

**STRATEGY
RESEARCH
PROJECT**

The views expressed in this paper are those of the author and do not necessarily reflect the views of the Department of Defense or any of its agencies. This document may not be released for open publication until it has been cleared by the appropriate military service or government agency.

ACHIEVING STRATEGIC BATTLESPACE AWARENESS

BY

**COLONEL WILLIAM G. FILLMAN
United States Army**

**DISTRIBUTION STATEMENT A:
Approved for public release.
Distribution is unlimited.**

19980526 164

DTIC QUALITY INSPECTED 2

USAWC CLASS OF 1998



U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050

USAWC STRATEGY RESEARCH PROJECT

Achieving Strategic Battlespace Awareness

by

Colonel William G. Fillman, United States Army

Colonel Jay E. Lawson
Project Advisor

The views expressed in this paper are those of the author and do not necessarily reflect the views of the Department of Defense or any of its agencies. This document may not be released for open publication until it has been cleared by the appropriate military service or government agency.

U.S. Army War College
CARLISLE BARRACKS, PENNSYLVANIA 17013

DISTRIBUTION STATEMENT A:
Approved for public release.
Distribution is unlimited.

ABSTRACT

AUTHOR: Colonel William G. Fillman, United States Army

TITLE: Achieving Strategic Battlespace Awareness

FORMAT: Strategy Research Project

DATE: 13 March 1998 PAGES: 53 CLASSIFICATION: Unclassified

To meet the U.S. National Military Strategy and Joint Vision 2010 requirements for battlespace awareness and battlespace knowledge, we should establish a Joint Project Office for Battlespace Awareness/Knowledge. This Office should assume responsibility for breaking the paradigm of stovepiped system development and data management within the Services and the DoD Combat Support Agencies. Commercial mission partners will ultimately provide the required technology. By 2010, DoD will need a central data warehouse to provide the warfighter with an awareness product. A Defense Technical Services Agency, carved out of current intelligence combat support agencies, is a viable solution. Today, DoD should focus on establishing the requirements and doctrine, training leaders and user personnel, and developing the organizational structure to facilitate the achievement of dominant battlefield awareness by 2010.

TABLE OF CONTENTS

ABSTRACT	III
PREFACE	VII
LIST OF ILLUSTRATIONS	IX
LIST OF TABLES	XI
ACHIEVING STRATEGIC BATTLESPACE AWARENESS	1
The Goal: Dominant Battlespace Awareness	1
The Requirement for Battlespace Awareness	2
The Example of Desert Storm	4
The Digital Solution	6
The Technological Challenge	8
Achieving a Near Term Capability	18
The 2010 Solution	24
Towards Dominant Battlespace Knowledge	25
CONCLUSION	27
APPENDIX	29
ENDNOTES	31
BIBLIOGRAPHY	37

PREFACE

The organization I directed from 1995 to 1997 had the mission of providing national imagery support for the U.S. Army. I participated in numerous efforts during this period to deploy a basic battlespace awareness capability for the field army, merging imagery and topographic data. I observed numerous contractor demonstrations that were ultimately lacking in the ability to rapidly update the situation in a particular battlespace and provide precision locations. During this assignment I became convinced that a centralized effort was needed to meet the challenge of providing battlefield awareness to the warfighter, a position I argue for strongly in this paper.

LIST OF ILLUSTRATIONS

Figure 1: Battlefield Awareness and Data Dissemination(BADD) .	16
Figure 2: Building an Integrated View of Battlespace	21

LIST OF TABLES

Table 1	Service Automated Command & Control Systems	3
Table 2	Advanced Concept Technology Demonstrations (ACTD)	11

ACHIEVING STRATEGIC BATTLESPACE AWARENESS

If you have all the knowledge on the large battlefield and the enemy does not, then you have Dominant Battlefield Awareness. In that case, you win.

Admiral William A. Owens, former Vice Chairman, JCS

The Goal: Dominant Battlespace Awareness

By 2010, a major Department of Defense (DoD) goal is to know with certainty where enemy and friendly forces are within a given battlespace. The term for this capability is Dominant Battlespace Awareness (DBA). Former Vice Chairman of the Joint Chiefs of Staff, Admiral William Owens has stated the need most succinctly. He predicts that by 2010 within a battlespace 200 by 200 miles, warfighters must know almost everything that matters to achieve dominance.¹ Advanced sensor and information fusion will provide near-perfect, real-time discrimination between targets and nontargets.² At present, the Services, DoD's Combat Support Agencies³, DoD research centers, and a host of contractors are independently pursuing the "Awareness Grail," spending vast amounts on various demonstration programs.⁴ To achieve this battlefield awareness objective within a limited budget, however, DoD should now assign one executive agent for this mission and begin reorganizing its information-related

Combat Support Agencies to meet the 2010 Dominant Battlefield Awareness goal.

The Requirement for Battlespace Awareness

Preparing for the future is the third leg of the National Military Strategy; Joint Vision 2010 establishes the concept of U.S. dominance of the future battlefield.⁵ A basic assumption of Joint Vision 2010 is that enhanced command and control, improved intelligence, and other applications of new technology will transform the traditional functions of maneuver and strike into new operational concepts of dominant maneuver and precision engagement.⁶

The Quadrennial Defense Review identifies the key to future success for U.S. forces as development of an integrated "system of systems," linking intelligence collection and assessment, command and control, weapons systems, and support elements to achieve battlespace awareness.⁷ A standard command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) architecture is envisioned to detail where enemy and friendly forces are within a particular battlespace. C4ISR has thus emerged as the way to achieve battlespace awareness.⁸

Achieving this level of awareness will require the total integration of the vast amounts of data available within the DoD Information Infrastructure(DII).⁹ It will also necessitate the deployment of new technology, such as wide area surveillance sensors, automated decision making tools, and communication/dissemination links.

Currently, the battlefield commander and his staff find themselves awash with data--overwhelmed by the information flow. For the past twenty years, each Service has spent billions developing automated command and control systems to assist the warfighter in managing the data flow. Table 1 lists the major Service systems.

SERVICE AUTOMATED COMMAND & CONTROL SYSTEMS

<u>Army:</u>	Standard Theater Army Command and Control System(STACCS)
<u>Navy:</u>	Joint Operational Tactical System(JOTS)
<u>Air Force:</u>	Contingency Tactical Air Control System Automated Planning System(CTARS)
<u>Marine Corps:</u>	Marine Air Ground Task Force Command, Control, Communications, Computers, Intelligence (MAGTFC4I)

Table 1¹⁰

Many of these systems have proven successful, but most share

one limiting characteristic: the flow of data moves from the collection node to a processing node and is displayed to a particular staff element without being correlated with other relevant data, thereby creating an information stovepipe. These systems require a military staff process to merge the relevant data into an overall picture for the commander. Since staffs at each echelon see the data differently, this variation produces a concomitant effect on decision making: Different conclusions are reached from the same data.¹¹ This process also takes time and personnel, two commodities that will be extremely limited on the battlefield of the future. In fact, the battlefield of 2005 will place a premium on rapid decision making over a vastly extended battlefield.¹²

The Example of Desert Storm

Desert Storm offers an excellent example of how the same data at different echelons can lead to different conclusions. One of U.S. Central Command's (the Theater Commander) major operational objectives was to destroy the elite forces of the Iraqi Army, the Republican Guards, who were engaged in the Kuwaiti Theater of Operations. As the ground war progressed and the U.S VII Corps pushed rapidly into Iraq in February 1990, communication between the Corps; Third US Army its higher

headquarters; and the Theater Land Component Commander, U.S. Central Command (CENTCOM) became increasingly difficult due to the constraints of distance and bad weather. Nonetheless, VII Corps made extraordinary efforts to keep its higher headquarters informed.

