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A comparative analysis of information systems and Command and Control program concepts to support the common operating picture

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THESIS

A COMPARATIVE ANALYSIS OF INFORMATION SYSTEMS AND COMMAND AND CONTROL PROGRAM CONCEPTS TO SUPPORT THE COMMON OPERATING PICTURE

by

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September 2002

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13. ABSTRACT ***(maximum 200 words)***

A Collaborative Information Environment (CIE) provides a set of tools for the commander and the warfighters, at all levels, to access a near real-time, fused, accurate picture representing the battlespace. The CIE introduces a variety of capabilities to assist decision-makers by providing a common relevant operational picture and the ability to conduct collaborative planning. Several information systems, currently under development, are being designed to provide improved situational awareness, and offer potential support to the CIE.

This thesis research was performed to support U.S. Joint Forces Command (JFCOM), J9, Joint Experimentation Division, as part of their effort to develop new warfighting concepts to support the transition of the military force to the fighting force described in Joint Vision 2020. Ten information systems, identified by JFCOM, were analyzed and compared on a set of criteria that were developed and refined as part of this research. The objective was to compare these information systems on the established criteria to provide a basis for assessing the level of support provided by these systems to the CIE and emerging warfighting concepts. Descriptions of the ten systems are provided along with data that was collated from a variety of sources to conduct the analysis.

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A COMPARATIVE ANALYSIS OF INFORMATION SYSTEMS AND COMMAND AND CONTROL PROGRAM CONCEPTS TO SUPPORT THE COMMON OPERATING PICTURE

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A Collaborative Information Environment (CIE) provides a set of tools for the commander and the warfighters, at all levels, to access a near real-time, fused, accurate picture representing the battlespace. The CIE introduces a variety of capabilities to assist decision-makers by providing a common relevant operational picture and the ability to conduct collaborative planning. Several information systems, currently under development, are being designed to provide improved situational awareness, and offer potential support to the CIE.

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The process of studying command and control, common operational picture systems, and the associated developing technologies, was very interesting. I would personally like to thank my wife, Ginger, through this demanding and time consuming process of studying the background to analyze ten systems being developed to present a Common Operational Pictures.

I would also like to thank the representatives of the systems for their time given to participate in the interviews. Credit is due to my thesis advisors, Prof. Hutchins, for being very involved in providing professional assistance and solid advice in the formulation of this project and Prof. Kemple, for his encouragement and recommendations.

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I. INTRODUCTION

A. COLLABORATIVE INFORMATION ENVIRONMENT RESEARCH

This research involves providing analytical support to the United States Joint Forces Command (JFCOM), J9, Concepts Development Division, Norfolk, VA. Assistance was provided in the form of an analysis of future Command and Control (C2) information management systems currently under development. JFCOM identified a group of information systems that offer potential support to emerging C2 concepts being developed at JFCOM. JFCOM is involved in concept development to provide guidance to transform the U.S. military forces as envisioned in Joint Vision 2020. One concept seen as critical to the Joint Force operating in a network-centric environment is the Collaborative Information Environment (CIE).

The CIE is being designed to provide a Common Relevant Operational Picture (CROP) along with tools that provide the ability to collaborate and perform interactive planning. In essence, the CIE should present information to the commander in a way that facilitates developing a shared situational awareness amongst the staff and the necessary decision-makers. The CROP will be designed to process and present information from the Global Information Grid (GIG) in a way that provides a timely, fused, accurate, assured, and relevant "picture" that can be tailored to meet the requirements of the warfighting commander. The goal for the CROP is to present the right information, at the right place, at the right time, in the right presentation format to accelerate the warfighter's decision-to-action operations tempo. Access to the CROP will permit the dynamic, flexible sharing of information that is relevant to the warfighting commander and staff.

B. DISCUSSION

1. Rapid Decisive Operations

The concept of Rapid Decisive Operations (RDO) is based on a knowledge-centric approach to warfare that takes advantage of advances in information and communication technology combined with a concurrent effort to reorganize the forces and reshape their tactics. Warfighters will be networked so that they can collaborate and exchange information with other warfighters to develop a shared situational awareness of the battlespace. Examples of the advantages to be gained by operating within a networked force include: developing enhanced knowledge of the capabilities of hostile and/or friendly forces, rules of engagement, intelligence, developing situations and updates, trends, and how this information affects political, economic, and military considerations. This enhanced understanding should, in turn, permit warfighters to combine our unique national advantages in mobility and precision to achieve more rapid resolution of small-scale contingencies without the application of mass and overwhelming brute force. The CROP concept offers great potential to support RDO. The CROP is anticipated to be the vehicle by which relevant information, required by the Joint Force, is presented in the format and timeframe to most effectively support the warfighter.

2. Increased Access to Information

Throughout history, gathering, exploiting, and protecting information have been and will continue to be critical in command, control, and intelligence. The future warfighter will have increased access to information and improvements in the speed and accuracy of prioritizing and transferring data brought about by advances in technology. This faster access to information will enable the commander to orient to the problem faster than the enemy can react and decide what course of action will work best. Simply put, the CROP concept will guide future research and development to define what

information needs to be collected, how it should be processed (analysis and fusion), how it will be disseminated, and how it will be presented in the future to enable RDO.

3. Support to JFCOM

JFCOM requested assistance from the Naval Postgraduate School to conduct research to support the process of developing and testing different aspects of the emerging concepts for future warfighting. JFCOM's Point Paper of 2 August 2001 describes the following milestones of the recently signed directive authorizing the development of the Information Dissemination Management (IDM) and Global Information Grid (GIG) Capstone Requirements Documents (CRD) as follows: (1) In July 1999 the Joint Requirements Oversight Council (JROC) selected JFCOM to lead the IDM CRD development effort. IDM is defined as the means and process by which information dissemination is managed to ensure user (warfighter) awareness of the available information. IDM also includes providing access to that information without having to know exactly where it is or what format it is in, and the delivery of the information in a timely manner that supports the user's needs. (2) In November 1999 the JROC selected JFCOM to lead the GIG CRD development effort. The GIG is defined by Office of the Secretary of Defense (OSD) as the globally interconnected, end-to-end set of information capabilities, processes and personnel. It includes all Department of Defense (DoD) owned and leased communications systems, supporting capabilities, and associated services to achieve information superiority. The GIG is intended to support all DoD, national security, and related intelligence community missions and functions, provide capabilities from all operating locations, and to interface with coalition, allied and non-DoD users and systems.

The IDM CRD directive guidance was approved by the JROC on 8 May 2001 (JROCM 079-01). The IDM and GIG CRDs are intended to: (1) capture fundamental, overarching information capability requirements that allow warfighters and other authorized users in DoD and the intelligence community, anytime and anywhere, to satisfy their validated user information requirements; (2) guide all DoD components in developing Operational Requirements Documents (ORDs) for new systems and for

upgrading legacy systems; and (3) guide future information technology investment to ensure interoperability.

4. DoD Documentation for Better Situational Awareness Tools

The need for better situational awareness has always been a critical element for commanders. Military commanders have always desired to know the location of all forces (enemy and friendly), their activities and capabilities, and the environmental circumstances. Many recent advances in technology are attempting to improve situational awareness by presenting battlespace events on digital displays. These technologies will provide the commander with a common operational picture representing important information.

DoD documents stating the need for better situational awareness tools are found in many recent significant official publications. Some examples include: Joint Vision 2010 and Joint Vision 2020 [Ref 1]; Requirements Identification Document for GCCS Phase III, 22 Dec 1998 [Ref 26]; COP Technical Requirements Specification, Dec 1998; and the Theater Air Missile Defense CRD, [Ref 43].

C. SYSTEM EVALUATION

The CIE is envisioned to use web-based technologies, artificial intelligence, and collaboration and information management tools in a real-time environment. As an emerging tool, many prototypes and concepts are being developed and tested in an attempt to provide an improved CROP capability. This thesis research consisted of collecting material on, and analyzing, systems and programs that are related to CROP concepts. The following ten C2 information systems were analyzed:

1. Global Command and Control System (GCCS)
2. Global Information Grid (GIG) Capstone Requirements Document (CRD)
3. Information Dissemination Management (IDM) Capstone Requirements Document (CRD)
4. Family of Interoperable Operational Pictures (FIOP)
5. Single Integrated Air Picture (SIAP)
6. Knowledge-Web (K-Web)
7. Command Post of the Future (CPOF)
8. Joint Theater Logistics (JTL)
9. Adaptive Battlespace Awareness (ABA)
10. Joint Battlespace Infosphere (JBI)

D. CRITERIA

The above systems were analyzed using the criteria listed below. These criteria evolved over the course of conducting the research to reflect the emphasis desired by JFCOM, J-9. Significant distinctions between the systems using these criteria were observed. The full set of criteria is identified in Chapter III of the thesis.

1. System Background and additional information.
2. Type of Program and its maturity: Is it a system, concept or methodology?
3. Functionality: What is the primary function of the program, i.e., Operator/Planner Situational Awareness, facilitates time critical target decisions, etc.?
4. Primary User Community: What level of user is it targeted for?
5. Funding: Who is providing it?
6. Technology Issues Addressed: Technical design approach, methodologies, or technical documentation addressed.
7. Purpose? What function is it developed to support?
8. Program Orientation: Joint or Service specific?
9. Who is determining the requirements?
10. Collaborative tools and capabilities?

E. RESEARCH QUESTIONS

1. What comparison criteria can be used to evaluate the systems under consideration?
2. Which programs and capabilities offer the greatest potential for follow-on development?

F. SCOPE OF THE THESIS

The scope of this thesis was limited to analyzing the ten programs identified by JFCOM as providing potential support to the emerging CROP concepts. Research performed for this thesis consisted of conducting the three phases of work listed below:

1. Developed evaluation criteria for comprehensive system analysis balanced between future desired CROP capabilities and average capabilities of the present systems
2. Utilized the criteria to perform an objective evaluation of each system
3. Provided JFCOM, J-9, a summary of the comprehensive system analysis

G. METHODOLOGY

To develop a working familiarity with the new warfighting concepts currently under development at JFCOM, a literature review was conducted on Network Centric Warfare (NCW), information superiority and dissemination, command and control, Rapid Decisive Operations, Joint Interactive Planning, Common Relevant Operational Picture and the way these concepts will be supported by the Global Information Grid (GIG).

Next, after becoming familiar with the terminology and the concepts mentioned in the above paragraph, research on the emerging CROP systems identified by JFCOM was initiated. Balancing the objectives of the developing warfare objectives with respect to underlying commonalities amongst the CROP system, a set of criteria was developed and refined through the interview process to provide the best quantifiable metrics to distinguish the systems. Through interviews with several users of C2 information

systems and a literature review of CIE, research was conducted to determine desirable characteristics in CROP systems that will help enable warfighters to make sound, practical and timely decisions at all three levels (tactical, operationally, and strategically). The methodology used to obtain information on the systems analyzed in this thesis research consisted of conducting a literature search of books, periodicals, CD-ROMs, internet web pages, informational pamphlets, and library information. Interviews were then coordinated with program managers or significant representatives of the systems identified for analysis. Information gleaned from the interviews and literature search was collected and processed to provide additional system information for each system. The intent is to provide a description of each of the systems identified as offering potential value to the developing CIE and an analysis of the ten systems using the set of criteria that were developed to conduct this analysis.

