, but also included the JITC's evaluation of the elements of the Net Ready KPP (PM FBCB2, 2011, p. 3–2). The JTIC evaluation was based upon requirements identified in the JCR Information Support Plan (ISP) and Interoperability Certification Evaluation Plan (ICEP). The risk assessments were comprised of the information assurance (IA) requirements. The JBC-P

Test and Evaluation Master Plan (TEMP) describes the assessments as "designed to reduce the risks due to the threat of computer network attack. Software vulnerabilities and poor system configuration constitute avenues for unauthorized access to the system, manipulation or theft of data, and denial of service" (PM FBCB2, 2011, p. 3–2).

Field Test (FT) is a joint event using limited resources. The Marine Corps Test Team supported each FT in the controlled lab spaces of each test site with desktop systems and test support contractors. The Army executed each FT with support contractors and soldiers.

The Marine Corps and Army conducted specific DT events to evaluate JCR. The Army changed the way it evaluated and test networked capabilities for the ABCS. Network Integration Events (NIE) are a semi-annual combined evaluation of systems that will be coupled and fielded to soldiers as part of a capability set: These events were aimed to reduce the amount of time and number of resources necessary to field the systems. The Army states that the NIE "assesses potential network capabilities in a robust operational environment to determine whether they perform as needed, conform to the network architecture and are interoperable with existing systems" (bctmod.army.mil).

Field User Evaluations (FUE) is specific to the Marine Corps test strategy and normally executed concurrently with the NIE. The FUE were limited in scope and resources, but they included Marines operating JCR-equipped fixed and vehicle-mounted BFT systems. The Marines were formally trained and individually filled C2 roles in the Marine Division. The FUEs were executed in simulated operational settings (training areas) aboard MCB Camp Pendleton. Scenarios were developed and executed under the supervision of a test director (Marine Corps infantry field grade officer). The scenarios reflected real operational situations to validate system capabilities and interoperability. At the conclusion of each FUE, the Marines provided vital feedback via surveys and questionnaires. Moreover, the Marine Corps used a FUE for an operational assessment of the JCR capabilities.

Additionally, the Army team conducted events similar to the scope of an FUE, called Customer Test (CT) and Limited User Test (LUT). Each event utilized various

numbers of soldiers, test personnel, and fixed/mounted systems. The Army relied on its LUTs for an operational assessment of the JCR capabilities towards fielding. The JBC-P FoS PMO conducted an FUE in conjunction with each Army CT/LUT. The normal sequence of tests to evaluate JCR was SSAT, RRE, JITC/risk assessment, and then FUE/LUT/CT/FT/NIE (dependent on the scope of the operating force support and test objective).

c. *Results*

The Marine Corps formally began JCR testing in August 2009 during RRE5. Statistics were kept on C2 (message completion/transmits) and SA (PLI sharing with the Joint COP). Percentages were calculated based on time available divided by total test time. Figure 8 depicts the C2/SA results for all Marine Corps test events. Test results were not initially favorable for a number of reasons.

- The software did not support the desired level of Marine Corps requirements. As a result, the vast majority of the priority SCRs generated at each hotwash was Marine Corps related.

- C2R did not support the concept of operations developed to inject Marine Corps address book data in the Tactical Data Communications Network (TDCN) environment. The team had a 10% success rate.

- VMF was incompatible with JTCW.

- Unlike the Marine Corps, the Army did not evaluate JCR independently. Each event, other than SSATs, was a multisystem (with multiple PMOs) test. There were no less than 12 systems testing collectively, simulating the Army Battle Command System (ABCS), headed by ATEC. However, there was neither configuration control nor a single point of contact. Each system executed separate test plans. Consequently, systems would drop off the grid in the middle of the test period, which adversely impacted the already complex architecture. For instance, numerous times DDS would be down for maintenance without notification. If proper shut down procedures were not followed, null tracks would populate the architecture.

- Low SA uptime percentages reflected the reliability of the connection between the NOC, DDS, and GCCS-A in a complex network architecture. Unit Task Organization corruption was the leading C2 issue.

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Event	Date	SW Version	XCVR	C2	SA
RRE5	Aug 09	1.1.1	BFT 1	35.0%	0.0%
FT 1	Oct 09	1.1.4	BFT 1	55.0%	18.4%
RRE6	Mar 10	1.1.4	BFT 1	69.0%	0.0%
RRE 7	Oct 10	1.3	BFT 1	54.4%	27.0%
FUE 1	Dec 10	1.3.1.1	BFT 1	89.0%	38.0%
FT 2	Feb 11	1.3.1.1	BFT 1	40.0%	37.0%
RRE 8	Apr 11	1.3.1.2	BFT 2	88.0%	12.0%
FUE 2	Jun 11	1.3.1.2	BFT 2	83.0%	39.2%
Arch. Test	Oct 11	1.3.1.2	BFT 2	N/A	83.2%
RRE 9	Oct 11	1.3.1.3	BFT 2	95.2%	93.8%
FUE 3	Nov 11	1.3.1.3	BFT 2	75.8%	88.3%
RRE 10	Mar 12	1.3.1.4	BFT 2	100%	80.1%
SIPR Event	May 12	1.3.1.4	BFT 2	87.6%	93.2%

Figure 8.   Calculated C2/SA (From Product Manager, DFSA, 2011

The test team worked furiously with their Army counterpart to gain a better understanding of the issues and to address potential challenges. Additionally, a Data Exposure Working Group was established that included members from the FBCB2, Mission Command, and JBCP FoS PMOs. The group's objectives were to work through the issues identified by the test team, identify problem areas, and develop and recommend solutions. As a result of the multipronged effort, the following resolutions were implemented.

- New tactics, techniques, and procedures (TTPs) were developed to support the data flow.

- Procedures were included in the field service bulletin that published the proper system maintenance sequence.

- Vital processes were documented and proven.

  o   The Marine Corps address book was uploaded to the C2R server.

  o   The Marine Corps' Unit Task Organization was downloaded from the C2R server.

  o   Both JCR Terrestrial and JCR Celestial, with KGV-72, were configured and operated properly.

- DC, CD&I redefined how JCR was to be evaluated.

      o   The Increment II SA thresholds were used instead of the ones listed in the *DACT ORD* (originally 100% SA at all times, now only 75% PLI of the platforms in immediate battlespace and 50% in the extended, which changed how the percentages would be calculated).

- The developer included main Marine Corps fixes in follow-on software releases that made the software more stable.

Once all the changes were implemented, there were significant improvements in the C2/SA percentages (reference Figure 8, after FUE 2). More important, all future tests were under configuration management with better communication between test personnel for the different systems. It was understood that each event was a system-of-systems test and joint effort.

Leadership from the PMO, Marine Corps Operational Test and Evaluation Activity (MCOTEA), and DC, CD&I met on a number of occasions with their Army counterparts to discuss the way ahead for JCR. The Marine Corps stakeholders determined a specific Marine Corps operational test (OT) was not necessary. The leadership considered a number of reasons before making the decision.