Based upon the rapid crumbling of most of the Iraqi defenses in Kuwait proper, CENTCOM judged that the Iraqis were defeated everywhere. Meanwhile, U.S. VII Corps was attacking the Republican Guards in a series of hard-fought brigade-size battles against a defense in depth. Consequently, CENTCOM was continually dissatisfied with VII Corps progress. With most of the Coalition Ground Forces in the final pursuit phase by 27 February 1991, CENTCOM assumed VII Corps must be also, which led to the fateful decision to end the war before the Republican Guards could be completely destroyed. Seven years later we still live with the consequences of this decision: Saddam Hussein remains the ruler of Iraq due mainly to the support of the Republican Guards.¹³

We can only speculate on what a common view of the battlefield may have provided those involved in the cease-fire decision. If CENTCOM had understood the defensive efforts of the Republican Guard, how would the estimate of the time needed for

VII Corps to achieve the Guards' destruction have been affected? What would have been CENTCOM's recommendation to the U.S. National Command Authority concerning the cease-fire? Would CENTCOM have taken different actions at the Theater level, utilizing air forces to bottle up and destroy the Republican Guard before it could escape. I believe the answer to each of these questions is "yes".¹⁴ Achieving dominant battlefield awareness will go far toward preventing a recurrence of such a situation.

The Digital Solution

Digitization offers the promise of fully integrated data bases in the future. Digital information is data reduced to its most basic format, ones(1s) and zeros(0s), which then can be electronically read. Thus at its base, all digital data is the same. This makes it conceptually possible to merge this data in new ways to achieve synchronization.¹⁵

A digitization effort with great promise in this regard is the C4I for the Warrior Program. The Joint Staff J-6 directs C4I for the Warrior; the Defense Information Systems Agency(DISA) serves as the lead agency. By 2005 DISA's goal is to have a joint "network of networks" capable of generating and delivering fused information to the tactical level. The ultimate objective

is a global grid of systems providing a worldwide network for transferring information. Artificial intelligence techniques will support data fusion and integrated multimedia products. Using this system, the CINC, Service, and support agency area networks will simultaneously share information in a Defense Information Infrastructure (DII) Common Operating Environment (COE).¹⁶ Common technical standards have been established by DISA. Since 1996 a Joint Technical Architecture (JTA) has been mandated for all new C4I systems. The JTA focuses on commercial standards and on common technical standards, protocols, and conventions, rather than products. It establishes the technical interoperability codes for joint systems.¹⁷ Another major DISA effort is its Shared Data Environment (SHADE) Program to integrate existing databases and establish common software.

Likewise, the DoD C4I Integration Support Activity (C4ISA) has established DoD guidelines for related architectures and system development. Unfortunately, many DoD elements have not been disciplined to utilize these common standards in their contracts. Moreover, waivers are allowed and a condition of compliance is that participating Services/agencies can implement these standards in accord with their own budgets.¹⁸

Two examples of differing programs underway are the Army's Warfighter Information Network(WIN) and the Navy's Information Technology for the 21st Century. The Navy will be using Microsoft Corporation's Broadcast PC, configured in the Windows 98 operating system, employing Windows NT Workstations and server technology.¹⁹ Conversely, the Army's Warfighter Information Network(WIN) Program, developed to support Army XXI, relies on military standard technology for its solution. Commercial solutions are used only as a supplement to military specified solutions.²⁰

Standardization in the storage, transmission, manipulation, dissemination, and networking of vast amounts of electronic digital information is the key to achieving battlespace awareness.²¹ Only through the adoption of such standards can large amounts of diverse data be successfully merged. Through the budget, discipline must be enforced to ensure that all DoD efforts meet one set of standards.

The Technological Challenge

C4I for the Warrior offers two types of systems: legacy systems, existing systems that will continue to function until a designated future time; and migration systems, modern systems that will be deployed to absorb multiple legacy systems.

Presently, awareness is provided by the Global Command and Control System(GCCS). This open, client-served network consists of existing command and control, logistics, and intelligence legacy systems. GCCS makes these systems available to the customer on a single terminal station. These data systems are not interactive, though interactivity is a future goal. Once again, however, this system relies on the human element, the ultimate processor, to both manage the data flow and interpret the data.²²

Intense DoD experimentation is underway to achieve greater battlespace awareness. Early technological leaders, such as direct-to-home television broadcast technology to transmit digital video, audio, and data to inexpensive receivers, are beginning to emerge and garner large scale investments from the Services and various DoD agencies.²³ These initial efforts depend mainly upon intelligence sensors, processors, and dissemination systems for source information. More advanced systems also utilize DoD organizational reporting systems to provide essential awareness data on friendly forces, including logistics flow, activity, and readiness.

At the foundation of any awareness data base, however, must be a common weather, terrain, and electromagnetic picture of a

particular battlespace. Precise geo-location data is particularly vital for targeting, both to successfully destroy an enemy and to prevent fratricide.²⁴

Current military situation assessment systems exploit only a fraction of available multi-sensor data; they are unable to continuously update the battlespace picture so that it can be used to detect tactically significant patterns and events. DoD's Defense Advanced Research Projects Agency (DARPA) is working to develop this capability. Programs are underway in three areas: sensors and communications for wide-area surveillance and dissemination of data; exploitation of the sensor data; and information integration.²⁵

In each area, DARPA has resourced Advanced Concept Technology Demonstrations (ACTD) to produce demonstration systems. ACTDs enable DoD to seek out emerging technologies for critical military needs and incorporate useful technologies into fieldable prototypes. Prototypes are then evaluated by warfighters. Awareness related ACTDs are listed in Table 2, analysis follows:²⁶

Awareness-Related Advanced Concept Technology Demonstrations

<u>Name</u>	<u>Operational Sponsor</u>
High Altitude Endurance Unmanned Aerial Vehicles (HAE UAV)	DARO/Air Force
Rapid Terrain Visualization (RTV)	ACOM/Army
Semi-Automated Imagery Processing (SAIP)	ACOM/Army
Precision Signals Intelligence Targeting Systems (PSTS)	PACOM/Navy
Integrated Collection Management (ICM)	ACOM/DIA
Combat Identification (CID)	ACOM/Army/Marines
Dynamic Database (DD)	ACOM
Battlefield Awareness and Data Dissemination (BADD)	ACOM/EUCOM/Navy/Army

Table 2

The Tier II-plus High Altitude Endurance Unmanned Aerial Vehicles (HAE UAV) are Global Hawk and Dark Star. These systems will provide broad-area, all weather, day-night identification of both fixed and mobile targets on land, at sea, and in the air. Precise coordinates are developed by means of on-board Global Positioning Systems (GPS). On-board communication relays provide 200-mile radius line-of-sight communication from the 45-65,000 foot altitude ranges of these UAVs.