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II. BACKGROUND

This chapter provides the background and foundation for the thesis by introducing Joint Vision 2020, Network Centric Warfare, Rapid Decisive Operations, the Global Information Grid, and the Common Relevant Operational Picture.

A. JOINT VISION 2020

The United States military forces follow the directives set forth by the President and the Secretary of Defense. The Department of Defense uses the guidance provided by the National Security Strategy and the National Military Strategy to determine its future direction and concerns. Joint Vision 2020 (JV2020) is a conceptual template to guide the transformation of America's Armed Forces to fight and win the Nation's wars. With the end of the Cold War and the Allied dominance in the Gulf War, potential foes of the United States are expected to employ asymmetric approaches, such as using smaller, nearly clandestine units, to minimize America's technology advantages in traditional conflicts. Therefore, preparation to minimize and prevent these attacks requires a more flexible strategy, greater cross-collaboration and coordination with various agencies, and a greater capability to understand the "battlespace."

1. Full Spectrum Dominance

The overall goal of the transformation described in JV2020 is the "creation of a force that is dominant across the full spectrum of military operations – persuasive in peace, decisive in war, preeminent in any form of conflict." [Ref 1] To meet the uncertainty of future threats, our U.S. Armed Forces are to be faster, more lethal, and more precise than the adversary. However, decreasing military budgets over many years and increasing commitments of the U.S. military, required new ways of considering technology, tactics, techniques and policy. Information superiority and technological innovation are seen as critical keys to future warfighting. These two "enablers" will

allow the full power of the "Information Age" concepts and technologies to be brought to bear, transforming today's capabilities for maneuver, strike, logistics, and protection into dominant maneuver, precision engagement, focused logistics, and full dimensional protection to achieve full spectrum dominance. [Ref 2] Information superiority is critical to enable fusing future capabilities to new developments in warfare techniques and tactics, for example, experimenting with how a networked centric force will alter present military tactics. Figure 1 provides an example of the way future warriors will transfer information to and from the command operations center via a satellite to provide the commander with a clearer picture of the situation during the "fog of war."

Figure 1. Connected Warrior Reaching Back through the Use of Technology [From: Ref 6].

Information technology has exploded in recent years due to increased micro-chip density and transmission capacity. Moore's Law has proven consistent since the 1960s: circuit chip density doubles every 18 months. Additionally, fiber optic transmission capacity is doubling every 12 months. These tremendous technological advances, when combined with Metcalfe's Law, which states that the utility of a network equals the square of the number of users, indicate the vast power provided by networks. These advancements have lead to a "revolution in military affairs." Changing technology accompanied by change in organization and tactics can have synergistic effects. Paul Wolfowitz, Deputy Secretary of Defense, stated that Germany changed only about ten

percent of their forces to apply the combination of armor, air, and radio communications to coordinate their effective Blitzkrieg attacks during World War II. [Ref 3] JV 2020 envisions information technology advances will have the same synergistic effect in modern warfare as communication advances had in WW II. [Refs 3, 4]

2. Difference Between Joint Vision 2010 and Joint Vision 2020

Although the focus is still on Full Spectrum Dominance, JV 2020 expanded the precepts of JV 2010 by: including multinational and interagency interoperability; highlighting information operations and focusing more on joint C2; recognizing that information superiority leads to decision superiority; and placing a greater emphasis on Military Operations Other Than War (MOOTW).

B. INFORMATION SUPERIORITY

Information technology is one of the key enablers required to achieve JV 2020's vision for full spectrum dominance. Information technology has ushered in the computer as an effective tool in the command and control arsenal, as reflected by many military organizations changing "command and control" (commonly referred to as C2) to "command, control, communication, and computers" (commonly referred to as C4). Communication and computers are vital to obtain, process, and disseminate information; information is vital to commanding and controlling the organizational networks of people and activities. The transformation of the joint force to reach full spectrum dominance rests upon our ability to obtain and capitalize on information.

Information superiority is based on the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same. Information superiority provides a competitive advantage when it is effectively translated into superior knowledge and decisions. John Boyd's Observe-Orient-Decide-Act decision processing cycle, or "OODA Loop," stresses that if the decision maker can go through these four phases (of observing,

orienting, deciding, and acting) faster than the enemy, it will be possible to coerce the enemy to our desires and shape the battlefield to our advantage. Information superiority will also provide improved situational awareness by shortening the observing and orienting phases, thus "tightening" the OODA loop. JV 2020 states: "The joint force must be able to take advantage of superior information converted to superior knowledge to achieve 'decision superiority' - better decisions arrived at and implemented faster than an opponent can react, or in a noncombat situation, at a tempo that allows the force to shape the situation or react to changes and accomplish its mission." Figure 2 illustrates the way faster processing of information can create a faster tempo. [Refs 1, 5, 7]

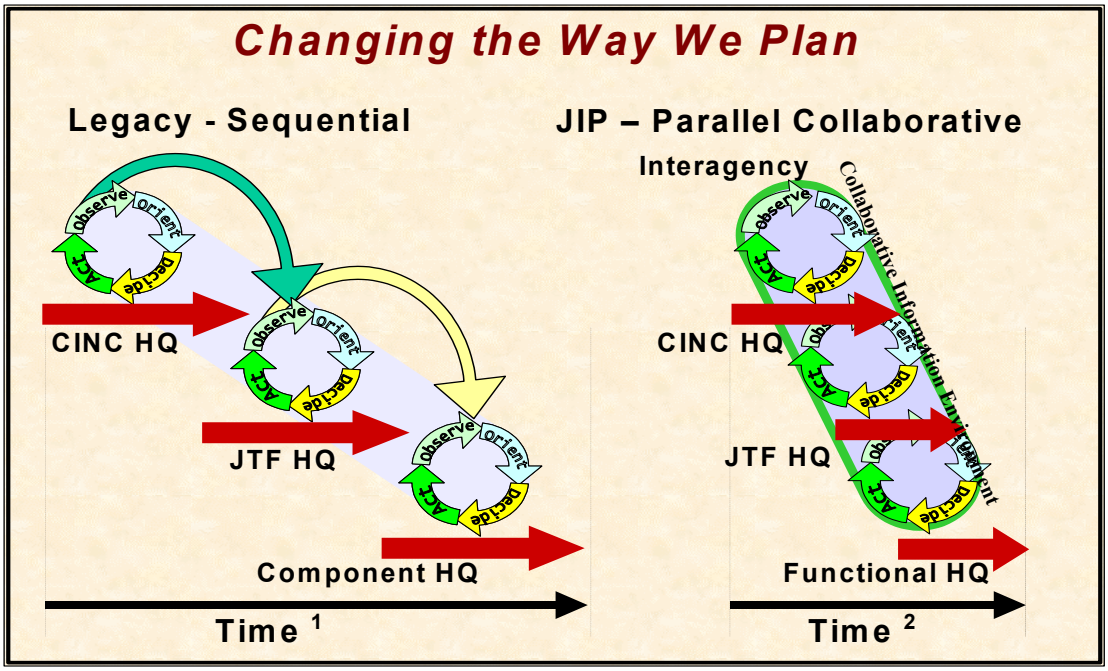

Figure 2. Comparison of Traditional and Parallel Collaborative Planning [Ref 7].

Information, information processing and communication networks are at the core of every military activity. Throughout history, military leaders have regarded information superiority as a key enabler of victory. [Ref 1] The effectiveness of information superiority was demonstrated during the Gulf War with the relative ease with which the Allied Forces were able to control their forces compared to the effects of the

loss of communication on the Iraqi side. Our reliance on information and information systems will continue to grow. Threats will become more complex, sophisticated, and more clandestine. The battlefield of the future will be very asymmetric. Asymmetric warfare is defined as each force avoiding the enemy's strength and attacking each other's vulnerabilities and weaknesses. In addition, our forces must be able to fight a wide range of potential adversaries from organized clandestine cells to hostile nations. However, as our reliance on information technology grows, so will our vulnerabilities. Protection of the software, hardware, and networks from adversaries will be vital as the forces rely on those mediums to carry the information that is necessary for warfighting in the future. [Ref 1]

C. NETWORK CENTRIC OPERATIONS

Network Centric Operations (NCO) are characterized by the use of an information-based strategy to create and exploit information superiority using military forces networked together to conduct operations. In addition to JV2020, some service specific examples of networked warfighting concepts and experimentation include Network Centric Warfare (US Navy), the Future Combat System (US Army), the Dynamic Air Tasking Order (US Air Force), and Sea Dragon (US Marine Corps). These new concepts are about human and organizational behavior utilizing the connectivity of modern technology. NCO is based on adopting new warfare concepts and applying them to military operations. As an example, in *Network Centric Warfare: Developing and Leveraging Information Superiority* [Ref 5], the authors describe how combat power can be generated from the effective linking or networking of the warfighting enterprise. NCO is characterized by the ability of geographically dispersed forces (consisting of entities such as ships, aircraft, sensors, command centers, etc.) to create a high level of shared battlespace awareness that can be exploited via self-synchronization and other network-centric operations to achieve the commander's intent. Network Centric Warfare (NCW) supports speed of command, the conversion of superior information – to decision - to action. Action is the key – implementing the results of the decision. NCW is an emerging military response to the Information Age that utilizes an evolved "info-

structure" to enable a shared awareness and knowledge among all warfighters. This awareness and knowledge is leveraged by new adaptive command and control approaches accompanied by self-synchronizing forces (i.e. forces that quickly adjust to the situation). The "bottom line" is an increased tempo of operations, increased responsiveness, lower risks, lower costs, and increased combat effectiveness. [Ref 5]

NCW involves deriving combat power from the synergistic, coordinated decisions and actions of distributed interacting entities based on significantly improved access to information. NCW reflects and incorporates the characteristics necessary for success in the information age. NCW is built around the concept of linking information through communication networks.

A network centric force is effectively linked or networked by an "info-structure." The info-structure provides the capability to share and exchange information among geographically distributed forces including sensors, decision-makers, and shooters, with global access to assured information whenever and wherever needed. In concrete terms, NCW relies on a seamless (horizontal and vertical integration of components) network of sensors, decision makers, and shooters. The network enables speed of command. The horizontal and vertical integration of network components allows information to travel quickly in multiple "directions" vice the associated delays of waiting for the information to go up and down chains of command. This universal access to information allows command structures to be flattened, thereby speeding up command. Reducing the numbers and layers in the command structure puts decision makers in parallel with shooters and transforms command from a step hierarchical function to a continuous process. This reduces the delays associated with decision-making and decreases the enemy's opportunity to regain the initiative. Capitalizing on information superiority integrated into the networked force will enable the commanders to coordinate their units into a more effective fighting force. [Ref 2]

D. COMMAND AND CONTROL AND C2 SUPPORT SYSTEMS

This section briefly describes command and control (C2), the systems to support C2, important attributes to consider in a C2 system, and the benefits to be accrued by the organization with respect to shared situational awareness.