- The Director, Operational Test and Evaluation (DOT&E) had approved the executed combined PM FBCB2 Updated JCR Test and Evaluation Strategy (2010), with capstone events (i.e., FT, FUE, and LUT) to support the Army fielding decision. These events included a combination of field test, limited user test, and field user evaluations.
- Field Test 2 (FT2)
  - The purpose of FT2 was to conduct a structured, controlled, and formally evaluated field test within an operational architecture using soldiers and mission-based test conduct to obtain performance and reliability data on JCR version 1.3.1.
  - The objectives were to evaluate
    - C2 and SA performance,
    - soldier management of the network,
    - initialization (platform and NOC) and the JCR database,
    - Type 1 encryption measures, and
    - Service interoperability between the different communication paths:

- - Celestial to Terrestrial,
    - the ABCS and backward compatibility, and
    - Army and Marine Corps platforms.

  - Limited User Tests (in conjunction with FUE 2 and 3)
    - The supporting units were 3rd Brigade, 1st Armored Division, 1–41 Infantry Battalion, and elements from 1st Marine Expeditionary Force equipped with JCR version 1.3.1.
    - The evaluation objectives were the following:
      - support the FBCB2-JCR fielding decision;
      - assess
        - Entirely new software code, but with the same basic function as previously;
        - The new database structure and SA process (SDSA);
        - The improvements made to the L-Band Network Operations Center;
        - The Type 1 encryption device; and
        - Total system information assurance;

      - address outstanding issues from previous test events such as
        - Celestial to Terrestrial interoperability,
        - Network configuration and management,
        - Classified messaging, and
        - Reliability of the platform integrations;
      - evaluate training and maintainability; and
      - demonstrate interoperability with the joint community.

- JCR underwent a robust DT strategy and its capabilities have proven more capable than envisioned.

- The JBC-P FoS PMO exhausted its resources towards DT and completed multiple FUEs.

- The JCR software matured and test results remained consistent with expectations.

- MCOTEA observed all DT events and provided the PMO with an operational assessment of the JCR capabilities.

- Initial JITC Message Conformance Test (MCT) was conducted in August 2011 at the MCTSSA site. Many trouble reports were generated and provided to the developer. Fixes were included with follow-on software patches that resolved the most critical issues. The MCT was redone to verify resolutions of the priority areas.

The following section relies heavily on the JBC-P FoS JCR NIE 12.2 Test Report (SPAWAR, Atlantic, 2012a) provided by the JBC-P PMO.

The test team evaluated the JCR capabilities on the operational Secret Internet Protocol Router Network (SIPRNET). The test plan was developed to verify and validate JCR functionality in the planned USMC and Army architecture on the live operational network (SPARWAR, Atlantic, 2012a, p. 4).   The SIPR Event was conducted at the MCTSSA site in conjunction with NIE 12.2 (Army unit at Fort Bliss, TX). The Marine Corps' JCR fielding software solution, version 1.3.1.4, was evaluated within the live architecture. The Texas A&M University (n.d.) security webpage describes the SIPRNET:

> The SIPRNET is the Department of Defense's largest network for the exchange of classified information and messages at the SECRET level. It supports the Global Command and Control System, the Defense Message System, and numerous other classified warfighting and planning applications. Although the SIPRNET uses the same communications procedures as the Internet, it has dedicated and encrypted lines that are separate from all other communications systems. It is the classified counterpart of the Unclassified but Sensitive Internet Protocol Router Network (NIPRNET), which provides seamless interoperability for unclassified combat support applications and controlled access to the Internet.

Test cases were generated to focus on functionality and interoperability between the Army and the Marine Corps. The test was executed for 80.75 hours. Both SA and C2 uptimes exceeded the thresholds (SA 75.25 hours [93.2% of total time] and C2 70.75 [87.6%]). During this evaluation, issues with C2 and SA were experienced by the team. However, swift coordination with subject-matter experts at the CTSF and NOC identified and resolved the issues. Two of the major issues were related to SA flow from the DDS and pulling the unit task organizations from C2R. The following excerpts are from the SPAWAR NIE 12.2 Test Report (SPAWAR, Atlantic, 2012a) that describes the two issues and resolutions.

> The team discovered that DDS peering issues contributed to a majority of SA loss between USMC terrestrial and celestial systems. DDS developers located at CTFS and APG resolved the issues when they occurred. Other contributing factors to SA loss were due to IOS and GCCS-J CST

corruptions. The team was required to request additional ports from the Marine Corps Network Operations and Security Center (MCNOSC) on SIPR for CST connections between CTSF and MCTSSA. There were two contributing factors to the loss of C2. [The] first issue was with the NOC C2 gateway crashing. These instances were observed on three occasions during this evaluation. The NOC has submitted an SCR for a fix (SCR T25962). On May 22nd, the NOC applied a hot fix that resolved this issue. Further instances of the NOC C2 Gateway cashes were not observed following the application of the hot fix. The second contributing factor to loss of C2 for USMC systems was due to routing issues between MCTSSA and APG. Network engineers added the necessary route to both routers to enable C2 traffic to traverse the network.

Issues were encountered when the team attempted to pull Army UTO datasets from C2R via the MRC UTO application. Working with C2R and JCR developers, the team found that certificates issued from the C2R FSR for MRC systems were not properly authenticating with C2R. The permissions set on the "key store" certificate and "trust store" certificate were set to "root" when permissions needed to be set for the "C2Rservice" accessing the certificates. The issue highlighted a certificate distribution issue between USMC and Army that prompted discussing between both project offices. (SPAWAR, Atlantic, 2012a, p. 7)

Figure 9 is the cumulative list of all the SIPR Event's test cases completed with their status.

Test Case	Status
1.1 Map Accuracy	PASS
1.2 Map Scale	PASS
2.1 VMF Messages	PASS
3.1 Overlay Transmit and Receive	PASS
4.1 PLI Completeness	PASS
4.2 Average Time for Updates	PASS
4.3 PLI Display	PASS
5.1 Verrify Interoperability	PASS
6.1 Purging GPS Key	PASS
6.2 Remotely Purging the Systems	PASS
7.1 Chat Capability	PASS
USA: 1.1 C2R Load of USMC Role Data	PASS
USA: 1.2 USMC Initialization	PASS
USA: 3.1 USMC Terrestrial to USMC Celestial (C2)	PASS
USA: 4.3.1 USMC Terrestrial to USMC/Army Celestial (SA)	PASS
USA: 4.3.2 USMC/Army Celestial to USMC Terrestrial (SA)	PASS
USA: 6.1 Adding Army Role Data to USMC Address Book Through Hook	PASS
USA: 6.2 USMC C2R Pull of Army SDSA	PASS
USA: 17.1 NOC DDS to CORE DDS Network Loss	PASS
USA: 17.2 Restart of GCCS-A COP Zone	PASS
USA: 17.3 Clearing of GCCS-A PLI	PASS
USA: 17.4 DDS Clears GCCS-A Topics	PASS
USA: 17.5 Restart of USMC BNJTCW	PASS
USA: 17.6 Restart of USMC HHQ IOS	PASS
USA: 17.7 USMC REGT IOS to HHQ IOS Network Loss	PASS
USA: 17.8 Restart of USMC REGT IOS	PASS
USA: 17.9 Clearing of HHQ IOS PLI	PASS
USA: 17.10 USMC REG JTCW Network Loss	PASS
USA: 17.11 Restart of USMC REGJTCW	PASS
USA: 17.12 USMC BNJTCW Network Loss	PASS
USA: 17.13 Restart of USMC BN JTCW	PASS
USA: 17.14 Clearing of REG JTCW PLI	PASS
USA: 17.15 Attempt to Create the USMC "Null" Track	PASS

Figure 9.   Cumulative Test Cases (From SPAWAR, Atlantic, 2012a)

The SIPR Event was the last Marine Corps-declared JCR test event to evaluate its operational effectiveness. For all future DT events, JCR will be evaluated on a limited basis, primarily to assess compatibility with the Increment II capabilities.