Future sensor packages include hyper-spectral and ultra-spectral sensors that can examine hundreds to thousands of slices of the electromagnetic spectrum to provide extremely accurate identifications.²⁷ Early experiments with these sensors have proven them highly successful at identifying man-made objects against a natural background.²⁸ For example, different patterns of camouflage uniforms laid out on the ground have been identified by a high-altitude aircraft-mounted hyper-spectral sensor.²⁹

The impact of these new capabilities has been detailed by USAF Colonel Roy Edwards, Program Manager for the Airborne Communications Node at DARPA. In Bosnia, a suite of three Global Hawk UAVs (in around the clock operation) could replace 15 communications relay sites, each manned by 50 soldiers and guarded by another 54 soldiers. The Global Hawk/Dark Star will become "virtual satellites" for the warfighter on the ground.³⁰

The vital geographic portion of any awareness databases will be provided through technologies developed in the Rapid Terrain Visualization ACTD. Imagery is draped over terrain elevation data to project a 3-D view of the battlespace. The better the terrain data, the better the product. This ACTD includes

procedures to collect and process terrain elevation and imagery data and to rapidly extract terrain features from imagery.³¹

We also need the ability to distinguish a broad range of targets from nontargets at all levels of war and to identify critical targets from target clusters, along with continuous battlespace targeting. This is perhaps the hardest challenge; we may need a new level of technology to meet this challenge. Two DARPA Programs address this need: the Semi-Automated Imagery Processing(SAIP) ACTD and the Precision Signals Intelligence (SIGINT) Targeting System(PSITS) ACTD. SAIP exploits national and theater imagery intelligence. Artificial intelligence methods are used to recognize vehicle formations on imagery and pass the result to an imagery analyst for confirmation.³² PSITS routes tactical and strategic SIGINT to a central processing facility where the data is fused to produce a precise geolocation of a threat emitter.³³

The Integrated Collection Management(ICM) ACTD is designed to gather and dynamically focus diverse national, theater, and tactical sensors as a Joint Task Force surveillance system- of- systems, which seeks to provide comprehensive collection situational awareness of the theater intelligence collection effort. The goal is to enable dynamic sensor tasking in support

of tactical time-critical targeting.³⁴ Real-time linking of targeting information to warfighters will be vital. The loop from decision to action is expected to be compressed into seconds.³⁵ The Dynamic Database Program(DDP) goal is to produce a continuously updated, integrated, multi-echelon picture of a dynamic battlespace. It converts an immense quantity of multi-sensor data into significant situational information.³⁶

The Joint Combat Identification(CID) ACTD aims to provide real-time, accurate knowledge of one's own location, the location of other friendly forces, the location of enemy forces, and the location of neutrals. The goal is to provide immediate, positive identification of forces as hostile, friendly, or unknown at the point of engagement. This effort is directed at incorporating a combat identification capability into a battlespace awareness database.³⁷

One DARPA ACTD that is moving to full fielding is the Battlefield Awareness and Data Dissemination(BADD)Program. It provides the dissemination of large databases utilizing the Joint Broadcast Service(JBS), an interim stage in the deployment of DoD's Global Broadcast Service(GBS). The BADD ACTD seeks to expand bandwidth by 1000 times for multimedia information delivery to lower, mobile echelons. It will establish

information dissemination server(s) which access multiple data sources--including national and theater intelligence, operational and logistics databases. It provides a graphic depiction of the current situation which is consistent between echelons and thus allows the user to tailor his view of the battlespace by drilling down through the supporting information infrastructure to find the precise information he needs. For example, if the user is looking at the image of a bridge, the data base could be interrogated to yield information on the length, width, height, and condition of the bridge. It also provides a warfighter workstation, a so-called Warfighter's Associate, to allow the user to receive, request, store, manipulate, and view integrated information distributed by the JBS/GBS. A tactical internet circuit back to the broadcast center enables the user to request specific products. Input centers can be established at any echelon.

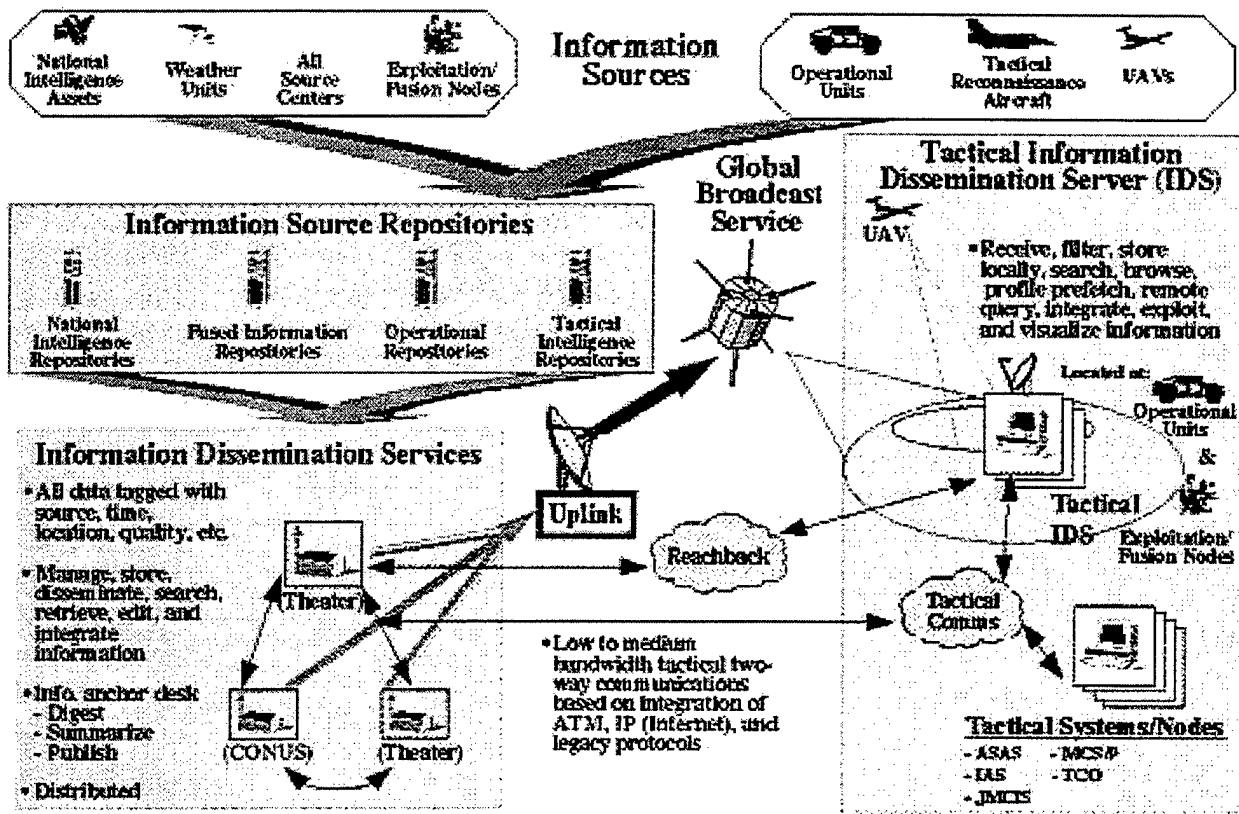


Figure 1: BADD Vision³⁸

BADD has been tested in two forums. In Bosnia an interim capability was set up in 1995. The Bosnia Command and Control Augmentation Initiative (BC2A) provides broadcast service for the U.S. European Command to provide cable news network, intelligence, and operational data to U.S. forces in Bosnia. Most recently, during the Army's Task Force XXI and Division XXI Advanced Warfighting Experiments, Warfighter's Associate Workstations were placed down to the Brigade level. Overall, BADD worked well.³⁹

Beyond DoD, a U.S. national information environment (NIE) is beginning to electronically link organizations and individuals around the country. It merges civilian and military information networks and technologies. Within it, the DoD Defense Information Infrastructure (DII) Common Operating Environment (COE) is taking shape.⁴⁰ Both the civilian and military participants want the same thing: an environment that must be accessible anywhere, with full color, full motion, and interactive multimedia products. It should include data, text, audio & video, thereby providing a simulated world through virtual reality.⁴¹ This capability sets the stage for mission partnerships with industry to satisfy a common need.