1. Definition

The ultimate aim of information superiority is decision superiority, that is, better informed decisions lead to superior courses of action. Operational decisions are handled at the Joint Force Commander's (JFC) level to influence and shape the subordinate commander's tactical decisions. Many factors affect C2, and in turn, shape actions in the battlespace. Joint Pub 1-02 defines C2 as the exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. [Ref 5]

Command is viewed as an essential element of warfare; it resides with the commander and consists of authority, decision-making, and leadership. Command is the process by which the commander perceives and decides on the end state and objectives to be sought and the means to achieve them; it is part art and part science. Control is the way the commander executes command; it is the regulation of forces and other battlefield operating systems to accomplish the mission in accordance with the commander's intent. [Ref 18] It includes collecting, processing, displaying, storing, and disseminating information to create a common operational picture (COP) and using information during planning, preparing for, executing, and assessing operations. The three elements of the control process are: (1) Information (intelligence about reality and the situation), (2) People/communication (organizational sharing of information, communication, and decision-making), and (3) Structure Support (aids that assist the people involved in the use of the information). [Ref 8]

Figure 3 depicts the Army's C2 processes (which is similar to the other services), organizational support, and their interaction. C2 is further described as:

The focus of C2 is the commander. He determines what to do and directs actions. C2 is a continuous process; the staff must diagnose what is happening, even if unexpected, and develop appropriate solutions for the commander's decision. Effective C2 demonstrates the ability to:

1. Identify and react to changes in the situation

2. Provide a continuous, interactive process of reciprocal influence between the commander, the staff, and available forces

3. Mitigate chaos or reduce uncertainty

4. Determine force responsiveness and user resources

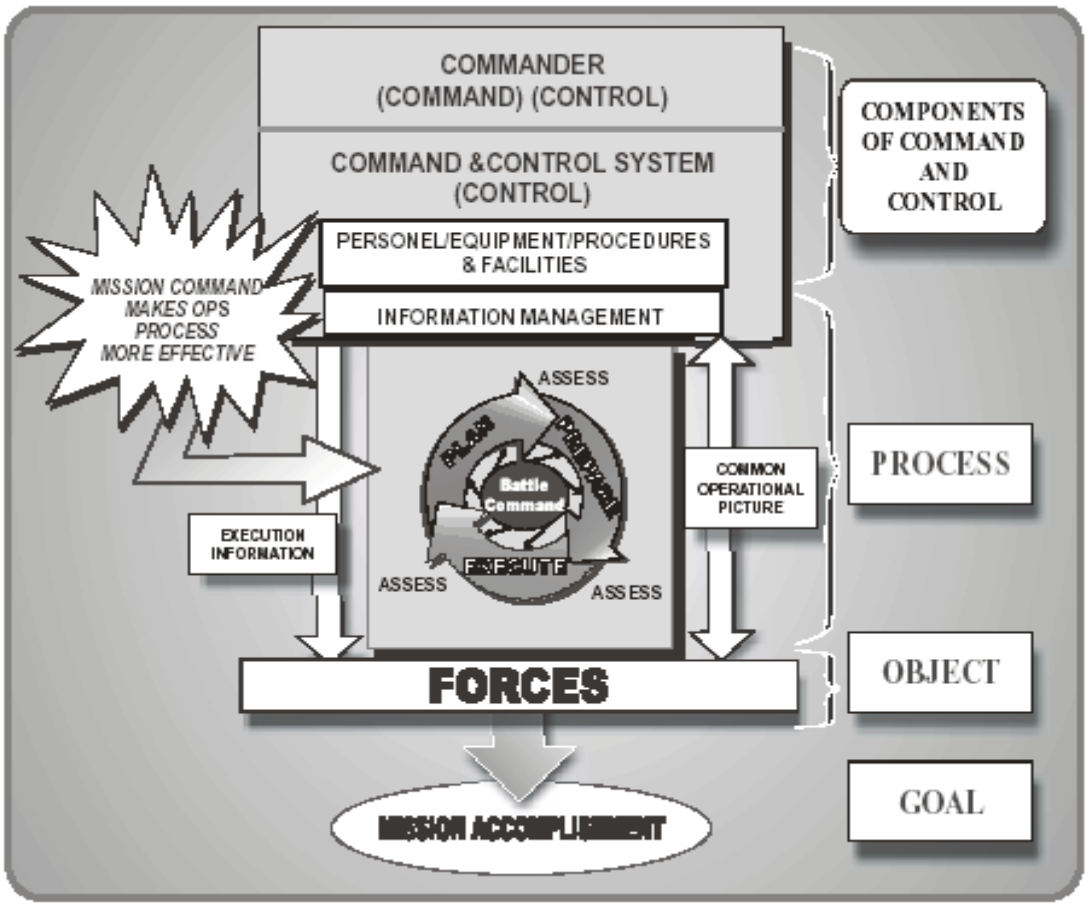

Figure 3. Simplified Illustration of Command and Control [From: Ref 19].

However, the most effective command and control cannot eliminate chaos or uncertainty and create precise, mechanistic, predictable order. The commander—using the C2 system—uses the decision-making process to establish his intent and allocate

resources. To implement his decisions, he directs coordinated actions by subordinate forces to tasks that collectively represent mission accomplishment. The staff supports the commander's decisions by using C2 processes. They use information management to collect, process, display, store, and disseminate information to build a common operational picture to determine requirements. Finally, the commander, assisted by the staff, observes execution and adjusts the plan in a dynamic environment where unexpected opportunities and threats present themselves. C2 is a force multiplier and a vital component of mission accomplishment in that it gives purpose and direction to military operations and integrates subordinate and supporting forces to allow separate activities to achieve coordinated effects." [Ref 19, p. 61]

Command, control, communication, and computer (C4) systems are the vehicles the commander uses to collect, process, develop and disseminate directives. The C4 system is the arrangement of personnel, information management, procedures, and equipment and facilities essential to the commander to plan, prepare for, execute, and assess operations. A commander cannot exercise C2 alone except in the simplest and smallest of units. Even at the lowest levels, closer study reveals that a commander needs support, however little, to exercise C2 effectively. At every echelon of command, the C2 system provides that support.

2. C2 System Objectives

C2 systems must provide commanders and authorities at all levels, who are performing all functions, with timely and adequate data and information to plan, direct, and control their activities, such as, operations, logistics, intelligence, and personnel. C4 objectives include: (1) producing a unity of effort to leverage force upon the task; (2) exploiting total force capabilities to help the commanders; (3) properly positioning and responding to critical information; and (4) producing an accurate and timely battlespace picture through fusing information. [Ref 9]

3. C2 System Attributes

Certain characteristics of a C2 system are desirable to portray the situation to the commander and develop trust in the system. For example, a survey administered to several dozen Marine Corps Officers asked them to rate C2 system attributes that would effectively assist the officers in the C2 process. [Ref 10] Thirty-three attributes included in the survey are listed in Table 1:

Accessibility	Ease of Use	Reliability
Accountability	Expandability	Responsiveness
Accuracy	Flexibility	Ruggedness
Adaptability	Human Interface	Selectivity
Availability	Interoperability	Self Diagnosis
Comprehensiveness	Maintainability	Simplicity
Continuity of Ops	Material Economy	Timeliness
Controllability	Mobility	Time Savings
Currency	Modularity	Validity
Data Control	Personnel Economy	Versatility
Ease of Formatting	Productivity	Vulnerability

Table 1. Tactical Combat Operations Attributes Presented to the Users [Ref 10].

The officers rated each attribute to indicate those attributes that were most important when using a C2 system. Ratings were averaged to provide a relative score of importance. The fourteen most important attributes are listed in Table 2. Results point to the critical importance of the human interface along with the need for an accurate and timely representation of the situation. Future systems need to be developed to include these essential attributes.

Attribute	Weight		Attribute	Weight
Human Interface	0.189		Time Savings	0.057
Accuracy	0.123		Availability	0.055
Maintainability	0.102		Responsiveness	0.052
Mobility	0.068		Ruggedness	0.051
Timeliness	0.064		Validity	0.045
Continuity of Ops	0.063		Vulnerability	0.037
Reliability	0.058		Interoperability	0.036

Table 2. The Fourteen Most Critical C2 System Attribute Averages [Ref 10].

The need for the commander to "see and feel" and to be able to direct activity within the battlespace has been, and will continue to be, vital. New tools associated with the CIE, such as the COP and interactive planning tools, are intended to provide both better information and improved capabilities to collaboratively plan and execute directives to shape the battlefield. This requires a networked warrior linked to a networked force. As the battlespace becomes more digitized and linked, the COP system will present that information accurately and quickly so that the commander can assess, decide and act.

4. Shared Situational Awareness

A key enabler of C2 is the ability to understand the situation and respond to it. The purpose of the COP is to present significant information and actions in the battlespace to the commander and his staff so that they can "see" the action in near real time, assess it and decide on a course of action quicker than the adversary. Situational awareness (SA) is defined as: "the result of a dynamic process of perceiving and

comprehending events in one's environment, leading to reasonable projections as to possible ways that environment may change, and permitting predictions as to what the outcomes will be in terms of performing one's mission." [Ref 11, p. 9] In effect, it is the development of a dynamic mental model of one's environment and the ability to anticipate future events or problems so that appropriate actions can be taken. [Ref 11, p. 69]

Shared SA is seen as critical to future military forces. Development of modern electronic networking technologies and the concept of information operations have given rise to the belief that military staffs will be able to quickly develop a "shared situational awareness." It is anticipated that this shared SA will greatly facilitate decision-making, thus permitting faster response to military situations. Lt. Generals Paul J. Kern and John N. Abrams, provided a definition of shared situational awareness as part of their testimony before the Senate Armed Services Committee in 1998 as,

> Shared situational awareness . . . translates to a clear and accurate, common, relevant picture of the battlespace for leaders at all levels and a reduction in the potential for fratricide. *Situational awareness answers three fundamental battlefield questions: Where am I? Where are my friends? Where is the enemy?* The sharing of timely information enabled by digitalization improves significantly the ability of commanders and leaders to quickly make decisions, synchronize forces and fires, and increase the operational tempo. [Ref 12]

Endsley, one of the principal researchers investigating situational awareness, has identified four critical factors in the development of SA as:

1. Perception (acquiring the available facts)
2. Comprehension (understanding the facts in relation to one's expert knowledge of such situations)
3. Projection (envisioning how the situation is likely to develop in the future provided it is not acted upon by any outside force)
4. Prediction (evaluation of how outside forces may act upon the situation to affect your projections). [Ref 11]

This process, as stated by Endsley, can be incorporated into our thought processes to help decision-makers anticipate and plan for the next situation. The developing COP systems are being primarily designed to focus on the first two steps above, perception and comprehension. An accurate presentation of the facts will enable the commander to

comprehend the situation with respect to previous knowledge or experience. Being aware of the situation provides the foundation for developing better understanding, judgment, confidence and wisdom.

Endsley's concentration on SA has initially been focused in the military aviation community. The military has invested in significant research to increase a pilot's cognitive abilities in handling aircraft. This effort has translated into a greater effectiveness of the pilot with respect to enemy aircraft, thereby increasing aeronautical capabilities. The pilot must know what is going on in the aircraft's environment (the cockpit, the instruments, the plane's capabilities, weaknesses, and strengths, etc.) and be aware of the surrounding situation (with respect to the enemy, ground, air traffic, altitude, etc.).