B.   INCREMENT II—JOINT BATTLE COMMAND-PLATFORM

1.   Overview

Joint Battle Command-Platform (JBC-P) is the next generation FBCB2 system. The JBC-P is an Army-led Acquisition Category (ACAT) II program designated by the Joint Requirement Oversight Council (JROC) as having joint interest. The system supports the Tier 1 Joint Capability Areas of Joint C2, Joint Battlespace Awareness, and Joint Net-Centric Operations (Marine Corps Systems Command, 2012, p. 9). JBC-P achieves digital information (C2 and SA) interoperability, vertically and horizontally between joint warfighting elements in current and future operating environments. JBC-P will leverage BFT FoS hardware and add capabilities to include handheld devices and beacon systems. JBC-P capabilities increase accuracy and density of SA to further mitigate risk of fratricide. Additionally, the system increases the efficiency of orders transmission; graphical overlays; and friendly, hostile, neutral, unknown, and non-combatant SA (SPAWAR, Atlantic, 2011, p. 3). The system improvements/enhancements will answer JROC convergence directives.

The PEO C3T is the Milestone Decision Authority (MDA) for the JBC-P program. The MDA officially initiated JBC-P software development, and the program entered the acquisition cycle at MS B in September, 2009 (Department of the Army, PEO C3T, 2009). The program received MS C approval on July, 17, 2012 (Department of the Army, PEO C3T, 2012). Commander, MARCORSYSCOM is the Program Decision Authority (PDA) for the Marine Corps, as a participating service. PDA ADM (Marine Corps System Command, 2011) "authorizes the Marine Corps continued participation in the Army's program." MARCORSYSCOM manages the program as the JBC-P Family of Systems (FoS). The PMO is comprised of Increment I (BFT FoS) engineers, logisticians (government and support contractor), and JBC-P specific engineering team. The *JBC-P FoS Life Cyle Cost Estimate* (Marine Corps Systems Command, 2012) describes the JBC-P FoS as the following:

> [A] Weapon System program with a product line made up of systems and products formerly associated with the Blue Force Tracker (BFT) FoS (Increment I) and JBC-P (Increment II). The United States Marine Corps

(USMC) is participating in the U.S. Army (USA) JBC-P program under the authority of the Commander, Marine Corps Systems Command (MCSC) and will not be entering into an acquisition milestone decision process. The term JBC-P FoS encompasses both Increment I and Increment II. Increment I consists of JCR software, BFT mounted systems, Tactical Operations Center (TOC) Kits, the improved BFT-2 transceiver, and the KGV-72 National Security Agency (NSA) Type 1 Programmable In-Line Encryption Device (PIED). (p. 9)

According to Director, Capabilities Development Directorate Letter of Clarification (LOC; 2012), the "established JBC-P FoS Authorized Acquisition Objective (AAO) is 26,566 systems (Handheld: 6,920, Mounted: 18,275, TOC Kit: 1,371)" (p. 1). The PMO fielding strategy for the JBC-P capabilities is aligned with the Army's. If the schedule holds, both Services will request a fielding decision in 1st quarter FY2014 after a successful operational test. According to the *JBC-P CDD* (Department of the Army, 2008), "initial operational capability (IOC) is achieved when one Marine Corps Regiment is completely fielded with all variations of the JBC-P Product Line" (p. 65). The IOC is tentatively scheduled for 4th quarter FY2014. Figure 10 depicts the JBC-P FoS schedule.

Moreover, JBC-P FoS is currently supported by separate funding lines for the individual increments. Late in FY2012, the PMO initiated a two-year transition strategy to merge acquisition efforts along with funding lines in order to support planned FY2014 Increment II fielding.
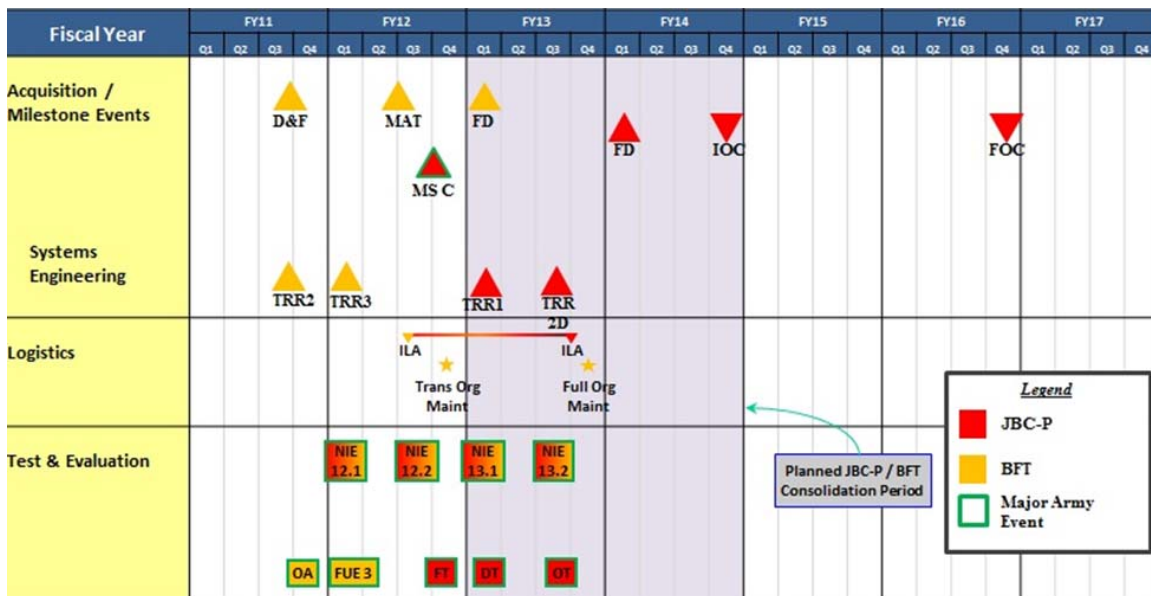
Figure 10.   JBC-P FoS Major Events Schedule (From Product Manager, DFSA, 2012)

JCR version 1.3 is the baseline for the JBC-P software to reduce the development risk associated with software development. JBC-P enhances both FBCB2 and DACT capabilities and leverages mature technologies that have been combat proven by both the Marine Corps and Army. PM FBCB2 established an MOA with the government software development agency, Aviation and Missile Research, Development and Engineering Center (AMRDEC) Software Engineering Directorate (SED), in Huntsville, AL, to develop and integrate the JBC-P capabilities (Program Manager Force XXI Battle Command Brigade and Below, PEO C3T, 2009, p. 20). The enhanced capabilities will leverage the current JCR NOC and existing network architecture. The JBC-P TEMP provides more clarity on the upgrade.