Communication bandwidth has been a major limiting factor, but it will soon be greatly expanded with the implementation of advanced fiber optic, optical, and digital wireless communications.⁴² The Teledesic suite of 288 communication satellites in low earth orbit portends a new era. Teledesic will cover 95% of the earth's surface with a capacity of 20,000 fiber-optic like, high bandwidth links. Company co-founder Bill Gates promises bandwidth on demand.⁴³

Another harbinger is the Iridium wireless network that will orbit 66 satellites close to the earth. It will offer hand-held

voice, paging, and fax services to any point on the planet. DISA has purchased a high-capacity connection to Iridium for \$15 million and will purchase about 2,000 hand sets to test its capabilities. If successful they plan to increase usage to about 120,000 hand sets. Another system being examined is the Globalstar Telecommunications 56-satellite system, scheduled to begin commercial operations in 1999.⁴⁴

Ultimately, critical civilian technologies will emerge that can be exploited for military uses. U.S. corporations are spending \$1.5 trillion annually on information technologies. Meanwhile, the entire DoD Research & Development Budget totals \$60 billion.⁴⁵ Companies such as Microsoft, Motorola, AT&T, Sprint, Digital Equipment Corporation, LUCENT Technologies, NEC Corporation, Sun, and others will provide the solutions. DoD must provide the doctrine and requirements, trained leaders and personnel, and organizational structure to take advantage of these emerging commercial efforts.⁴⁶

Achieving a Near Term Capability

In its doctrine, organization, and training, DoD should be positioning now for 2010. Under the umbrella of DARPA's related ACTDs, numerous demonstration programs are underway.

The National Imagery and Mapping Agency (NIMA) touts its Geospatial Framework effort as capable of providing compatible data anywhere on earth, to include maps, weather data, and imagery of troop dispositions. NIMA's projects a \$10 billion budget for this program over ten years.⁴⁷ The National Reconnaissance Office (NRO) has promised a new global system to deliver tailored information on demand wherever the customer is located.⁴⁸ The Defense Intelligence Agency (DIA) offers its Joint Intelligence Virtual Architecture (JIVA) as the answer.⁴⁹ The National Security Agency (NSA) claims its Binocular data base can provide a common forum for awareness.⁵⁰

Meanwhile, the Global Broadcast Service (GBS) is moving to full fielding under a Joint Program Office (JPO). As part of the JPO, a Joint Information Management Center (JIMC) has been set up to take information for broadcast, properly package it, and then transmit the data. Moreover, each of the Services has subsidiary ACTD Programs underway at their Service Battlelabs. Numerous contractors have moved quickly to one camp or another, establishing their proprietary interests.⁵¹

The philosophy that underlines these diverse efforts is good: We are in the experimental stage, let a thousand flowers bloom! But DoD cannot afford the expense of such redundancy in

these lean times. The end state of present awareness efforts may well produce the same stovepiped systems we now have in the intelligence collection community.

Current non-interactive intelligence data bases require their own administration, processing, and dissemination structures.⁵² Also, if the intelligence agencies host the awareness databases, potential for awareness that includes the friendly picture is unlikely. Operations personnel will be leery of supporting an intelligence-driven solution.⁵³

Before we end up with several awareness stovepipes, it is time for DoD to establish unity of effort. The recent formation of Joint Program Offices (JPO) offers a method for bringing DBA to the warfighter, while maximizing utilization of resources. Responding to DoD's Acquisition Reform, DoD formed JPOs to manage projects in which more than one Service had an interest. The JPO is jointly manned. It assumes the mission of overseeing the development, acquisition, and support for a project. The Services manage a system's life-cycle once deployed. Funds for the JPO are to be provided by the Services. However, Congress usually must mandate the dollar amounts that the Services must provide.⁵⁴

The time has come to establish a Joint Project Office for Dominant Battlefield Awareness/Knowledge (JPO-DBA/DBK) with the mission of fielding an interim awareness database by 2005. Its charter should authorize JPO-DBA/DBK to establish a facility where commercial industry in partnership with DoD can demonstrate its wares in a nonproprietary environment.⁵⁵ The JPO

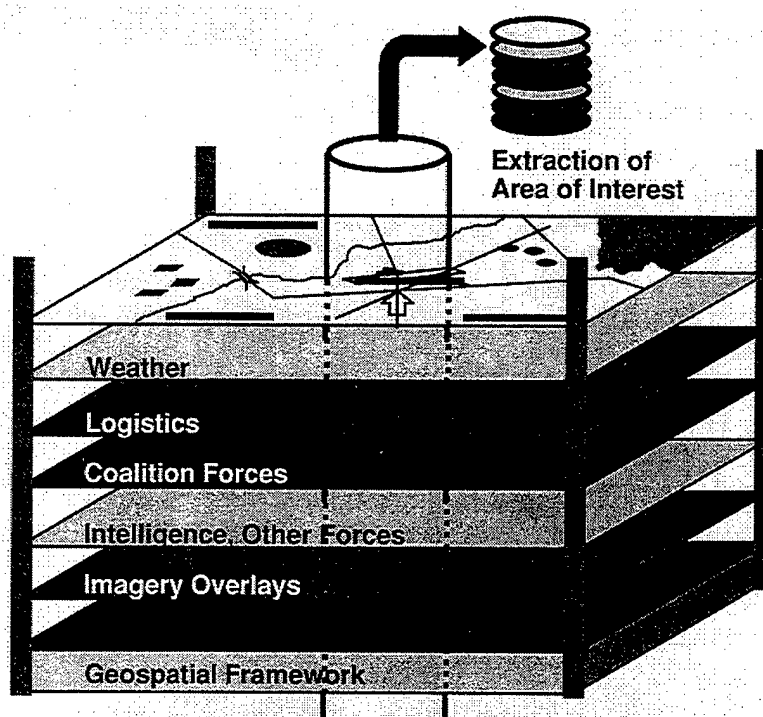


Figure 2: Building an Integrated View of Battlespace⁵⁶

should be staffed and resourced to establish an Awareness Data Warehouse⁵⁷ that can draw upon and merge data from all current Combat Support Agency and Service databases. It should integrate this data so it can be visually displayed on a current

terrain/imagery/weather picture on the BADD Warfighter Associate workstation that is being fielded. This JPO's initial efforts should focus on establishing a common set of requirements and a common doctrine for DBA. Requirements must conform to JTA standards. Doctrinally, the JPO should work with the Joint Staff to publish a Joint Publication in the 3.0 series (Operations) that identifies fundamental principles to guide the development of awareness.