A pilot's effectiveness is directly tied to his SA, and the ability to maintain it in a rapidly changing and stressful environment in which decisions (some life and death) must be made in a split-second. Many studies have focused on pilots and their SA. One study defined SA as the pilot's knowledge of a dynamically changing situation. The study defined four elements that comprise SA: (1) *Where* – knowledge of location in space; knowledge of spatial relationships between objects; (2) *What* - knowledge of the presence of threats and their objectives; knowledge of system state variables such as engine status); (3) *Who* - knowledge of who is in command; and (4) *When* - knowledge of events as mission progresses. According to this perspective, the notion of time is an important characteristic of situation awareness – that the past is critical to understanding the present, and both past and present information must be used to predict future events. [Ref 12, p. 8]

Interest is now growing regarding ways to develop systems to assist land and sea-based commanders and their staffs in developing and maintaining shared SA. A goal for the systems is to present the right information, at the right time, in the right format for the commander in the command operations center. However, questions remain regarding the correct amount of information. Although the area of coverage of a commander's command post is larger than a pilot's cockpit, there are many similarities and parallel processes. Future systems must deliver a clear presentation of information and provide a

"sense of being there" so that the situation can be quickly understood. Decision support systems will be required to filter and integrate information to reduce distractions and allow more focused attention on critical decisions, thus resulting in improved effectiveness. Further research and development will be required to produce systems that increase the commander's ability to comprehend the four elements relating to SA (the who, what, where, and when) and also to train the decision-makers and users to use these systems. Many factors can degrade a person's SA. Nofi's classifies the primary distracters of SA as: [Ref 21]

1. Degraders of *individual SA* include the following: Ambiguity (conflicting information), fatigue, expectations and biases, psychological stress, misperception, task under-load or overload, lack of information, information overload, interruption or irrelevancy, mission complexity, fixation/attention narrowing, erroneous expectations, lack of experience, personality, education, religion and cultural differences, and others.
2. Degraders of *group SA* include the following: False group mindset, "press on regardless" philosophy, insufficient training, poor communications skills, perception conflict, personal turbulence, degraded operating conditions, for example, "real time" vs. "virtual time."
3. *Other distracters of SA* include: team members' lack of understanding of the team mission and their roles, and how information flows into and among the team, and how they make decisions.

System designers must make every effort to minimize the effects of these degraders of SA. Processed data needs to be presented in a format that increases the decision-makers ability to develop and maintain SA. An effective presentation of relevant information should reduce the "fog of war" by providing the commander with a better understanding of battlespace events. Essential battlespace information includes the status of red and blue forces, location changes, status and availability of resources, equipment and weapons, intelligence updates, political considerations, ROE, commander's intent, etc.

The "cognitive hierarchy" chart, in Figure 4, summarizes the way data is received, processed, and transformed into information. As experienced leaders use their judgment to process this information, based upon their previous knowledge and experience, they develop an understanding of the situation. From this understanding, leaders form their

conclusion and act upon their understanding of the situation. The COP is intended to help the commanders in this process of turning data into understanding. [Ref 9]

By capitalizing on the advantages offered by a network centric force, information superiority, and advances in C4 systems, warfighters of tomorrow should be better able to utilize the information in conjunction with knowledge gained from their experience to create the desired effects through rapid and decisive operations.

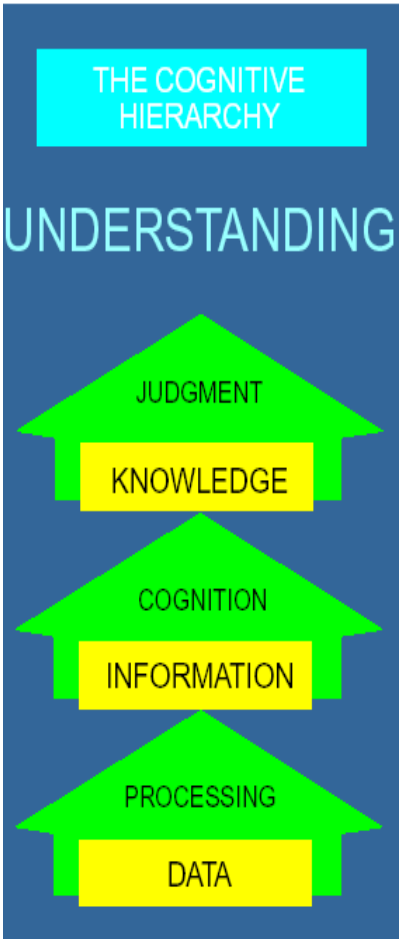

Figure 4. Cognitive Hierarchy of the Understanding Process [From: Ref 9].

E. RAPID DECISIVE OPERATIONS

The April 2000 *Defense Planning Guidance* tasked JFCOM to develop new joint warfighting concepts and capabilities that will improve the ability of future Joint Force Commanders to *rapidly* and *decisively* conduct particularly challenging and important

operational missions, such as coercing an adversary to undertake certain actions or denying the adversary the ability to coerce or attack its neighbors. Rapid Decisive Operations (RDO) is a knowledge-based concept that describes how to achieve rapid victory by attacking the coherence of an enemy's ability to fight. It involves the synchronous application of the full range of our national capabilities by a fully networked and coherent joint force. RDO employ our asymmetric advantages in knowledge, precision, and mobility of the joint force against an adversary's critical functions to create maximum shock and disruption, defeating his will and ability to fight.

Figure 5 summarizes many of the significant differences between the older traditional means of warfighting and the newer concepts involved in RDO. RDO are designed to enhance the ability to influence and deter an enemy (through diplomatic, information, military and economic operations) and, if deterrence fails, provide the capability to rapidly and decisively coerce or defeat the enemy through precision in order to accomplish our strategic objectives without a lengthy campaign or an extensive buildup of forces. [Ref 13]

Differences between today's way of warfighting and the new way requires a considerable shift from a larger force to that of smaller, integrated forces focused on achieving specific coordinated effects. RDO employs a coherently joint, networked force to conduct integrated, synchronized actions closely linked to strategic objectives. Joint action will be designed to apply the right mix of precision fires, maneuver, and information operations capabilities throughout the battlespace to successfully execute specific effects-based missions against key links and nodes. These actions will be more closely linked to strategic actions through greater synchronicity and integration. These concepts are presently being exercised in Afghanistan. Integrated C2 systems, interoperable combat systems, and a coherence of action will empower the future warfighter. [Refs 7, 13]

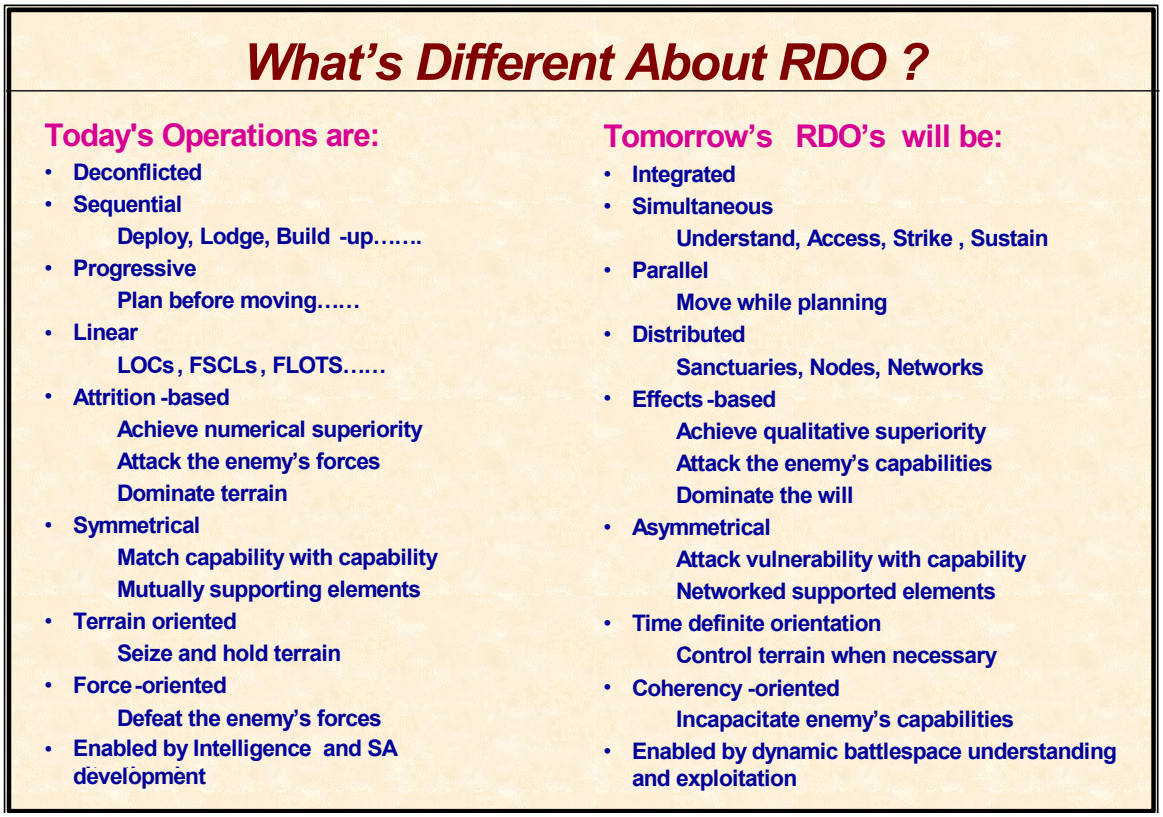

Figure 5. The Traditional Means of Warfighting Compared to RDO [Ref 7].

F. GLOBAL INFORMATION GRID

As advances in information technology and interconnectivity expand, and as the capabilities of the networked force improve through experimentation, the basis of the Global Information Grid (GIG) is being laid. The GIG is a globally interconnected, end-to-end set of information capabilities, associated processes and personnel for collecting, processing, storing, disseminating and managing information on demand to warfighters, policy makers, and support personnel. The GIG includes all owned and leased communications and computing systems and services, software (including applications), data, security services and other associated services necessary to achieve information superiority. The GIG's interoperability builds upon the existing Defense Information Infrastructure (DII) Common Operating Environment (COE) building blocks of: Joint Technical and Joint Systems Architectures, a shared data environment, the migration of legacy systems, and adherence to commercial standards. [Ref 13]

The GIG is expected to enhance combat power through increased battlespace awareness, an improved ability to employ weapons beyond line-of-sight, employment of massed effects instead of massed forces, and by shortening the decision cycle of the commander. These enhancements to combat power will be enabled by changes in the way the force is organized, new procedures, and new doctrine. All these changes must evolve together to create the maximum synergistic effect.