> JBC-P builds on the experience of over thirteen years of evolutionary development of digital, battle command information systems that provides integrated, on-the-move, timely, relevant Command and Control/ situational awareness (C2/SA) information to tactical combat, combat support and combat service support commanders, leaders, and key C2 nodes. The first increment (FBCB2) concentrated on the capabilities required to prosecute the close fight and was primarily focused on the Army units at the Brigade and Below. The second increment, the JBC-P program, will become the cornerstone of the Joint Blue Force Situational Awareness (JBFSA) envisioned to support the joint warfighter. The JBC-P program will be an evolutionary acquisition delivering JBC-P software,

leveraging on existing assets and new hardware capabilities. Future JBC-P hardware procurements will be directly linked to the JBC-P software development efforts as a baseline requirement. Subsequent future contracts for JBC-P hardware will be obtained with full and open competition with a requirement to perform with the JBC-P software. (p. 20)

2. Capabilities

This section was extracted from the JROC validated and approved *JBC-P CDD*, dated May 6, 2008 (Department of the Army, 2008). The document is a conversion from the Army FBCB2 ORD and Marine Corps DACT ORD, to a JBC-P CDD (Department of the Army, 2008, p. 20). The *JBC-P CDD* also states the basis for JBC-P as "the Joint Requirements Oversight Council Memorandums 161–03 and 163–04 directive to converge to a single JBFSA capability for the Army and Marine Corps" (Department of the Army, 2008, p. 2). Additionally, the document takes into consideration and leverages a number of fielded systems and others still in development.

 The JBC-P capabilities include the following:

- provides an enhanced situational awareness of the environment as well as enhanced collaborative decision-making processes,

- allows joint forces to exploit network linkages among dispersed joint forces to improve coordinated maneuver and integrated situational awareness,

- allows the future joint forces to be able to share and exchange information,

- supports a system that is deployable worldwide, and

- supports all types of units and operations. Additionally, the system allows for the joint force to rapidly shift from one operation to another with little to no interruption. (Department of the Army, 2008, p. 9)

Moreover, the CDD describes the JBC-P strategy as the following:

The overall JBC-P strategy is to provide incremental capabilities to the joint force that support current and future joint operational concepts. Based on funding, technical feasibility, performance and/or schedule issues, particular JBC-P increments may only provide partial capability. We will develop future increments as the joint warfighters increase their understanding of already developed capabilities and required Transformational technologies continue to mature. (Department of the Army, 2008, p. 14)

d.   Key Performance Parameters

The following *JBC-P CDD* (Department of the Army, 2008) excerpts provide details on the system's key performance parameters (KPP) along with each corresponding threshold and objective measure.

KPP 1. Net Ready.

JBC-P must support Net-Centric military operations. JBC-P must be able to enter and be managed in the network, and exchange data in a secure manner to enhance mission effectiveness. JBC-P must continuously provide survivable, interoperable, secure, and operationally effective information exchanges to enable a Net-Centric military capability.

(a) Threshold. JBC-P must fully support execution of joint critical operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for transition to Net-Centric military operations.

(b) Objective. JBC-P must fully support execution of all operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for Net-Centric military operations. (Department of the Army, 2008, p. 15)

KPP 2. Shared Blue Situational Awareness.

(a) Threshold. All Operational JBC-P equipped platforms must display, as reported by other JBC-P FoS, 75% of joint PLI within the platform immediate battlespace and 65% within the platform extended battlespace. The friendly location data will be accurate to within 200 meters for ground platforms, 50 meters for dismounted soldiers, 500 meters for rotary wing or UAV aircraft of the actual position. For relatively stationary platforms the PLI data will be reported within 20 minutes for ground mounted and dismounted platforms and 2 minutes for aviation platforms.

(b) Objective. All Operational JBC-P shall display, as reported by other JBC-P FoS, 95% of joint PLI w/in immediate battlespace and 85% w/in extended battlespace. The friendly location data will be accurate to within 100 meters platform, 10 meters dismounted soldier, 250 meters rotary wing/UAV aircraft of the actual position. (Department of the Army, 2008, p. 16)

KPP 3. Shared Survivability

(a) Threshold. Survivability information, as reported by JBC-P FoS, must be displayed and an alert provided on 75% of operational JBC-P equipped

platforms within the applicable danger zone within the specified time of the entity being reported.

(b) Objective. Survivability information, as reported by JBC-P FoS, must be displayed and an alert provided on 95% of operational JBC-P equipped platforms within the applicable danger zone within the specified time of the entity being reported. (Department of the Army, 2008, p. 16)

KPP 4. Sustainment (Materiel Availability).

(a) Threshold. The operational availability for the JBC-P shall be 90%.

(b) Objective. 95%. (Department of the Army, 2008, p. 16)

e.   Handheld

The handheld solution is no longer under the JBC-P development effort. The requirement has transitioned to the Nett Warrior dismounted effort. The Nett Warrior CDD requirements were mapped against the JBC-P CDD and a determination was made that they were similar enough that Nett Warrior would take responsibility. However, the Marine Corps still relies on the JBC-P CDD for its solution, particularly for testing. The JBC-P FoS PMO established a workgroup to determine what specific Marine Corps interoperability requirements are met in the Nett Warrior CDD. The workgroup results are still pending. Furthermore, the PMO is uncertain the solution will be ready for the planned IOT&E during NIE 13.2.

3.   Software Builds

Part of the Army's modernization strategy is to develop, test, and field associated capabilities collectively to the warfighter. Capability sets are inceptions of this strategy. The JROC-approved JBC-P CDD operational requirements were prioritized to be developed accordingly via software builds. The software builds are incorporated within pooled capability sets (CS) and evaluated for fielding during the NIE. Subsequent software builds on the previous software. JBCP is being developed incrementally, and this approach supports the program strategy. A combined team that included representatives from the Marine Corps, Army, Special Operations Forces, and other stakeholders completed the prioritized list of requirements. The team conducted a System

Requirements Review (SRR) semi-annually to review the prioritized list. During the SRR, the team recommended changes to existing requirements or introduces new ones.

There are specific artifacts that are associated with introducing capabilities into JBCP software builds in which the Marine Corps have been participating in. The platform software is the same for the Marine Corps and Army. However, the Marine Corps team has been developing its own capabilities packages for the builds. These capabilities are specific to Marine Corps higher echelon requirements. Currently, JBC-P has four software builds that comprise the core system requirements. These initial software builds contain the bulk of the Army requirements and the Marine Corps' interoperability requirements. Software Build Four contains the capability to interface with JTCW. It includes the ability to share VMF with JTCW and to send PLI reports to JTCW. Software Build Four is a deliverable for CS 13. The following provides the Army clarification for CS 13.