First, it should establish a common definition of battlespace. Joint Publication 2.01 currently defines the concept, but this is an intelligence publication only. The Air Force sees battlespace as limitless, the Army views it as the commander's area of interest, the Navy sees it as the area of influence and the area of interest, while the Marines term it the area of operations. All agree it encompasses air, space, land, and sea. But the Navy and Marines also define a "sub-surface" component, and the Navy adds an electromagnetic component.⁵⁸ Joint Pub 2-01 adds cyberspace and aspects of human psychology, but it offers the disclaimer that the definition is applicable only in the context of this one joint publication! Clearly, we need a shared common definition of battlespace.

Awareness also requires new modes of thinking. Leaders and users must trust the data presented before they will use it for decision-making. Building confidence requires a training effort, the purview of the Services. The JPO should facilitate this by developing training opportunities with industry, preparing training packages with hardware and software support for Service schools, and establishing branch offices at the main Service training centers to both train warfighters in the use of awareness technologies and to benefit from warfighter feedback. Full advantage should be taken of the Joint Exercise Program to demonstrate emerging awareness capabilities. Warfighters will have to feel comfortable with what they are "virtually seeing" before they believe the data.

Along with training packages, initial production efforts should focus on major regional contingencies, underway operations, and development programs. Continuation of Awareness ACTDs should provide the impetus for these kind of products. Once again warfighter feedback will be critical.

Awareness can share the success of JBS/GBS and move to a fielded capability within two to three years. Staffing and funds for this JPO should be carved out of the intelligence agencies, particularly out of their collection stovepipes that will no longer be needed to disseminate data separately. Since the

Intelligence Community is correctly perceived to have only sustained a 25 percent cut under the DoD drawdown, in contrast to almost 40 percent for the rest of DoD, this concept should garner political support.⁵⁹ Moreover, the House Permanent Select Committee on Intelligence has already recommended establishing an Intelligence Acquisition Agency to perform intelligence research and development functions. Thus legislative support should be forthcoming.⁶⁰

The 2010 Solution

By 2005, the DBA database could be the largest and most expensive in the world. Just imagine what it will take to maintain a current database of merely the digitized terrain of the entire world. Though the primary mission of foreign data collection will remain with the intelligence agencies, operations centers throughout DoD will emerge as vital sources of data for awareness.

The 2010 solution I recommend is an expansion of a proposal by the House National Security Committee in its far reaching study of the U.S. Intelligence Community, the 1995 Intelligence Community 21(21st Century) Study. Buried in the recommendation section is the proposal to merge NIMA, NSA, NRO, and the Central Measurement and Signature Intelligence (MASINT) Office(CMO, part

of DIA) into a Technical Services Agency. This proposal aims at breaking the collection stovepipes and at initiating an effort to utilize common technical standards in order to deliver processed information to the warfighter.⁶¹ The analytical elements of these organizations would be placed in DIA or Central Intelligence Agency(CIA), as appropriate.

This initiative will free up thousands of personnel billets and billions of dollars to focus on the Information Dominance mission of JV 2010.⁶² Reliable estimates indicate that about 90% of the estimated \$28 billion U.S. National Intelligence Budget is devoted to technical collection.⁶³ The Joint Project Office Awareness/Knowledge will be at the heart of this effort, merging its initial efforts and data warehouse into the new Defense Technical Services Agency.

Towards Dominant Battlespace Knowledge

The ultimate goal is to move from Dominant Battlespace Awareness to Dominant Battlespace Knowledge(DBK), that is to advance beyond simply knowing where friendly and enemy forces are to knowing what they are doing and accurately predicting what will they do. Such a system of systems will require a totally interactive artificial intelligence technology that is just beginning to emerge.

One area of concentration for future experiments should be the use of intelligent agents. Different types of softbots (software robots) could be used to monitor and protect the data flow and to corral and marshal data at the appropriate dissemination center for movement to the warfighter. At the user end, softbots would be vital for monitoring the data flow to alert the user to key information. These softbots can also monitor underway operations to alert the warfighter to those that go off plan and to move targeting data to weapons platforms. Equipping these softbots with expert systems to make routine decisions for the warfighter, genetic algorithms to learn the user's preferences, and natural language for communication would greatly facilitate the knowledge effort.⁶⁴

The rise of threats to the American homeland will present unique challenges.⁶⁵ Achieving DBK for the defense of America portends a possible loss of privacy for many parts of our society. Present laws and regulations preclude the U.S. Intelligence Community from maintaining information files on U.S. citizens or corporations except under special circumstances, and even then for only limited time periods. It is doubtful the American citizenry will accept such a "military big brother" watching over them. Future planning for consequence management

may require the establishment of an independent civilian agency, similar to the National Aerospace and Space Administration, to administer the U.S. portion of the database.

CONCLUSION

Many DoD programs remain at the experimental stage in the search for Dominant Battlespace Awareness. To meet the requirements of the U.S. National Military Strategy and Joint Vision 2010, the time has come to appoint an executive agent to focus and unify this effort. A Joint Project Office Awareness/Knowledge offers an appropriate solution. Such an effort is needed to break the paradigm of stovepiped data management within the Services and Combat Support Agencies. DARPA is providing the seed money and has viable programs underway to stimulate industry. Commercial mission partners will ultimately provide the sensors, processors, storage devices, and communications links needed to achieve awareness. By 2010 we must have established a DoD central data warehouse to provide the warfighter with an awareness product. This will require some reorganization. A Defense Technical Services Agency carved out of the intelligence combat support agencies offers a viable solution. One key future issue will be protection of information concerning American citizens. Ultimately, an awareness database

that includes U.S. data should probably remain in civilian hands. Today DoD should focus on establishing the requirements and doctrine, on training leaders and personnel, and on developing the organizational structure to facilitate the successful achievement of dominant battlefield awareness by 2010.

WORD COUNT: 5,952

APPENDIX

ACRONYMS

ACOM	U.S. Atlantic Command
ACTD	Advanced Concept Technology Demonstration
BADD	Battlefield Awareness and Data Dissemination
C4I	Command, Control, Communication, Computers & Intelligence
C4ISA	DoD C4I Integration Support Activity
CID	Combat Identification
COE	Common Operating Environment
CSA	Combat Support Agency
DARO	Defense Airborne Reconnaissance Office
DARPA	Defense Advanced Research Projects Agency
DBA	Dominant Battlespace Awareness
DBK	Dominant Battlespace Knowledge
DD	Dynamic Database
DIA	Defense Intelligence Agency
DISA	Defense Information Systems Agency
DoD	Department of Defense
EUCOM	U.S. European Command
GBS	Global Broadcast Service

GPS	Global Positioning System
HAEUAV	High Altitude Endurance Unmanned Aerial Vehicles
ICM	Integrated Collection Management
IMINT	Imagery Intelligence
JBS	Joint Broadcast Service
JIVA	Joint Intelligence Virtual Architecture
JPO	Joint Project Office
JV 2010	Joint Vision 2010
MASINT	Measurement & Signatures Intelligence
PACOM	U.S. Pacific Command
PSTS	Precision SIGINT Targeting System
RTV	Rapid Terrain Visualization
SAIP	Semi-Automated Imagery Processing
SIGINT	Signals Intelligence
UAV	Unattended Aerial Vehicle

ENDNOTES

¹ Admiral William A. Owens, U.S. Navy(Ret.), "The Emerging System of Systems," US Naval Institute Proceedings, May 1995, 1-4.

² Owens, 3.

³ The Combat Support Agencies have the mission of supporting wartime operations. These include: the Defense Logistics Agency, Defense Information Systems Agency, National Security Agency, National Imagery and Mapping Agency, and the Defense Intelligence Agency.