The Joint Chiefs of Staff envision the GIG to provide:

1. A single secure grid providing seamless end-to-end capabilities to all warfighting, national security, and support users
2. Support for DoD and intelligence community requirements
3. Joint, high capacity netted operations fused with weapons systems
4. Support for strategic, operational, tactical, and base/post/camp/station
5. Plug and play interoperability for US and allied forces
6. Tactical and functional fusion
7. Information/bandwidth on demand
8. Defense in depth against all threats [Ref 13]

The grid, portrayed in Figure 6, provides a visual depiction of the networked architecture and information flow required by the warfighter. The GIG will be a key enabler of network-centric operations and will be essential for achieving information and decision superiority. It will enable C2 system integration of joint forces, improve interoperability of systems, and increase optimization of bandwidth capacity thereby improving the warfighting capabilities of the warfighter across the full spectrum of conflict. The GIG is expected to provide enhanced operational capabilities while providing a common operational environment for C2, combat support, combat service support, intelligence, interagency interactions, and business functions. In particular, it is anticipated that the GIG will support the:

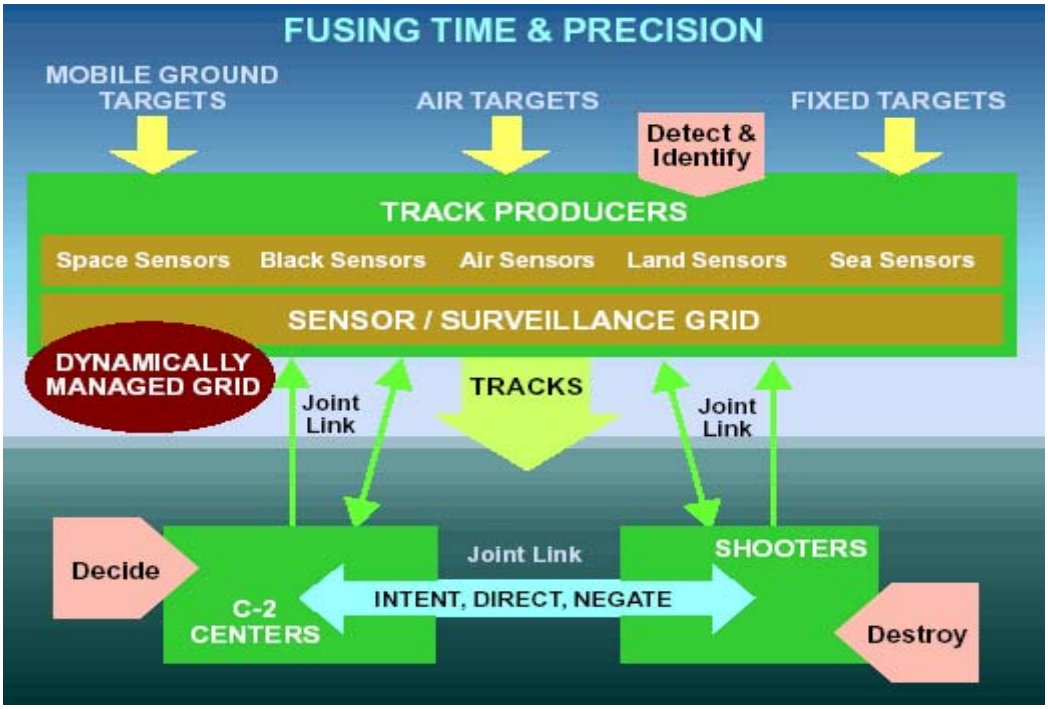

Figure 6. The "Grid" of Sensory Inputs into the GIG [Ref 9].

1. Warfighters' ability to operate with reduced forces at high operational tempos where dynamic planning and redirection of assets is the norm
2. Delivery of information concerning targets, movement of forces, condition of equipment, levels of supplies, and disposition of assets to joint commanders, their forces, and the National Command Authority within specified time frames
3. Warfighters' ability to obtain and use combat and administrative support information from national, allied, coalition, and other widely dispersed assets
4. Collection, processing, storage, distribution, and display of information horizontally and vertically throughout organizational structures across the battlespace
5. Rapid and seamless flow and exchange of information around the globe to enable collaborative mission planning and execution from widely dispersed locations and at different levels (to include strategic, operational, tactical, and business)
6. Timely, assured connectivity and information availability for decision makers and their advisors to support effective decision-making
7. Integrated, survivable, and enduring communications for the National Command Authority, Integrated Tactical Warning and Attack Assessment (ITW/AA), and strategic forces [Ref 14]

G. COLLABORATIVE INFORMATION ENVIRONMENT

Many JV2020 concepts and the most recent Defense Planning Guidance's desired operational capabilities are incorporated in the evolving CIE. The CIE will provide the warfighter the ability to share information to enhance situational awareness, reduce planning timelines, and enhance organizational effectiveness. Enabled by high-speed bandwidth connectivity and electronic collaborative tools, the CIE will facilitate the exchange of information among members of the Joint Force and those organizations working with the military forces. The CIE is being developed to support two developing concepts, Joint Interactive Planning (JIP) and the Common Relevant Operational Picture (CROP). Leveraging these two concepts is expected to produce an exponential advantage for future operations by providing the capability to conduct collaborative planning and develop shared situational awareness. Both new concepts (JIP and the CROP) are envisioned to significantly contribute to achieving the four objectives of C4 systems: (1) produce a unity of effort to leverage force upon the task, (2) exploit total force capabilities to help the commanders, (3) properly position and respond to critical information, and (4) produce an accurate and timely battlespace picture through fusing information. [Ref 9]

1. Joint Interactive Planning

Joint Interactive Planning is defined as bringing together, through information technology, the right people, with the right information, at the right time for planning a joint operation. JIP is intended to improve C2 capabilities by providing a greater unity of effort, incorporating greater collaboration capabilities (from personnel and their knowledge), and tightening the decision cycle. JIP will allow supporting staffs and other resources, separated by geography, time, and organizational boundaries, to collaboratively develop and coordinate planning and execution. The capability to rapidly exchange information and to conduct collaborative planning throughout the battlespace

will enable decision-makers to achieve greater results regarding the C4 objectives above. [Ref 19]

The JIP concept, comprises three elements: (1) an *interactive joint planning group* – i.e., a virtual environment of the traditional planners to allow the collocation of applications, data and people in a shared workspace, (2) an *adaptive, tailored planning process* – integrating the planning group and the products in a distributed environment to assist in the planning phase, and (3) a *dynamic, shared plan* – from the continuous and iterative planning process using information technology for information fusion. [Ref 19]

2. Common Relevant Operational Picture

The CROP concept refers to the presentation of timely, fused, accurate, and assured information that is available to every organization and individual involved in a joint operation. Commanders and other decision-makers at all levels can tailor the information to meet their individual requirements. The CROP must be sufficiently robust and adaptable to accommodate the exchange of information with defense officials and other governmental, international, coalition forces, and private organizations. The information will be readily accessible to approved users and will support all military operations. The CROP is envisioned to be a key element of information superiority and battlespace awareness, and to provide a single global operational picture for use by all joint forces. [Ref 20]

The CROP, once developed, will provide the ability to share and present information in a manner to better support the decision-maker. Providing a common picture to all decision makers should facilitate developing a shared situational awareness, which will assist the collaborative planning process, thereby tightening the decision cycle. [Ref 20]

The CROP, as depicted in Figure 7, is conceived of as incorporating weapon sensors feeding the individual weapons, their platforms and other interconnected units; information sensors feeding the C2 center; information feeding the fire control databases, feeding the SA databases, and finally the common operational picture databases.

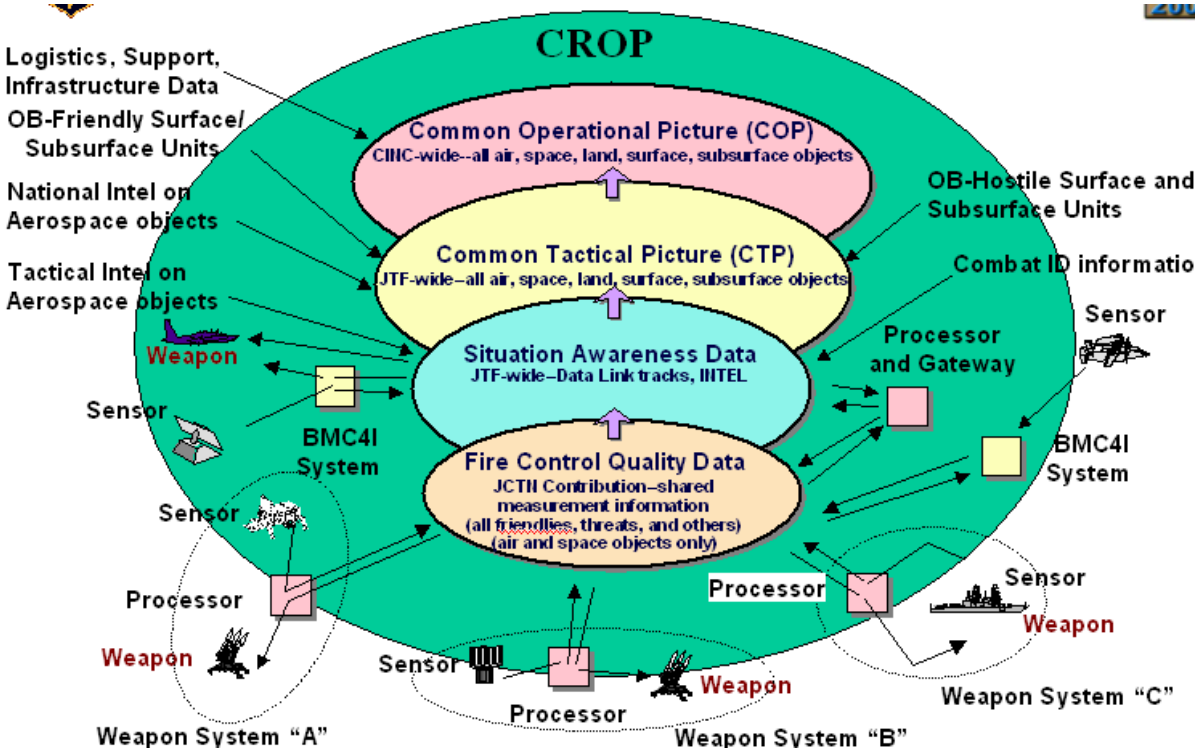

Figure 7. The CROP and its Interactions with Other Systems [From: Ref 15].

The underlying theory is that if the CROP presents information in a readily understandable, scalable, tailorable, filterable and interactive format, this will provide the best decision support to users at all levels. Decision makers should then be able to make faster, more accurate decisions which then means the decision cycle can be compressed. This compression will be possible as a result of decision makers more rapidly being able to grasp the picture. [Ref 16] The objectives of the CROP are to: (1) enable decision-makers to share a common understanding of the situation and commander's intent, (2) improve synchronization of Joint operations, (3) enable highly informed decisions, (4) reduce redundancies and decrease the force operational footprint, (5) provide a "global infosphere of pertinent information," and (6) help prevent fratricide. [Ref 16]

a. Virtual Warehouse

The GIG provides the infrastructure to enable the CROP as a globally interconnected, end-to-end set of information capabilities, associated processes, and personnel. It is anticipated that the CROP will collect, process, store, manage, and provide information on demand to policy makers, warfighters, and support personnel. Essential to the CROP is the construct of a "virtual warehouse" of information that includes the following: tracks, friendly, neutral, and enemy force dispositions (aerospace, land, sea); intelligence, maps, and imagery; environment, logistics, and planning data; weather, socio-economic, and cultural information. Users will access the virtual warehouse of information to extract the timely, fused, assured, and relevant information they need to accomplish their mission. A high level of shared battlespace awareness is the anticipated result of enabling commanders to quickly access the relevant information. [Refs 16, 17] Figure 8 illustrates how the CROP will pull and process data from multiple databases within the GIG to provide the user with customizable views of warfighting information.