> CS 13 will begin to field to eight brigade combat teams in 2012. CS 13 is the first fully-integrated suite of network components fielded as part of Capability Set Management and as a result of the Army's new Agile Process. CS 13 delivers an unprecedented integrated network solution capable of supporting mission command requirements for the full range of Army operations, and an integrated voice and data capability throughout the entire BCT formation. (Department of the Army, n.d.a)

Software Build Five is projected to include additional Marine Corps capabilities required for JBC-P initial fielding. The build includes the ability to build overlays, pull unit and platform tracks along with PLI from JTCW, and push out to selected JBC-P users. Moreover, Build Five contains enhanced JTCW interoperability and initial interoperability capability with other Marine Corps-unique systems and tactical radio wave forms.

4. Test and Evaluation

a. Overview

The Marine Corps test strategy is aligned to the Army. Both Services evaluate JBC-P capabilities utilizing the JBC-P CDD KPPs. Joint test events are conducted to maximize resources and better assess mutual requirements. When

necessary, the Marine Corps team conducts independent testing for specific Marine Corps requirements. In addition to the established test sites at SPAWAR and MCTSSA, the JBC-P FoS PMO provided test personnel to augment the Army's test team collocated at the SED. This initial team's primary mission is to conduct SSAT, in order to test Marine Corps-specific requirements in each build released by the developer. These three sites are mutually supported with dedicated personnel to assess each JBC-P software build. The comprehensive teams at the SPAWAR and MCTSSA are tasked with conducting all Increment I and Increment II development testing efforts.

b. Test and Evaluation Master Plan

The *JBC-P Test and Evaluation Master Plan (TEMP)* (U.S., Army Office of Program, FBCB2, 2011) underwent a vigorous review and edit process by the stakeholders. The finalized version is enroute to approval. The following provides more details on the document.

> The TEMP describes an integrated test and evaluation strategy that will leverage all available data sources including but not limited to plan developmental and operational testing. The TEMP also includes measures to evaluate the performance of the system during these test periods; an integrated test schedule; and the resource requirements to accomplish the planned testing. (U.S. Army Office of Program Office, FBCB2, 2011, p. 1–1)

The following describes the JBC-P Test and Evaluation Working Integrated Product Team (T&E WIPT) that was established to be the focal point to manage testing.

> T&E WIPT membership will include all organizations having direct or indirect testing responsibilities. These organizations include: PM FBCB2, MARCORSYSCOM, Army Test and Evaluation Command (ATEC), PM Heavy Brigade Combat Team (HBCT), MCTSSA, SED, Central Technical Support Facility (CTSF) and the Joint Interoperability Test Center (JITC). The JBC-P system T&E concept includes test events conducted by both the contractor and the Government to ensure that the JBC-P software and hardware variants meet performance requirements, are safe for use by soldiers, are operationally suitable, survivable and effective, interoperable, and qualified for use. (U.S. Army Office of Program Office, FBCB2, 2011. p. 3–1)

c.   Development Tests

As a result of lessons learned from JCR testing, all JBC-P DT events are jointly coordinated. The PEO C3T ADM (Department of the Army, PEO C3T, 2012) requires the PMO to "conduct a formal DT and LUT to confirm the system's readiness to conduct Initial Operational Test and Evaluation (IOT&E)" (p. 1). Moreover, the ADM states that the PMO must "return to the MDA post LUT and provide an update. MDA must be confident of system maturity and ability to meet criteria to enter IOT&E, else approval will be rescinded" (Department of the Army, PEO C3T, 2012, p. 1). Each software build released by the developers undergoes the same series of test events as JCR, SSAT, RRE, JITC Certification, Risk Assessment, and FUE/LUT/NIE. The SPAWAR Software Test Report (SPAWAR, Atlantic, 2012b) states the major difference between the RREs for JCR and JBC-P is that the JBC-P "event architecture not only provides the connectivity to exercise VMF messaging, PLI, and interoperability, but also backwards compatibility with JCR" (p. 2). Additionally, joint User Juries were conducted during the early stages of development to solicit feedback from fleet Marines and soldiers.   The users evaluated handheld prototypes and the mounted software and then completed surveys at the conclusion of each event. The feedback drove the development effort for the new user interface that is similar to today's gaming interface. Representatives from the TICM, CD&I, SED, JBC-P FoS PMO, and PM FBCB2 executed and monitored each event.

(1)   Results. The Marine Corps Test Team was not actively engaged in testing of the first three software builds. The builds did not address Marine Corps requirements, so the team's role was limited. Software Build Four was the first to complete the full gamut of test events by both Services. RRE-11 was completed September 10, 2012. Overall, the test was a success. The test team identified numerous issues with the software build. The SPAWAR *Software Test Report for the JBC-P RRE-11 Test Event* (SPAWAR, Atlantic, 2012b) states that the priority issues were "incorrect Marine Corps symbol code information displayed on the JTCW, [the] data set (UTO) used by JBC-P was unique and not compatible with JCR (different formats), and field orders sent from JBC-P were unable to send attached overlays that contained free draw

objects" (p. 5). The priority issues were resolved after coordinating with the Army team. The fixes were promptly "integrated and distributed to all test sites to improve software stability" (SPAWAR, Atlantic, 2012b, p. 6). At the event conclusion, the test team recommended to "refine and publish USMC data initialization processes for inclusion of USMC JBC-P roles in the test build [and] … USMC data initialization processes for JCR test UTO distribution and loading of data into C2R" (SPAWAR, Atlantic, 2012b, p. 7).

In November 2012, the Marine Corps conducted an FUE in conjunction with NIE 13.1. The FUE was successful in evaluating JTCW interoperability utilizing static MCTSSA JBC-P platforms. The FUE test report is being incorporated with the Army's NIE 13.1 report and is not yet finalized.

d. Operational Testing

PEO C3T ADM (Department of the Army, PEO C3T, 2012) "authorized entry into the Low Rate Initial Production (LRIP) phase for the purpose of completing manufacturing development and conducting IOT&E." NIE 13.2, scheduled to begin March 2013, will be the IOT&E event. For both Services, Software Build Five will support the scheduled IOT&E. The JBC-P FoS PMO is awaiting delivery of the software build to schedule the required SSAT and RRE. The JBC-P TEMP (U.S. Army Office of the Program Office, 2011) states that the IOT&E objectives are to "ensure the ability of the JBC-P to be integrated on a variety of system platforms without inhibiting soldier performance, seamlessly interoperate with Battle Command Systems, and evaluate JBC-P's operational effectiveness, suitability, and survivability" (p. 3–4). The draft TEMP also describes each Service DOT&E activity's responsibility for operational testing. It designates ATEC as the lead OT agency (lead evaluator) and MCOTEA as supporting agency. The following TEMP excerpt provides details on each activity's responsibility:

> ATEC is responsible for planning and conducting developmental and operational testing and completing independent system evaluations of the JBC-P systems. Both the Developmental Test Command (DTC) and Operational Test Command (OTC) develop test plans and instrumentation to support testing, as well as conduct test events…

Marine Corps Operational Test and Evaluation Activity (MCOTEA) independently plans, executes and evaluates testing of material solutions against Warfighter capabilities, under prescribed realistic conditions and doctrine, to determine operational effectiveness and suitability. MCOTEA is the authority for Operational Test and Evaluation for the USMC and will plan and execute USMC-specific OT&E. MCOTEA will support ATEC for Joint Interoperability T&E planning and reporting. (U.S. Army Office of Program Office, FBCB2, 2011, p. 2–2)

To effectively simulate the realistic operational environment, the agencies are coordinating to attach the Marine Corps unit to the OTC unit at Fort Bliss. A truly joint evaluation that includes an assortment of Marines and Soldiers from one location has always been a goal on this effort and also DOT&E encouraged.