⁴ National Imagery and Mapping Agency, Geospatial Information Infrastructure Master Plan, Volume 1-1, Stakeholders Annex(Washington, D.C.: National Imagery and Mapping Agency, 17 October 1997). This annex documents Service by Service, agency by agency, and for selected parts of industry, academia, as well as for the United Kingdom military, the differing technical approaches being utilized.

⁵ U.S. Department of Defense, National Military Strategy (Washington, D.C.: U.S. Department of Defense, October 1997), 2-3. The triad are: Shape the international environment, Respond to the full spectrum of crises, and Prepare Now for an uncertain future.

⁶U.S. Joint Chiefs of Staff, Joint Vision 2010 (Washington, D.C.: U.S. Department of Defense, 1997), 19-21. Dominant maneuver will be the multidimensional application of information, engagement, and mobility capabilities to position and employ widely dispersed joint forces. Precision engagement will consist of a system of systems that enables our forces to locate the objective or target, provide responsive command and control, generate the desired effect, assess success, and retain the flexibility to reengage with precision when required.

⁷ U.S. Department of Defense, Report of the Quadrennial Defense Review (Washington, D.C.: U.S. Department of Defense, May 1997), vi.

⁸ IBID, 15. Battlespace is defined as any area over which the warrior exercises control or has an interest regardless of echelon. It may include areas of land, air, sea, and space. Dominant Battlespace Awareness(DBA) details where enemy and friendly forces are in a battlespace. Dominant Battlefield Knowledge(DBK) includes DBA, but expands its scope to include what the enemy is doing.

⁹ U.S. Joint Chiefs of Staff, Joint Pub 6-02, Joint Doctrine for Employment of Operational/Tactical Command, Control, Communications, and Computer Systems (Washington, D.C.: Joint Chiefs of Staff, 1 October 1996), IV-1. The Defense Information Infrastructure encompasses the information transfer, processing, storage, manipulation, retrieval, and display resources of the Department of Defense.

¹⁰ C4I Integrated Support Agency, C4I Handbook for Integrated Planning (CHIP) (Washington, D.C.: Office of the Assistant Secretary of Defense, Command, Control, Communications, and Intelligence, January 1995), 6-6 to 6-7.

¹¹ John H. Cushman, Thoughts for Joint Commanders (Annapolis, MD: John H. Cushman, 1993), 40-47.

¹² Lt. Gen. C. Norman Wood, USAF (Ret.), "Secure Information Demonstrations Stimulate Modern Military Thinking", Signal, March 1997, 15.

¹³ Tom Clancy and General Fred Franks, Jr. (US Army, Ret.), Into the Storm, A Study in Command (New York, N.Y.: G.P. Putnam's Sons, 1997), 211, 231, 256, 558, 567, 578, 412, 417. General Norman Schwarzkopf (US Army, Ret.) and Peter Petre, It Doesn't Take A Hero (New York, N.Y.: Bantam Books, 1992), 522-547. Rick Atkinson, Crusade (New York, N.Y.: Houghton Mifflin Company, 1993), 421-425.

¹⁴ Clancy and Franks, 474

¹⁵ Don Tapscott, The Digital Economy, Promise and Peril in the Age of Networked Intelligence (New York, N.Y.: McGraw-Hill, 1996), 100-102.

¹⁶ C4ISA Handbook, 6-6 to 6-7.

¹⁷ Defense Information Systems Agency, "Joint Technical Architecture Briefing," available from <<http://www-jta.itsi.disa.mil/jta/jtabrief.html>>; Internet; accessed 28 Jan 98.

¹⁸ Armed Forces Communications and Electronics Association, "Shared Data Environment Briefing," available from <http://spider.osfl.disa.mil/dii/brief/afcea_brief/afcea_brief.html>; Internet; accessed 17 December 1997.

¹⁹ Bob Brewin, "DoD awards high-speed broadcast service pact," Federal Computer Week, 1 December 1997, 22, 26.

²⁰ Otto J. Guenther, LTG, USA, Retired, "Managing the Race for Information Dominance," ARMY, June 1997, 23-25. U.S. Army Training and Doctrine Command (TRADOC) System Manager Satellite Communications, The Army Satellite Communications (SATCOM)

Architecture(Ft. Gordon, GA: U.S. Army Signal School, April 1997), 12-6 to 12-24.

²¹ National Imagery and Mapping Agency, Geospatial Information Infrastructure Master Plan, Volume 1(Washington D.C.: National Imagery and Mapping Agency, 17 October 1997), 28,33.

²² U.S. Department of the Army, Center for Strategic Leadership, Global Command and Control System, (Carlisle Barracks, P.A.: Defense Printing Service, October 1997), 1-4. GCCS connectivity is the Secret Internet Protocol Router(SIPRNET). This provides access to existing databases, such as Time Phased Forces Deployment Databases, and Intelink. GCCS also includes planning tools for different users to work on the same problem. It uses a standard Graphical User Interface pull-down Windows and point-and-click technology that is very user friendly.

²³ TRADOC System Manager Satellite Communications, 12-18.

²⁴ Defense News, "Military Simulation & Training Technology Supplement--Winter 97," Defense News, 24-30 Nov 97, insert, 1-28.

²⁵ John Boatman, "Jane's Defense Weekly Interview-Mr Larry Lynn, Director of the US Advanced Research Projects Agency," 9 September 1995; available from <<http://www.janes.com/public/defense/interviews/0909.html>>; Internet; accessed 10 October 1997.

²⁶ Mr. Troy A. Crites, "ISO Battlefield Awareness Program Portfolio,";available from<<http://maco.dc.isx.com/iso/battle/index.html>>; Internet; accessed 23 October 1997.

²⁷ Dr. Mark E. Davis, "Counter CC&D Program,"; available from <<http://maco.dc.isx.com/iso/battle/cccd.html>>; Internet; accessed 23 October 1997.

²⁸ Signal, "Technologies Improve Radar Ground, Foliage Penetration," Signal, December 1997, 25-28.

²⁹ David A. Fulghum, "Military Reconnaissance Slices the Spectrum Anew," Aviation Week & Space Technology, 4 November, 1996, 27-28.

³⁰ Bruce D. Nordwall, "UAVs May Sub for Satcom On Future Battlefield," Aviation Week & Space Technology, 28 April 1997, 52-55.

³¹ Defense Advanced Research Projects Agency, "Rapid Terrain Visualization,";available from <<http://www.acq.osd.mil/at/rtv.html>>; Internet; accessed 28 January 1998.

³² Dr. Thomas Strat, "Image Understanding,";available from <<http://maco.dc.isx.com/iso/battle/iu.html>>; Internet; accessed 23 October 1997.

³³ Defense Advanced Research Projects Agency, "Precision SIGINT Targeting System," available from <http://www.acq.osd.mil/at/psts.html>.>; Internet; accessed 28 January 1998.

³⁴ Defense Advanced Research Project Agency, "Integrated Collection Management," available from <http://www.acq.osd.mil/at/icm.html>.>; Internet; accessed 28 January 1998.

³⁵ Captain James R. Fitzsimonds, USN, "Intelligence and the Revolution in Military Affairs," in U.S. Intelligence at the Crossroads, ed. Roy Godson, Ernest R. May, and Gary Schmitt (Washington D.C.: Brassey's), 267.