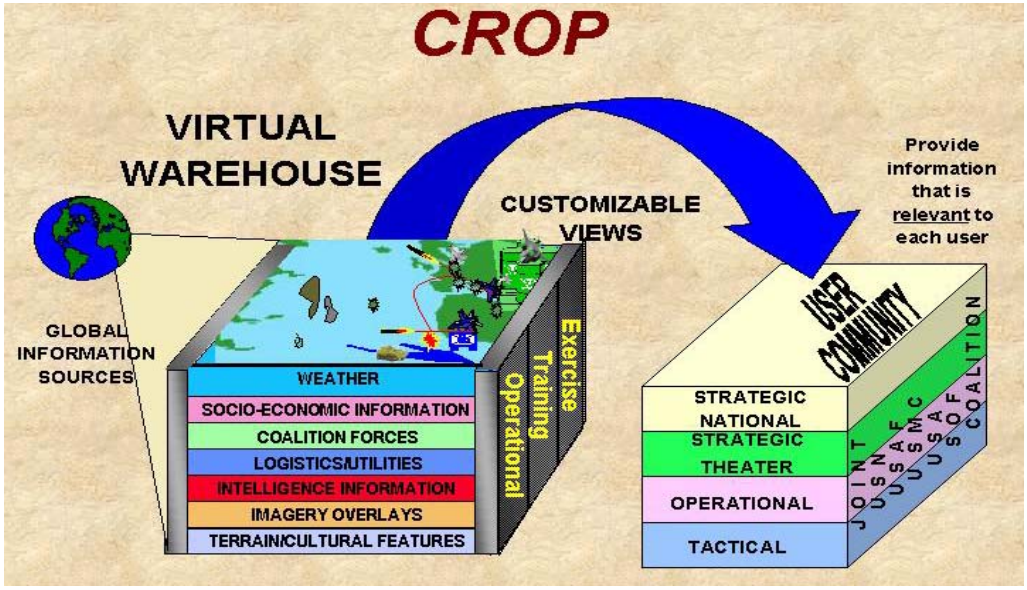

Figure 8. The "Virtual Warehouse" of Information Contained in the CROP [Ref 17].

Developing the CROP will include defining information requirements, for example, the GIG, CID (Combat Identification) and IDM CRDs, from the virtual warehouse, or a linked standardized source of data. The virtual warehouse will consist of data and information, which will range from real-time, short latency to static, long term. The virtual warehouse will have sensor-to-shooter data and a research library capability. Some of the data / information will be "pushed" (i.e. published) to the warriors (e.g. critical, time sensitive, and consistently known requirements) but most will be "pulled" (subscribed to) by the warriors. Future desired capabilities of the CROP include: (1) common information protocols, databases, and architecture, (2) increased "reach-out" and "reach-back" capabilities to access information, products, and services provided from supporting organizations not necessarily in the combat theater, (3) advanced planning and decision support tools, and (4) tailored displays that can be customized and that can merge and filter information. [Ref 17]

However, the basic concept underlying the CROP is to provide information and present it in a manner that will enable the decision makers to make *faster* and *better* decisions. Further study, working with present commanders, is needed to address the following issues:

1. What information do the warfighters require?
2. What are the sources of this information?
3. How will those sources feed the information warehouse?
4. How will the information be processed (analyzed and fused)?
5. How will the information be disseminated?
6. How will this data/information/knowledge be presented? [Ref 17]

As currently envisioned, the future CROP is expected to be available in approximately ten years with continual refinements and improvements over the years. It is planned to use an expansion of websites and object-oriented software, internets and intranets, powerful servers, multi-path/multi-media transmissions, bandwidth, and information management techniques and tools. The concept embodied in the CROP is to provide the joint context for the commander and all information-related activities; it will allow the development of a global infosphere that will be used by all joint, allied, and coalition forces for the full range of military operations, from peace keeping and

humanitarian assistance to major theater war. It would be used daily, whether monitoring global and local situations or planning and executing complicated combat operations. [Ref 17]

Access to the CROP will permit the dynamic, flexible sharing of warfighter information both vertically (across echelons) and horizontally (across functions). The CROP will use web-based technologies, artificial intelligence, and sophisticated information management and dissemination tools to enable near real-time access to both raw data (if desired) and fused, actionable information. The CROP will support multi-level security partitioning to enable the participation of allied and coalition forces in accordance with policy and information-sharing agreements. Advanced human-systems technologies (both input and presentation) will support user interaction with the CROP. These include conversational speech recognition, virtual reality and three-dimensional graphics, integration of personal handheld input-output devices with other workstations, and new interaction techniques that facilitate collaborative work on shared displays. [Ref 16]

b. Basic Requirements for the CROP

It is envisioned that the CROP will enable leaders to visualize the battlespace better, improve SA and solve complex battlespace challenges. These capabilities should enable organizations and staffs to become more widely dispersed, reducing the forces "footprint" overseas, thereby reducing their vulnerabilities. Smaller staffs will go forward with the commanders and the larger staffs and organizations will be in rear areas providing the invaluable "reach back" capability. The information system should be truly joint and comprised of a set of interconnected communications and sensor systems, software applications, and organizational structures that will provide:

1. A redundant, seamless network of cross-service and interagency links
2. Secure and responsive information that is available to all users when needed
3. Accurate and timely display of enemy locations and activities

4. A comprehensive catalogue of, and access to, networked databases relating to the operations area and adversary capabilities
5. Accurate, real-time friendly location and combat status, and neutrals
6. The capability to support split-based operations from force projection locations throughout the battlespace
7. Near-real-time processing of information to allow for a common operational picture of the battlespace
8. Multi-path, self-correcting, and regenerating network
9. Multilevel security access to allow sharing of information with a wide variety of military and non-military partners
10. Data and information that has been tagged for automatic "releasability"
11. Provide a basic and "tailorable" portal layout to the users [Ref 17]

c. Desired Capabilities for the CROP

Aside from the required capabilities identified above, the CROP capabilities will continue to expand over time to be more inclusive of C2 capabilities. Many challenges lie ahead with disadvantaged users, for example, ships and subs, and their capability to access information. Another problem will be bandwidth management; more people are demanding more networking capability.

This thesis summarized the desired operational capabilities of the CROP as described in JFCOM's CIE white paper. The desired operational capabilities are organized into five categories: presentation level, data level, information assurance, infrastructure, and applications and tools.

(1) Presentation Level.

a. Provide only the information required by the users. Users currently are not receiving information they need while they are simultaneously inundated with information they do not need. Additionally, there is a wealth of valuable information available from non-traditional sources that should be provided. To ensure the users receive only pertinent information, the following is suggested:

1. Have the warriors select from a "mission template" and identify the general information they will require prior to mission
2. Automatically "push" alerts and pertinent critical/sensitive information important to their security and force protection
3. Develop filters (for the information providers and users) to assist in eliminating superfluous information
4. Have all information in a virtual warehouse so the users can retrieve information as they identify additional requirements, as needed
5. Keep the system and the training simple
6. Provide the identification and location of all friendly, adversary and neutral entities for combat identification and prevention of fratricide

b. Present knowledge in a format that will assist the user in making *faster* and better decisions. The ultimate goal of the CROP is to provide all information required by each decision-maker and present this knowledge in a format that enhances their understanding of the current situation and what may happen in the future. In order for the CROP to provide effective assistance to the users, it must be customizable not only to the user's assigned mission, but also to the user's personal profile.

c. Rugged, light weight, and mobile information receipt and presentation equipment. Portable appliances (PDAs, laptops, etc.) are needed to monitor the situation, conduct their planning, collaborate with other decision-makers, and to disseminate information to their subordinates possibly while enroute.

d. Tailored displays that can aggregate and de-aggregate information for different levels. Customization of the presentation of information is important for different levels within the command structure. Information should be aggregated/de-aggregated by dimensional scaling (such as the scaling in MapQuest.com), adjusting symbol types, unit "tagging," and providing a cross-service terminology "thesaurus."

(2) Data Level.

a. Single global common data/information/knowledge source from which all joint forces derive their common operational pictures. Current common

operational pictures are common only to each service or the regional CINCs. The increased tempo, precision, and longer ranges of future operations require all forces to share and use the same information. An authoritative joint data center is envisioned to provide a virtual warehouse of information required by the warfighters and to provide a GIG that will assure the dissemination of information in a timely manner.

b. Develop common information protocols, databases, and architecture. The goal of providing a *single* global common data source to be used by all joint forces makes it essential to eliminate interoperability problems. The first step will involve developing common protocols and an architecture to guide the "building-up" and the framing of the structure. The developers need the detailed technical architecture and the users need the practical application architecture that allows them to know where and how they fit and rapidly make any necessary modifications.

(3) Information Assurance.

a. High quality survivable information systems. Because American forces will be more dependent on information technology, the best detection, monitoring, surveillance, and defense tools will be required to provide high quality service. These services must be resistant to eavesdropping, exploitation or damage. Multi-level security to and within the network will be required.

b. Support self-diagnostic programs. The CROP scope includes real-time data collection, data processing, information dissemination, and knowledge presentation. This will entail the ability to alert the users to any anomalies, show who is affected, provide recommendations for corrective actions, and provide estimated time for completion. An example of self-diagnostic programs is Intruder Detector Systems that "sniff" within the network for destructive situations.

(4) Infrastructure.

a. Using multiple appliance platforms. The system should be able to work across multiple appliance platforms, such as: PDAs, cell phones, laptops, pagers, etc.

b. Improved method to develop and field information systems. Information technology is advancing at an exponential rate and the DoD acquisition process will have difficulty keeping pace.

c. Flexible, adaptive network to collect, transmit, receive and display the right volume of information at the right time and at the right place. With increasing amounts of information, handling, sorting, and prioritizing the increased volume of information will be essential.

(5) Application and Tools.

a. Provide advanced planning, decision support, and presentation tools. Provide functional tools to enable faster and better decision-making. The ever-increasing amount of information available requires assistance in formatting it for situational understanding. Modeling and simulation, decision support, and presentation tools will enhance the system.

b. Advanced automation of the analysis and fusion process. Anticipated increases in the amount of information required by the decision-maker and the tempo of operations will require automation to keep pace.

c. Increased “reach back” and “reach out” capabilities. The users could access a virtual warehouse of all information, including confidential, at any time. Collocation is no longer required, but managing information will require “pushing” or “pulling” information to the warrior.

d. Provide data purging and archiving. To prevent information overload or poor decisions, data purging and archiving will need to be a featured capability.

e. Systems and networks that support confidence and trust in information. Only time will prove this.

f. Provide sufficient training. Training the users is so often neglected, but ironically the most important factor to acceptance and user understanding. Effort must be taken to incorporate the users in the design process and then provide training in the implementation phase.

III. SYSTEM DESCRIPTIONS AND EVALUATIONS

This section describes the criteria and then uses the criteria to describe and analyze each of the ten C2 information systems.

A. BACKGROUND

The Naval Postgraduate School is assisting JFCOM J-9 Joint Experimentation Directorate by analyzing C2 information systems, identified by JFCOM that offer potential support in the developing CIE/CROP technology concepts for the DoD. The evaluations of the technologies were challenging because the development of them ranged from a slide presentation of what the system would hope to achieve to a product that is currently being used, e.g. GCCS, which has hundreds of versions. Additionally, the systems ranged from developing middleware applications to guidelines for future development.