C. SUMMARY

This chapter provided the reader with details on the incremental approach effort to reach SA convergence. It also described each increment's capabilities, test and evaluation efforts and results of each test effort.

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IV. CONSIDERATIONS

This chapter will provide some key considerations from the analysis of Increment I and Increment II. It will describe some Army unique resources that impact how the Marine Corps will implement the increments.

Joint Capabilities Release (JCR) and Joint Battle Command-Platform (JBC-P) were intended to address the Joint Requirements Oversight Council (JROC) directive for a joint blue force tracking capability for the ground forces. However, both software solutions are more Army centric than Marine Corps centric. As a result, mismatches exist within and beyond the JBC-P between the Army and the Marine Corps. The primary challenge for the Marine Corps' team is marrying JBC-P with organic Marine Air-Ground Task Force (MAGTF) systems. Additionally, the Marine Corps shares the current theater of operations with the Army. The L-band satellite infrastructure is fully supported with Army resources. The Marine Corps will be challenged when operating independently. Moreover, the JBC-P development schedule has shifted and many of the Marine Corps capabilities are prioritized lower than the Army's. Consequently, the Marine Corps schedule may be disjointed from the Army's fielding strategy.

A. SYSTEM DEPENDENCIES

JROC Memorandum 163–04 (JROC, 2004) required the Army and the Marine Corps to adopt the same C2SA systems for their entire hierarchy. The memorandum directed the Army to adapt the Joint Tactical Common Operating Picture (COP) Workstation (JTCW) for the brigade and above solution and the Marine Corps to adapt FBCB2 for its platforms (battalion and below; JROC, 2004). However, the Army moved away from that path and designed JCR and JBC-P for the higher echelon solution, using the Army Battle Command System (ABCS) instead of JTCW. The Marine Corps requires JTCW to synchronize all the systems within the MAGTF architecture. JCR and JBC-P are essentially designed towards external resources that reside within the ABCS and operate as a system of systems. Those external resources are dependent on the system that the Marine Corps must accommodate. Marine Corps CONOPS was tailored to

function within the current technical parameters versus supporting tactical networks in order to make JCR and JBC-P operationally effective for Marine Corps units. The dependencies further complicate the already tangled architecture and increase the chance for potential network disruption. This issue exists in Increment I and has not been completely resolved for Increment II.

B.   COMMAND AND CONTROL REGISTRY

The Marine Corps does not have a high tier address book concept for all its units that is similar to the Command and Control Registry (C2R). Data products such as unit reference numbers (URN), organization structure, and Internet protocol (IP) addresses must be loaded to C2R in order to operate on the network.   The Army established Project Director Tactical Network Initialization (PDTNI) to manage all data products for ABCS. The PDTNI collects and manages all data products to enable digital communication and interoperability across its tactical Internet (peoc3t.army.mil/tni). In the Marine Corps, individual units are responsible to configure their IP addresses. They assign their unit names to be used and create the IP structure for the organization. The Marine Corps' expeditionary nature and consequent constant changing of IPs and network structure do not support the C2R concept.

C.   UNIVERSAL COLLABORATION BRIDGE

There is a distributed chat capability that is associated with JBC-P. Within the ABCS, the Universal Collaboration Bridge (UCB) program provides a translation service to JBC-P. UCB translates one chat protocol to another for the ABCS system-of-systems concept. The Marine Corps has no equivalent service. The Marine Corps team is working on a solution in order to transmit JTCW-generated messages to JBC-P.

D.   DATA DISTRIBUTION SYSTEM

Service interoperability is dependent on the Data Distribution System (DDS), Global Command and Control System-Army (GCCS-A), and the Army Service Component Command (Army cell) collocated with the regional COCOM. The procedures to enable data flow to the joint community, via both JCR and JBC-P, have not

been solidified as yet. The connection has been sporadic during DT for a number of different reasons. The Marine Corps team does not have a high degree of confidence the transmissions to the joint community will be seamless in operational environments. Situational awareness reliability during prior test events provided an indicator of a complicated configuration that is difficult to maintain. Additionally, a major challenge yet to be executed is establishing a connection from a Marine Expeditionary Unit, embarked on a naval vessel, to a regional COCOM.

E.   SATELLITE COVERAGE

BFT satellite coverage is not global, and with the current fiscal environment, global coverage once JCR and JBC-P are fielded may not be achievable. The Marine Corps has been sharing the battlespace with Army units executing combat operations in support of the Global War on Terrorism. Thus far, the Army has been financing the limited Marine Corps' L-band bandwidth usage. However, today's BFT satellite coverage area does not support expeditionary operations. Once JCR and JBC-P is widely fielded throughout the Marine Corps operating force and, specifically, the Marine Expeditionary Units, the Marine Corps will have to support its satellite usage. Currently, the Army provides BFT coverage only for regions where BFT-equipped Army units are located. The Defense Information Systems Agency (DISA), in the near future, will be responsible for managing all L-band satellite contracts for the DoD. The JBC-P FoS PMO is anticipating a request for funding from DISA in the near future to support a wider satellite coverage area. Revealed during discussions with PMO leadership, this issue is a top primary and has been briefed to Headquarters Marine Corps Command, Control, Communications, Computers, and Intelligence for resolution.

F.   SCHEDULE SHIFT

The incremental improvement approach for JBC-P software development has been a challenge for the developer. Each proceeding software build contains more capabilities than the previous version. The initial coupled capabilities priority list has changed and some Marine Corps-specific requirements were lowered. Furthermore, no developmental plan currently exists for some of the lowered priority requirements, and

the developer has struggled to achieve the threshold capabilities in Build Four. Early test results show limitations exist with the variable message format (VMF) standard, which is a significant requirement for JTCW. The originally planned capabilities in Build Five are the first Marine Corps fieldable version of the JBC-P software. The PMO is not confident follow-on Software Build Five will contain improved VMF capabilities. Additionally, the Marine Corps expected an improved JTCW interface in Build Five to go beyond the threshold interoperability capabilities. The expected capabilities include: Improved tracks and overlays exchanges, automated updates to the operational picture in JTCW, and JTCW data exchanges with JBC-P. Additionally, the PMO anticipated improvements in the functional address book process that facilitates address book information interactions between the Army and the Marine Corps systems.