³⁶ Major Tom J. Burns, USAF, "Dynamic Database," available from <http://maco.dc.isx.com/iso/battle/ddb.html>>; Internet; accessed 23 October 1997. Also, Mr. David Gunning, "Intelligent Integration of Information Technology (I3)," available from <http://maco.dc.isx.com/iso/battle/i3.html>>; Internet; accessed 23 October 1997.

³⁷ Defense Advanced Research Projects Agency, "Combat Identification," available from <http://www.acq.osd.mil/at/cid.html>>; Internet; accessed 28 January 1998.

³⁸ Defense Advanced Research Projects Agency, "Battlefield Awareness and Data Dissemination," from <http://www.acq.osd.mil/at/badd.html>>; Internet; accessed 28 January 1998.

³⁹ Dr Robert J. Douglass and LTC Jeffrey P. Gerald, USAF, "Battlefield Awareness and Data Dissemination," available from <http://maco.dc.isx.com/iso/battle/badd.html>>; Internet; accessed 23 October 1997. Also, William B. Scott, "U.S. Deploys Advanced SATCOM in Bosnia," Aviation Week & Space Technology, 13 May 1996, 55-57. Lastly, Colonel Keith Alexander, USA, "525th MI Brigade, Support to the Task Force XXI AWE", Military Intelligence Magazine, July-September 1997, 38-42.

⁴⁰ U.S. Department of the Army, Information Operations (Washington, D.C.: U.S. Department of the Army, 1997), 3.

⁴¹ Tapscott, 102, 105, 117, 172.

⁴² Ibid, 105.

⁴³ Paul Proctor, "Boeing Boosts Space Role with Stake in Teledisc," Aviation Week & Space Technology, 5 May 1977, 26.

⁴⁴ Quentin Hardy, "Iridium Gets U.S. as First Customer Of Wireless Communication System," Wall Street Journal, 26 January 1998, B7, pg 1.

⁴⁵ Signal, "Defense Strategy Balances Priorities," Signal, July 97, 6.

⁴⁶ Signal, "Military, Industry Partners Grab Information Systems' Brass Ring," Signal, September 1997, 91-94.

⁴⁷ Walter Pincus, "Space Imagery Overhaul Aims at Better Data and Easier Access," The Washington Post, 20 January 1998, Sec A, p. 7.

⁴⁸ Ibid.

⁴⁹ Defense Intelligence Agency, Vector 21: A Strategic Plan for the Defense Intelligence Agency(Washington, D.C.: U.S. Defense Intelligence Agency, January 1997), 20.

⁵⁰ Defense Science Board, Report of the Defense Science Board Task Force on Improved Application of Intelligence to the Battlefield(Washington D.C.: U.S. Department of Defense, July 1996), 61.

⁵¹ Signal, "Center for Applied Technology," Signal, January 1988, 65.

⁵² Congress, House, Permanent Select Committee on Intelligence, IC21: Intelligence Community in the 21st Century, Staff Study, 104th Congress, 2d Sess., 1996, Committee Print, 98-101.

⁵³ Defense Science Board, 32.

⁵⁴ Colonel Larry T. Thomas, U.S. Army Acquisition Corps, The establishment and organization of a Joint Project Office, interview by author, 22 January 1998, Carlisle, PA.

⁵⁵ Signal, "Center for Applied Technology," Signal, January 1988, 65.

⁵⁶ NIMA IPT, 10.

⁵⁷ John Teresko, Data Warehouses, Industry Week, 18 March 1996, 45. In order to have easily accessible information you need to have the information designed and organized into a data warehouse; an integrated data architecture that is both detailed and summarized, with historical data and metadata(data about data) that allows easy discovery of the needed information.

⁵⁸ Within the Services different definitions are detailed in Air Force Doctrine Document 1, Naval Doctrine Publication 1, and Army Field Manual 100-5, Operations, and Fleet Marine Force Field Manual 3, Command and Control.

⁵⁹ Twentieth Century Fund, In From the Cold, The Report of the Twentieth Century Fund Task Force on the Future of U.S. Intelligence(New York, N.Y.: The Twentieth Century Fund Press, 1996), 99-100.

⁶⁰ Signal, "Legislators Spur Virtual Intelligence Environment," Signal, October 97, 27.

⁶¹ IC21 Study, 23.

⁶² Commission on the Roles and Capabilities of the United States Intelligence Community, Preparing for the 21st Century: An Appraisal of U.S. Intelligence (Washington, D.C.: U.S. Government Printing Office, March 1, 1997) pg 10-6 to 10-9, 13-6.

⁶³ Twentieth Century Fund, 99-100 and Russ Travers, "The Coming Intelligence Failure," Studies in Intelligence, 1997, pg 40. Studies in Intelligence is the CIA monthly magazine that is published in unclassified format once per year.

⁶⁴ U.S. Department of the Army, Artificial Intelligence-An Executive Overview, (West Point, N.Y.: United States Military Academy, December 1994), 105-159.

⁶⁵ Steven Komarow, "Panel wants beefed-up National Guard," USA Today, 2 Dec 1997, p.1.

BIBLIOGRAPHY

Alexander, Keith, Colonel, USA. "525th MI Brigade, Support to the Task Force XXI AWE." Military Intelligence Magazine, July-September 1997, 38-42.

Armed Forces Communications and Electronics Association. "Shared Data Environment Briefing," available from <http://spider.osfl.disa.mil/dii/brief/afcea_brief/afcea_brief.html>. Internet. Accessed 17 December 1997.

Atkinson, Rick. Crusade. New York, NY: Houghton Mifflin Company, 1993.

Boatman, John. "Jane's Defense Weekly Interview-Mr. Larry Lynn, Director of the US Advanced Research Projects Agency", 9 September 1995. Available from <<http://www.janes.com/public/defense/interviews/0909.html>>. Internet. Accessed 10 October 1997.

Brewin, Bob. "DoD awards high-speed broadcast service pact." Federal Computer Week, 1 December 1997, 22-26.

Burns, Tom J., Major, USAF. "Dynamic Database." Available from <<http://maco.dc.isx.com/iso/battle/ddb.html>>. Internet. Accessed 23 October 1997.

C4I Integration Support Agency. C4I Handbook for Integrated Planning(CHIP). Washington, D.C. Office of the Assistant Secretary of Defense, Command, Control, Communications, and Intelligence, January 1995.

Clancy, Tom and Franks, Fred, Jr., General(US Army, Ret.). Into the Storm, A Study in Command. New York, N.Y.: G.P. Putnam's Sons, 1997.

U.S. Congress. House. Permanent Select Committee on Intelligence. IC21: Intelligence Community in the 21st Century, Staff Study. 104th Congress, 2d Sess., 1996. Committee Print, 98-101.

Cushman, John H. Thoughts for Joint Commanders. Annapolis, MD: John H. Cushman, 1993.

Commission on the Roles and Capabilities of the United States Intelligence Community. Preparing for the 21st Century: An Appraisal of U.S. Intelligence. Washington, D.C.: U.S. Government Printing Office, March 1, 1997.

Crites, Troy A. "ISO Battlefield Awareness Program Portfolio." Available from<<http://maco.dc.isx.com/iso/battle/index.html>>. Internet. Accessed 23 October 1997.

Davis, Mark E., Dr., "Counter CC&D Program." Available from <<http://maco.dc.isx.com/iso/battle/cccd.html>>. Internet. Accessed 23 October 1997.