B. CRITERIA

The survey instrument evolved from a basic questionnaire to comprehensive questionnaire as more the CROP articles pointed to required and desired capabilities. Experienced users of COP systems analyzed the questionnaire for product concerns and relativity toward a more complete product of a CROP. However, through the research, it was determined that the time required for these questions did not contribute to the analysis of the product; therefore, the questionnaire was shortened. The questionnaire was scrutinized by various people: who had used a visualization command and control product and were familiar with their limitations, who had contracting experience or were familiar with software development, and who were familiar with the CROP concepts.

The criteria sheet, below in Table 3, contains basic information for a high level review. The table summarizes the intent of the question that was given to the system representative.

Criteria	Further description of criteria
I.a. System Name	Name of system, program, or concept
System Description	Brief description
POC representative information	Information on how to reach a representative
Web-site	Location of website to obtain more information
Interview date	Date phone interview occurred with representative
i. Previous associated names or technologies?	What systems did this technology borrow from other developing or established systems
ii. Primary organizational sponsor? (i.e. PM?)	What organization is the sponsor
iii. Funding support? Whom? $?	From whom did they receive outside support
iv. Primary requirements "driver?"	What organization is driving the requirements
v. Is it a concept, prototype, Advanced Concept Technical Development (ACTD), or an actual system?	What level of development is the system
vi. How long has it been in development?	How long has the organization been officially working on this particular system
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	Is the program in the acquisition cycle? If so, where?
b. Purpose?	What is the purpose for building it
i. Why build it? Capabilities?	What significant capabilities does it have
ii. Ultimate Goal? (GCCS segment, other, etc)	Is this a GCCS segment? If not, how will it be used
iii. When will it be implemented or official testing? What command (where)?	Will it be officially tested by a DoD command? A civilian agency? If so, where and when.
iv. Interoperable w/ systems?	What system is it presently interoperable with?
c. Primary (1) and Secondary (2) Mission of System:	What is the primary mission of the system from the seven choices below
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	
iii. Combat action and operations	
iv. Logistics	
v. Operational planning, COA	
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	What is the system's primary function from the six choices below
i. Situational Awareness	
ii. Decision support	

ii. Collaboration	
iv. Planning	
v. Command and Control	
vi. Other - elaborate	
e. System strengths?	What are the system strengths?
f. Areas focusing on to improve the system?	What are the system weaknesses?
g. Time sensitive targeting? How?	Will the system support improvements to the call for more efficient time-sensitive targeting?
II. User	Who is the intended user?
a. Who is intended user? (JTF CDR, planner, support agencies,)	What level is the user?
b. Orientation? Joint? Service specific?	Is it orientated toward fixing a particular service problem or towards a joint situation?
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	
i. Deployable –move from-to: air-ship-shore?	Is it intended to be stationary or deployable?
ii. Size - Approximate number cubic feet?	How big is it?
ii. Set-up time- Approximate number of man-hours?	Approximate number of hours to set-up from out of box to fully integrated and functional?
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	Does it meet the standards?
ii. Programming Language?	What is the primary language used?
iii. Unproven technologies (i.e. XML), if so what	What new and unproven technologies does it employ?
c. Presentation of information	
i. Configuration customizable to:	Can the presentation of information be configured to meet the various constraints and limitations from the list?
1. Mission?	
2. Personal profile?	
3. Bandwidth considerations?	
4. Multiple appliances? (PDA, pager, comp.)	
5. Immediate alert notification capability?	
ii. Situation awareness?	Is the presentation capable of being adjusted easily to meet the following constraints?
1. Intuitive?	Is the format logical and can it be easily manipulated?

2. Adjustable for red-green colorblindness?	Can colors be altered to adjust for colorblindness?
3. View adjustable?	Can you adjust the angle of the presentation as necessary or desired?
4. Various overlays?	Can multiple overlays be added and removed from the presentation as necessary?
5. Drill down (to determine more info)	If an item is selected, can the information retrieved be queried for imbedded information?
6. Integrate multiple sources of information	Can the presentation project different information from different sources simultaneously?
7. Terrestrial coverage surface representation	Does the presentation of information cover information over the following different terrestrial surfaces?
a. Sea?	
b. Land?	
c. Aerospace?	
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	Some present systems are limited to being able to work solely over land or water, but not both. This question asks, for example, if a "helicopter symbol can be portrayed going across land and see?"
8. Symbology representations for:	
a. Does it use Mil-Std-2525B symbology?	Does the symbol follow the DoD standard as contained in the Mil-Std document?
b. Friendly and Enemy Intel Info?	Does it present information about both forces?
i. Size, act, loc, unit, time, equipment	Can it provide basic intelligence on the enemy?
ii. Update / project tracks	Does it show tracks of movement, and can it show track projections and distinguish the difference?
d. Capabilities:	
i. Wireless? Wireless technologies used?	Can the system information be transmitted on wireless networks?
ii. Tools	What types of collaboration tools are available to the users from the list below?
1. Learning tools (faqs, on-line training)	What tools are provided to help the user learn the system?
2. Office suite products (MS or StarOffice?)	Are the basic office products incorporated?
3. Search capability	What kind of search capability is provided?
4. Collaboration tools	Can it provide the following capabilities?
a. Text sharing	Share text to collaborate and work together?
b. Graphics	Can graphics be sent from one location to another?
c. Voice	Can voice or audio be sent?

d. Video	Can it present video information?
e. Modeling and simulation	Does it have any modeling and simulation tools?
e. Data	
i. Maintaining Integrity (security and/or updates)	What is the basic means to maintain data integrity?
ii. Infrastructure security? How?	What physical security mechanisms are employed?

Table 3. Criteria Sheet.

C. SYSTEM DESCRIPTIONS

1. Global Command and Control System (GCCS)

a. GCCS Purpose

GCCS is the DoD Joint C2 system that provides interoperable, responsive, secure information to the decision maker at the Unified Commands.[1] The purpose of the GCCS is to provide a system for generation and application of national military power for use by the National Command Authorities (NCA), the CINCs, the service staffs, and subordinate elements. The system is designed to be highly flexible and to be able to collect, process, disseminate and protect information, and support the C2 decision-making process.[2] GCCS is intended to address and unify C4I interoperability and capability issues for future development by categorizing the C2 process into eight vital capabilities: force deployment / redeployment, planning functions (deliberate and crisis action), force sustainment, force readiness, intelligence, SA, force employment, and force protection.[3] Goals for GCCS include the following: (1) sustain the currently deployed system; (2) provide an integrated, flexible, and secure system infrastructure, (3) provide new and enhanced functionality in response to prioritized requirements, and (4) provide a strategy and migration path to integrate emerging technology to GCCS.[4]

1 Global Command and Control System, Program Overview Presentation, GCCS PMO (DISA) 13 May 2002.

2 1999 Requirements Identification Document for Phase III GCCS, Joint Chiefs of Staff, 22 Dec 1998.

3 Global Command and Control System Strategic Plan 1999-2002, Joint Chiefs of Staff, 27 Dec 1999.

4 GCCS Program Overview Presentation by GCCS PMO dated 13 May 2002.

b. Background

GCCS is a common operating environment (COE), integration standard, and migration strategy that eliminates the need for inflexible stovepipe C2 systems and expensive duplication. It is the migration of existing systems into a new COE connected across the network and the integration of selected C2 systems into a comprehensive, interoperable system.[5] The core applications consist of the basic functions required by the warfighter to plan, execute, and manage military operations.

The future of GCCS will evolve by 2010 from its current state of service variants to a single GCCS joint platform comprised of common hardware, operating system, and COE supporting joint and Service-unique mission applications. GCCS will employ an open systems architecture providing secure, collaborative, web-based, and "tailorable" C2 that enables vertical and horizontal interoperability from the president down to the JF/functional/Service component HQs.[6]

GCCS Tasks. GCCS is intended to facilitate:

1. The CINCs, JFCs and service components in managing JF plans and operations
2. Integrating and presenting GCCS information to the commander
3. Readiness support requirements of the Services
4. A real-time (or near-real time) collaborative environment with decision support tools
5. "Building" a modern, open systems architecture (DII COE and JTA) for warfighting
6. Directly assigned and attached forces in the accomplishment of the mission
7. Situation awareness, assessment, decision, and implementation enabler
8. Relevant, essential, timely information presented in an understandable format
9. C2 capabilities providing force projection

5 Federation of American Scientists, http://www.fas.org/nuke/guide/usa/c3i/gccs.htm.

6 GCCS Draft Operational Requirements Document, http://www.teao.saic.com/gccsord/ord/default.asp, 9 May 2002.

10. A set of office, collaboration, modeling and simulation tools, and shared databases[7]

Defense Information Systems Agency (DISA) provides the strategy, technique and set of standards to guide the development of a large number of programs. Presently GCCS is complicated, interconnected, and interdependent where each service's version is disconnected from each other causing limited interoperability.[8] There are over 10,000 GCCS workstations throughout the world at 650+ locations. GCCS maintains information in a flat-file form and in a relational database.[9]

The GCCS process for developing technological advances stems from the ability to incorporate substantiated improvements into the GCCS family of systems. This process works by maintaining a common operating environment and architecture standards. The GCCS system improvement process allows desired submissions from the Combatant Commands, and then they are validated as joint requirements (by more than one CINC) into the GCCS Requirements Identification Database (GRID). Assessments are done from the desired capabilities, they are then prioritized through the Requirements Identification Document (RID) in 2-year cycles called "blocks." From the prioritized RID, they focus on the top 50 desired capabilities. There is a "data-call" on solutions with applications by ACTD, Combatant Commands, and the services. The requirements desired are analyzed for three solutions each. From that the potential best is selected from a plan that has an "executive agent" who champions the solution with proven life cycle maintenance and future funding.[10] For example, the GCCS evolution is summarized below:[11]

1. 1980s – WWMCCS: (World Wide Military Command and Control System)
    a. Based on 70s mainframe technology; upgrades every 2 – 3 years
    b. Service oriented not joint, provided technical admin support for C2
    c. Used for TPFDD (Time Phased Force Deployment Data)

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7 Global Command and Control System Strategic Plan 1999-2002, Joint Chiefs of Staff, 27 Dec 1999.