Moreover, the current constrained budgetary environment negatively impacted JBC-P funding. The development effort changed to accommodate the reduced resources. The PMO is not confident the final build will remain on schedule and anticipates significant shifts in the Software Build Five release schedule. The constraints have reduced the Marine Corps' upcoming future years' budgetary controls. Supporting Increment I–equipped units in OEF is priority. Therefore, procuring the hardware upgrades associated with Increment II in a timely manner will be a challenge.

G.   SUMMARY

This chapter provided key considerations that hamper Marine Corps implementation of the JCR and JBC-P packages.

V. CONCLUSION

This chapter summarizes what was learned while conducting this research. The chapter provides recommendations for procedure and policy that will lessen the complexities of joint programs. Additionally, this chapter provides recommendations for further research to better determine Increment II feasibility for fielding to the Marine Corps and analysis of Blue Force Tracker use in Marine Corps expeditionary operations other than war.

A.   SYNOPSIS

The combination of the lethality of modern-day weaponry, the chaos that exists on a joint battlefield, human factors, and stove-piped tactical situational awareness/command and control systems has increased the potential for inadequate situational awareness and, in the worst case, fratricide occurrences. The Joint Oversight Requirement Committee's directive (JROCM, 2004) for a Joint Blue Force Situational Awareness capability is warranted to improve tactical situational awareness and reduce fratricide occurrences. This analysis of the Marine Corps' efforts toward a viable solution evidenced that the overarching capability, as envisioned by the JROC, cannot come to fruition in the near future. As is common in most joint efforts, differences exist between the Marine Corps and Army, primarily in regard to requirements and organic resources. These differences inhibit developmental efforts and hinder the likelihood of fielding similar and interoperable capabilities.

The Marine Corps executed key efforts to comply with the JROC convergence directive: First, the vehicle-mounted Data Automated Communications Terminal (DACT) variant was distributed to operating forces on a limited basis; second, fielding the dismounted DACT was cancelled; and third, Marine Corps System Command (MARCORSYSCOM) rapidly procured the Army's Blue Force Tracker (BFT) systems and subsequently fielded to Marine units in the combat zones and at home stations. The MARCORSYSCOM program management office (PMO), Joint Battle Command-Platform Family of Systems (JBC-P FoS) initiated actions to align Marine Corps efforts

with the Army's aggressive incremental strategy to develop the joint capability. PMO JBC-P FoS established dual Marine Corps–specific test sites, augmented the Army's test team that was collocated with the software developers, and executed concurrent test events to synchronize with the Army test schedule.

The convergence effort is plagued with challenges. Joint Capability Release (JCR) represents Increment I towards interoperability, but its software and hardware capabilities have not proven fully capable of meeting Marine Corps operational requirements. JCR is essentially designed towards the Army Battle Command System (ABCS). The enhanced capability requires an overly complex architecture that is dependent on organic ABCS resources that do not reside within the Marine Air-Ground Task Force architecture. This dependency was evident while testing JCR. Testing revealed an overarching lack of a reliable network for SA/C2 without altering Marine Corps concept of operations. Additionally, reasonable concerns exist in developing, testing, and concept of employment for Increment II, Joint Battle Command-Platform (JBC-P). JBC-P is being developed incrementally. The Services' requirements were prioritized, coupled, and assigned to software builds. Each subsequent software build adds more capabilities to the previous. The software build development schedule shifted due to issues with the developer, which resulted in many Marine Corps–specific requirements being lowered on the priority list. Consequently, the planned Marine Corps fieldable solution is now delayed.

Moreover, the Army maintains the L-Band satellite network, the architecture and resources required to operate the BFT system. JCR and JBC-P encompass enhanced capability to the current network and architecture. The Army provides satellite coverage for all regions where BFT-equipped Army units are located. However, the resources are limited outside those regions and may be unavailable for Marine forces conducting traditional expeditionary missions.

B. LESSONS LEARNED

1.   JCR represents the interim solution towards full convergence. If the Marine Corps had greater influence during the JCR developmental phase, most of the

challenges would have been mitigated. JCR and subsequently, JBC-P, would have been designed to ultimately support the current Marine Corps architecture and concept of operations in the same manner as the Army. Additionally, greater influence during the negotiation sessions, where capability priorities were being established, would have ensured a practical Marine Corps solution and facilitated a seamless transition to JBC-P. The Marine Corps–specific requirements would have been equivalently considered when establishing the capabilities priority list.

2.   The Marine Corps resources are limited, but available resources should have been directed more efficiently. More resources should have been dedicated to expedite responses to the Army workgroup's inquiries on Marine Corps capabilities. As the JCR effort winds down, more JBC-P FoS PMO assets are being dedicated to JBC-P. The purpose is to develop solutions to the existing architecture and capability issues that will make JBC-P a viable solution for Marine forces with reduced consideration for interoperability with the Army.

3.   The JBC-P FoS PMO should have more effectively communicated the JCR and JBC-P system requirements with other programs within the MAGTF architecture. There are several Marine Corps programs that have only recently been involved in evaluating the impact of fielding JCR and JBC-P.

C.   RECOMMENDATIONS

1.   Procedural

For solutions intended for multi-Service purposes, the baseline design must support all Services' resources. Consistency in the core design will facilitate implementation and ultimately enhance suitability. Program funding must be stabilized for incorporating all of the joint system requirements, not just the funded Service's requirements. This is even more relevant during the foreseeable stringent budgetary environment, which dictates a heightened emphasis on commonality throughout the Services. Implementing JROC-mandated directives between the Services will be less challenging if solutions are designed towards an impartial Joint Capabilities Integration Development System process.

Moreover, additional consideration must be given to the fundamental nature in which each Service fights, while simultaneously maintaining the goal of Service interoperability. To be a tangible force multiplier, the capability must be designed to fit within the Service's battlefield concept of employment and facilitate interoperability. Any deviation would diminish the capability's value to the warfighter between the Services. Accomplishing this is extremely challenging as each Service must maintain the capability to operate with its existing, disparate C2/SA systems, while developing future systems that are interoperable.

2. Policy

Long-standing acquisition and funding policies, rooted in law, remain hindrances in developing truly joint systems. Acquisition funding primarily flows through each Service, which then prioritizes funding toward its own requirements, often at the expense of a less well-funded sister Service. While Congress is able to "fence" funding for programs through specific language in the annual appropriations bill, it would be difficult to address the specific requirements within the fenced program. This would continue to allow the funded Service to prioritize the Service-specific requirements and ignore the joint or sister Service requirements. This would result in the continued development of Service-specific C2/SA systems that are not particularly interoperable in the joint environment. In turn, future C2/SA developments would be constrained by the Service-specific system that was fielded and the issue would propagate infinitely.

While the Joint Chiefs of Staff have influence on the acquisition process through the JROC, there is little that can be done when funding to develop a Service's specific requirement is not available. Joint PMO's that report directly to the Defense Acquisition Executive (DAE) have been established to help eliminate the problem with Service acquisition funding, and that may be one tactic that could be employed to keep the focus on the joint requirements.