Defense Advanced Research Projects Agency. "Battlefield Awareness and Data Dissemination." Available from <<http://www.acq.osd.mil/at/badd.html>>. Internet Accessed 28 January 1998.

Defense Advanced Research Projects Agency. "Combat Identification." Available from <<http://www.acq.osd.mil/at/cid.html>>. Internet. Accessed 28 January 1998.

Defense Advanced Research Projects Agency. "Integrated Collection Management." Available from <<http://www.acq.osd.mil/at/icm.html>>. Internet. Accessed 28 January 1998.

Defense Advanced Research Projects Agency. "Precision SIGINT Targeting System." Available from<<http://www.acq.osd.mil/at/psts.html>>. Internet. Accessed 28 January 1998.

Defense Advanced Research Projects Agency. "Rapid Terrain Visualization." Available from <<http://www.acq.osd.mil/at/rtv.html>>. Internet. Accessed 28 January 1998.

Defense Information Systems Agency. "Joint Technical Architecture Briefing." Available from <<http://www-jta.itsi.disa.mil/jta/jtabrief.html>>. Internet. Accessed 28 Jan 98.

Defense Intelligence Agency. Vector 21: A Strategic Plan for the Defense Intelligence Agency. Washington, D.C.: U.S. Defense Intelligence Agency, January 1997.

Defense News. "Military Simulation & Training Technology Supplement--Winter 97." Defense News. 24-30 Nov 97, 1-28.

Defense Science Board. Report of the Defense Science Board Task Force on Improved Application of Intelligence to the

Battlefield. Washington D.C.: U.S. Department of Defense, July 1996.

Douglass, Robert J., Dr and Gerald, Jeffrey P. LTC, USAF.

"Battlefield Awareness and Data Dissemination." Available from <<http://maco.dc.isx.com/iso/battle/badd.html>>. Internet. Accessed 23 October 1997.

Fitzsimonds, James R., Captain, USN. "Intelligence and the Revolution in Military Affairs." In U.S. Intelligence at the Crossroads, ed. Roy Godson, Ernest R. May, and Gary Schmitt, 265-287. Washington D.C.: Brassey's, 1995.

Fulghum, David A. "Military Reconnaissance Slices the Spectrum Anew," Aviation Week & Space Technology, 4 November, 1996, 27-28.

Fulghum, David A. "New Intel Office Blends Target Data." Aviation Week & Space Technology, 5 May 1997, 56-57.

Guenther, Otto J., LTG, USA, Retired, "Managing the Race for Information Dominance." ARMY, June 1997, 23-25.

Komarow, Steven. "Panel wants beefed-up National Guard." USA Today, 2 DEC 1997, p.1.

Nordwall, Bruce D. "UAVs May Sub for Satcom On Future Battlefield." Aviation Week & Space Technology, 28 April 1997, 52-55.

National Imagery and Mapping Agency. Geospatial Information Infrastructure Master Plan, Volumes 1-3,. Washington, D.C., National Imagery and Mapping Agency, 17 October 1997.

Owens, Admiral William A., U.S. Navy(Ret.). "The Emerging System of Systems." US Naval Institute Proceedings, May 1995, 1-4.

Pincus, Walter. "Space Imagery Overhaul Aims at Better Data and Easier Access." The Washington Post, 20 January 1998, Sec A, p. 7.

Proctor, Paul. "Boeing Boosts Space Role with Stake in Teledisc." Aviation Week & Space Technology, 5 May 1977, 26.

Quentin, Hardy, "Iridium Gets U.S. as First Customer Of Wireless Communication System." Wall Street Journal, 26 January 1998, B7, pg. 1.

- Schwarzkopf, Norman General (US Army, Ret.) and Petre, Peter., It Doesn't Take A Hero. New York, N.Y.: Bantam Books, 1992.
- Scott, William B. "U.S. Deploys Advanced SATCOM in Bosnia." Aviation Week & Space Technology, 13 May 1996, 55-57.
- Signal. "Center for Applied Technology." Signal, January 1988, 65.
- Signal. "Defense Strategy Balances Priorities.," Signal, July 97, 6.
- Signal. "Military, Industry Partners Grab Information Systems' Brass Ring." Signal, September 1997, 91-94.
- Signal. "Technologies Improve Radar Ground, Foliage Penetration." Signal, December 1997, 25-28.
- Strat, Thomas, Dr. "Image Understanding." Available from <<http://maco.dc.isx.com/iso/battle/iu.html>>. Internet. Accessed 23 October 1997.
- Tapscott, Don. The Digital Economy, Promise and Peril in the Age of Networked Intelligence. New York, N.Y.: McGraw-Hill, 1996.
- Teresko, John. "Data Warehouses." Industry Week, 18 March 1996, 45.
- Thomas, Larry T., Colonel, U.S. Army Acquisition Corps. Formation and organization of a Joint Project Office. Interview by author, 22 January 1998, Carlisle, PA.
- Travers, Russ. "The Coming Intelligence Failure." Studies in Intelligence, 1997, 40-45.
- Twentieth Century Fund. In From the Cold, The Report of the Twentieth Century Fund Task Force on the Future of U.S. Intelligence. New York, NY: The Twentieth Century Fund Press, 1996.
- U.S. Department of Defense. National Military Strategy. Washington, D.C.: U.S. Department of Defense, October 1997.
- U.S. Department of Defense. Report of the Quadrennial Defense Review. Washington, D.C.: U.S. Department of Defense, May 1997.

- U.S. Department of the Air Force. Air Force Basic Doctrine. Air Force Doctrine Document 1. Washington, D.C.: U.S. Department of the Air Force, September 1997.
- U.S. Department of the Army. Army Vision 2010. Washington, D.C. U.S. Department of the Army, 1997.
- U.S. Department of the Army. Artificial Intelligence-An Executive Overview. West Point, N.Y.: United States Military Academy, December 1994.
- U.S. Department of the Army. Information Operations. Washington, D.C.: U.S. Department of the Army, 1997.
- U.S. Department of the Army. Operations. FM 100-5. Washington, D.C. U.S. Department of the Army, 1997.
- U.S. Department of the Army, Center for Strategic Leadership, Global Command and Control System. Carlisle Barracks, P.A.: Defense Printing Service, October 1997.
- U.S. Department of the Army, U.S. Army Training and Doctrine Command (TRADOC), System Manager Satellite Communications. The Army Satellite Communications (SATCOM) Architecture. Ft. Gordon, GA: U.S. Army Signal School, April 1997.
- U.S. Department of the Navy. Naval Warfare. Naval Doctrine Publication 1. U.S. Department of the Navy, 28 March 1994.
- U.S. Joint Chiefs of Staff. Joint Vision 2010. Washington, D.C.: U.S. Department of Defense, 1997.
- U.S. Joint Chiefs of Staff. Joint Intelligence Support to Military Operations. Joint Pub 2-01. Washington, D.C.: U.S. Joint Chiefs of Staff. 20 November 1996.
- U.S. Joint Chiefs of Staff. Joint Doctrine for Employment of Operational/Tactical Command, Control, Communications, and Computer Systems. Joint Pub 6-03. Washington, D.C.: Joint Chiefs of Staff, 1 October 1996.
- U.S. Marine Corps. Command and Control. FMFM3. Washington, D.C. U.S. Marine Corps, 16 June 1993.
- Wodd, Norman, Lt. Gen., USAF (Ret.). "Secure Information Demonstrations Stimulate Modern Military Thinking." Signal, March 1997, 15.