3. For Further Research

Marine Corps' JBC-P Fielding Strategy After Network Integration Evaluation 13.2 and Other Follow-On Evaluations

This analysis is insufficient to determine the feasibility of the Joint Battle Command-Platform (JBC-P) capabilities within the Marine Corps and realizing the Joint Requirements Oversight Council vision for full Blue Force Situational Awareness convergence. Better determination of the operational effectiveness and suitability of JBC-P, within the Marine Air-Ground Task Force architecture, will be made by analyzing the initial operational test and evaluation test report from Network Integration Evaluation 13.2 (March to May 2013).

Analyze BFT Use During Marine Corps Expeditionary Operations Other Than War

Findings from this analysis may provide a realistic view of the complexity of joint systems while meeting Service-specific requirements. Additionally, the findings may help determine specific Marine Corps capabilities that should be included in future JBC-P versions to support traditional expeditionary operations other than war (e.g., humanitarian assistance, disaster relief, and noncombatant evacuations). However, the Marine Corps should evaluate BFT usage in areas independent of Army resources to better determine suitability and reliability of the satellite network.

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APPENDIX

Sample Risk Reduction Event Test Cases

Attribute: Maps
Capability Statements: A Key Performance Parameter (KPP) for the DACT consists of the ability to display a map with GPS-derived position location information (PLI) [Interoperability KPP] represented on the map.
Measure: % Scalability.
Measure: % Successful Map Retrieval.
Measure: % Accurate Display.
Measure: Storage Capacity.

Attribute: Geodetic Reference and Navigation
Capability Statements: The DACT shall provide route (straight or curved) distance measuring, coordinates of an operator-designated point on a displayed map, and polar coordinates between any two user-designated points.
Measure: Distance Calculation Accuracy.
Measure: Route Planning. Pass
Measure: Direction of Travel Accuracy. Future Test
Measure: Grid Reference Conversion Accuracy.

Attribute: PLI
Capability Statements: A KPP for the DACT consists of the ability to display a map with GPS-derived position location information (PLI) [Interoperability KPP] represented on the map.
Measure: Average Time for Updates (5 minutes to receive updated COP).
Measure: % Completeness. [Completeness of PLI data after receipt (via terrestrial and/or satellite communications medium) from adjacent JBC-P FoS terminals, JTCW gateway, FBCB2 NOC/FBCB2-BFT L-Band systems.]
Measure: Change Track View. Not a DACT ORD Requirement
Measure: Display Accuracy. [Accuracy of PLI displayed.]

Attribute: Overlays and Symbols
Capability Statements: The DACT will be used to transmit, receive, store, retrieve, create, modify, and display map overlays and commanders' critical information requirements (CCIRs).
Measure: MAGTF Symbols and Unit Identifiers (Military Standard 2525B).
Measure: Completeness. [Overlay completeness after transmission].
Measure: Unit Symbol Scaling. Not a DACT ORD Requirement
Measure: Overlay Scaling.
Measure: % Successful Overlay Creation.
Measure: Edit.
Measure: Display.
Measure: Select-ability.

Measure: Transmit.
Measure: Receive.
Measure: Store.
Measure: Retrieve.
Attribute: Message Handling
Capability Statements: The DACT will be used to transmit, receive, store, retrieve, create, modify, and display map overlays and CCIR
Measure: Preformatted Message Template Capability. [23 message formats according to the *DACT ORD*. Nine threshold formats at a minimum.]
Measure: Content Completeness. [Message formats contain mandatory fields.]
Measure: % of Distribution Completeness. [JBC-P FoS text message distribution capability and associated message log/delivery status tools. Message distribution to all designated recipients after transmission.]
Measure: Accuracy. [Accuracy of text messages after distribution to designated recipients.]
Measure: Alerts. [Audio and visual message alert capability]
Measure: Sorting. [Verify message sort capability.]
Measure: % Successful Message Creation.
Measure: Edit.
Measure: Display.
Measure: Transmit.
Measure: Receive.
Measure: Store.
Measure: Retrieve.
Measure: Attachments.

Attribute: Cryptographic Capability
Capability Statements: The GPS receiver shall provide the ability to utilize an electronically inserted cryptographic key.
Measure: Verify GPS Cryptographic Capability.

Attribute: Rapid Purge Function
Capability Statement: The DACT will have a rapid purge function for critical operational information and GPS key (if installed) to guard against hostile exploitation.
Measure: Average purge time (< 10 min).
Measure: Zeroize GPS Key.
Measure: Remote Purge. [JBC-P FoS ability to purge hard drive and GPS key from a remote location.]

Attribute: MAGTF Command, Control, Communication, and Intelligence
Network Interoperability
Capability Statements: The mounted DACT, when connected to a local network segment, must have the capability to connect to existing network printers to allow the user to print messages (Threshold) and graphics (Objective).

Measure: Interoperability with JTCW.
Measure: Interoperability with transmission medium (EPLRS).
Measure: Positive Indication of Connectivity with JTCW Gateway.

Attribute: Joint and Allied/Coalition C2 System Interoperability
Capability Statement: The DACT will be in compliance with all appropriate options within applicable standards categories of the Department of Defense Joint Technical Architecture (JTA) to include information processing standards, information transfer standards, information modeling standards, human-computer interface standards, and information systems security standards.
Measure: Net Ready KPP.
Measure: JITC Certification

Attribute: Compatibility
Capability Statements: The DACT shall be capable of sending data via frequency hopping radios to reduce the effects of electronic warfare.
Measure: Compatible with Host Platform. Hardware

Attribute: Reliability
Capability Statements: The DACT shall have a threshold mission reliability of 90% and an objective mission reliability of 95%. This reliability shall include both hardware and software.
Measure: Reliability Growth Plan.
Measure: Software Metrics. [Reliability Metric—how many faults in the software as well as the number of faults expected when the software is used in its intended environment.]

Attribute: Self-Check Capability
Capability Statements: Upon activating the DACT, a top-level self-check shall be performed. If a fault is detected, the DACT shall display an error message indicating the fault.
Measure: Self-Check Capability Present.
Measure: Self-Check Fault Isolation Accuracy ($> 90\%$).
Measure: Self-Check False Alarm Rate ($< 10\%$).

Attribute: Impact on Related Systems
Capability Statement: Personnel requirements to operate and maintain the DACT are based on existing tables of organization and projected task organizations for all MAGTFs.
Measure: Related Systems Training Materials (JTCW and EPLRS) Adequate. Logistics

Attribute: Audio and Visual Alert

Capability Statement: The DACT shall provide an audio and visual alert of incoming messages. This alert shall be user selectable: audio, visual, both, or off. The audio alert shall have a volume control.
Measure: Verify audio and visual alert capability.
Measure: User Selectable On-Off Capability.
Measure: User Selectable Volume Control.
Attribute: Text Scrolling and Graphics Panning Function
Capability Statement: A scrolling or paging capability shall be provided for messages that exceed the display capacity.
Measure: Verify Text Scrolling Capability.
Measure: Verify Graphics Panning Capability.

Attribute: Data Input
Capability Statement: The DACT shall provide the capability for system data input and control using a pen stylist or equivalent device, and a keyboard/keypad.
Measure: Keyboard Adequate.
Measure: Pen Stylus Adequate.

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