8 GCCS I3 Implementation Plan, DISA, 17 Oct 2001.

9 LTC Matthias, GCCS Chief Engineer (DISA) Interview on 20 May 2002.

10 LTC Matthias, DISA 20 May 2002.

11 GCCS Program Overview Presentation by GCCS PMO dated 13 May 2002.

2. 1996 - GCCS v2.X: (Client-Server)
   a. COTS and JFC battlefield info focus, gave DoD a guiding concept
   b. Upgrades about every 18 months, better C2 capability
3. 1998 - GCCS v3.X: (Heavy-client)
   a. 2-stage strategy: Separate OS and applications
   b. OS is better coordinated and flexible (stage 1)
   c. Applications: Integrate NCA, NSA, JCS, CINC, CIA, FBI, FEMA info
4. 2003 – GCCS v4.X: (Thin client, selected Web and Client/Server)
   a. DB: Separate from applications, more flexible (JOPES 2000)
   b. Client: NT – Same computer at home, at work, at war
   c. Applications: Increasing web-enabled capabilities
5. 2006 – GCCS v5.X: (Network Centric C2)
   a. Enterprise (e.g. PKI, GDS, IDM) and web services
   b. Web-enabled applications for ubiquitous clients (wireless, PDA, etc.)
   c. Global Command and Control System Criteria Information

I. System Name	**Global Command and Control System (GCCS)**
System Description	The purpose of GCCS is to provide a system for generation and application of national military power for use by the National Command Authorities (NCA), the CINCs, & the service staffs.
POC Representative information	LTC G. Matthias (USA), Chief Engineer of GCCS DISA/C2 (Apps Eng) on 20 May 2002, (703) 882-1060: DSN: 381 NIPRNET: matthiag@ncr.disa.mil SIPRNET: matthiag@ncr.disa.smil.mil
Basic Info Web site	http://www.disa.mil/gccs
Interview date	20 May 2002
i. Previous associated names?	WWMCCS, but much more now
ii. Primary organizational PM?	DISA – responsible for design, development, integration, testing, deployment and sustainment of the joint GCCS (implementation accomplished by CINCs)
iii. Funding support? Whom? How much over next 2 yrs?	DISA – significant amount for >80 government people (mil & civ) directly in the GCCS PMO

	plus another 80 in direct support external activities (e.g., testing, security certification, etc.), OS, RDT&E and procurement]
iv. Primary requirements "driver?"	Joint Staff – w/ coordinated input of CINCs, validated and prioritized, solutions managed through an assessment of potential candidate solutions (candidate solutions must have an Executive Agent prior to adoption)
v. Is it a concept, prototype, or actual system?	Actual system
vi. How long has it been in development?	> 6 years operationally, longer in actual development
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	No ORD. Program plans for and executes in 24 month blocks as an evolutionary acquisition program. Currently, there is no ORD. Requirements are managed through IAW CJCSI 6721.01. ORD under development.
b. Purpose?	Provide the Joint Command and Control (C2) capability that is secure, interoperable, and responsive to warfighter requirements.
i. Why build it?	Warfighting capability.
ii. Ultimate Goal? (GCCS segment, other, etc)	See above.
iii. When will it be implemented or official testing? What command?	Employed at 625 sites (43 – "critical" commands) with 10K users worldwide.
c. Primary (1) and Secondary (2) Mission of System:	<u>All</u> - primarily combat ops and planning
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	
iii. Combat action / operations	Primary
iv. Logistics	
v. Operational planning, COA	Secondary
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	<u>All</u> – primarily C2
i. Situational Awareness	
ii. Decision support	
ii. Collaboration	
iv. Planning	
v. Command and Control	Primary
vi. Other - elaborate	
e. System strengths?	C2 and presently in use.

f. Areas focusing on to improve the system? (Weaknesses?)	Continual development to improve capabilities and enhancements. Decreasing time to market and improve training.
g. Does it facilitate time sensitive critical target decisions? How?	Yes, it allows the CDR to understand situation and enables better C2 capabilities
II. User	
a. Who is intended user? (JTFC, planner, support agencies,)	CINC or his delegate (JTFC)
b. Orientation? Joint? Service specific?	Joint – different "flavors" more specific to different services.
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	
i. Deployable –move from-to: air-ship-shore?	Yes, as long as it has connectivity
ii. Size - Approximate number cubic feet?	Small - Several servers
ii. Set-up time (man-hours)?	With connectivity; hours/small site, days/larger sites
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	Yes
ii. Programming Language?	Block 3:C, C++, lots of ADA Block 4: C++ and JAVA
iii. Unproven technologies (i.e. XML), if so what	XML and others, plans to continue developing
c. Presentation of information	
i. Configuration customizable to:	
1. Sub-Mission?	Yes
2. Personal profile?	Developing
3. Bandwidth considerations?	Developing
4. Multiple appliances? (PDA, pager, comp.)	Developing
5. Immediate alert notification capability?	Yes
ii. Situation awareness?	
1. Intuitive?	So-so, but should improve more as migrate more to PC and web based clients vice Unix "feel"
2. Adjustable for red-green color blindness?	Unknown
3. View adjustable?	2-dimensional but very adjustable from point of view perspective

4. Various overlays?	Yes – intel, imagery, tracks, sources, etc
5. Drill down (to determine more info)	Yes
6. Integrate multiple sources of information	Yes
7. Terrestrial coverage surface representation	
a. Sea?	Yes
b. Land?	Yes
c. Aerospace?	Yes
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	GCCS not limited, but data sources that input into GCCS might be limited, therefore, limit GCCS presentation
8. Symbology representations for:	
a. Planes?	Yes
b. Ships?	Yes
c. Vehicles?	Yes
d. Troops?	Yes
e. Missiles?	Yes – for Theater Ballistic; No – for ICBM
f. Friendly and Enemy Intel Info?	
i. Size, activity, location, unit, time, equipment	Yes, if input data sources exist
ii. Update / project tracks	Yes, if input data sources exist
d. Capabilities:	
i. Wireless? Wireless technologies used?	Yes – in development
ii. Tools	
1. Learning tools (FAQS)	Limited
2. Office suite products (MS or StarOffice?)	Both
3. Search capability	No, but browser has search capability
4. Collaboration tools	
a. Text sharing	Yes
b. Graphics	Yes, Net-meeting
c. Voice	No
d. Video	Yes with I3 – digesting streaming video (predator)
e. Modeling simulation	Limited

Table 4. GCCS Criteria Table.

2. Global Information Grid

a. Purpose

The purpose of the Global Information Grid Capstone Requirements Document (GIG CRD) is to describe the overarching information capability requirements for a globally interconnected, end-to-end, interoperable, secured system of systems that will support the National Command Authorities (NCA), warfighters, DoD personnel, information community (IC), policy makers, and non-DoD users at all levels involved in both military and nonmilitary operations.

The significance of the CRD is that it provides direction to all DoD and IC components for capability requirements and the key performance parameters in developing Operational Requirements Documents (ORDs) for new systems and for upgrading legacy systems. This CRD also guides future IT investments to ensure interoperability. All Mission Need Statements (MNSs), ORDs, and CRDs that are associated with GIG systems, regardless of acquisition category (ACAT), must show compliance with the GIG CRD to fulfill a system's operational purpose(s)/mission(s).[12]

b. Background

The Global Information Grid (GIG) Capstone Requirements Document (CRD) initiated the use of the word GIG, and now it has been documented in major publications, such as JV2020 and JP 6-0. The GIG, in general, means a globally interconnected, end-to-end set of capabilities for managing information applicable to the warfighter. Specifically, the GIG CRD was created over concerns regarding interoperability and end-to-end integration of automated information systems. However, demand for a GIG has been driven by the requirement for information superiority and decision superiority to achieve full spectrum dominance, as expressed in Joint Vision 2020 (JV 2020). JV 2020 also highlights the importance of a network-centric warfare

12 Global Information Grid Capstone Requirements Document, JROCM 134-01, 13 Aug 2001, (GIG EA) JFCOM.

(NCW) environment, enabled by the GIG by means of dramatically improved information sharing through the robust networking of warfighting forces. The GIG provides the enabling foundation for NCW[13], information superiority, decision superiority, and ultimately full spectrum dominance. The information advantage gained through the use of NCW envisions a warfighting force to achieve dramatically improved information positions, in the form of common operational pictures that provide the basis for shared situational awareness and knowledge, and a resulting increase in combat power. JFCOM has been reviewing many systems that attempt to achieve a shared situational awareness and knowledge among all elements and in a joint force environment, to increase future warfighting capabilities. The success of the GIG will depend in large part on how well it helps achieve fully interoperable forces by connecting today's islands of interoperability to allow force-wide information sharing.[14]

Goal: The GIG is envisioned to:

1. Support DoD and IC information requirements and allow warfighters and other authorized users to process, store, transport, and use information regardless of technology, organization, or location. U.S. forces will have "plug and play" interoperability, while allied and coalition partners will be afforded connectivity on an as needed basis.
2. Enable all warfighters to receive near real-time, fused battlespace situational awareness. It will allow commanders and their staff at the CINC, Joint Task Force (JTF), and Service Component levels to analyze data, anticipate requirements, focus on answers, and make real-time decisions rather than relying on historical information from multiple stove piped automated information systems applications.
3. Finally, to provide commanders with the environment needed to support information flow and exchange to accomplish missions collaboratively, simultaneously, and interactively, resulting in more efficient and substantially reduced operational decision making times.
4. The GIG is a key enabler of network-centric warfare and is essential for information and decision superiority. It will enable Command, Control, Communications, Computers and Intelligence (C4II) integration of joint forces, improve interoperability of systems, and increase optimization of bandwidth capacity thereby dramatically improving the warfighting

13 An in-depth treatment of NCW is provided in the book Network Centric Warfare: Developing and Leveraging Information Superiority, 2nd Edition (Revised), by David S. Alberts, John J. Garstka and Frederick P. Stein, C4ISR Cooperative Research Program (CCRP), August 1999.

14 Global Information Grid Capstone Requirements Document, JROCM 134-01, 13 Aug 2001, (GIG EA) JFCOM.

capabilities of joint forces across the full spectrum of conflict. The GIG will enhance operational capabilities while providing a common operational environment for conventional and nuclear command and control (C2), combat support, combat service support, intelligence, and business functions. In particular, the GIG will support:

a. Warfighters' ability to operate with reduced forces at high operational tempos where dynamic planning and redirection of assets is the norm.

b. Delivery of information concerning targets, movement of forces, condition of equipment, levels of supplies, and disposition of assets to commanders, their forces, and the National Command Authority within specified time frames.

c. Warfighters' ability to obtain and use combat and administrative support information from national, allied, coalition, and other widely dispersed assets.

d. Collection, processing, storage, distribution, and display of information horizontally and vertically throughout organizational structures.

e. Rapid and seamless flow and exchange of information around the globe to enable collaborative mission planning and execution from widely dispersed locations and at different levels (to include strategic, operational, and tactical).

f. Timely, assured connectivity and information availability for decision makers and their advisors to support effective decision-making.

g. Integrated, survivable, and enduring communications for the NCA, Integrated Tactical Warning and Attack Assessment (ITW/AA), and strategic forces.[15]

c. Global Information Grid Criteria Information

I. System Name	**Global Information Grid CRD**
System Description	A DoD set of standards to guide the informational architectural development of a common network to manage information flows and requirements
POC Representative info	Art Macdougall, Senior Engineer Advisor (2 yrs) Old Dominion University supporting JFCOM, 757-836-5610 macdouga@jwfc.jfcom.mil
Basic info web site	https://jdl.jwfc.jfcom.mil with Username as

15 Ibid.

	wg00061 and Password as J1f9C9m3
Date of interview	6 June 2002
i. Previous associated names/tech?	Initiated the GIG concepts. Tasked by JROC to CRD
ii. Primary organizational sponsor? (i.e. PM?)	JFCOM, J-6
iii. Funding support? Whom?	JFCOM, J-6
iv. Primary requirements "driver?"	Working groups with CINCs, services, and agency (NSA, DLA, DIA, DISA, NIMA) participation
v. Is it a concept, prototype, ACTD or actual system?	CRD – like a ORD but drives the ORD within a family of systems.
vi. How long has it been in development?	1999 (continuing with ORDs of compliance Col/CAPT review, then a Flag review with signatures with comments and needed changes). Then to Pentagon JRP-JRB-JROC
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	CRD, no ORD. More in requirements cycle CJCSI 3170.01B (IDs requirements)
b. Purpose?	
i. Why build it? Capabilities?	Created for guidance and interoperability for C4I2 systems. Sets requirements for developing systems.
ii. Ultimate Goal? (GCCS segment, other, etc)	Interoperability
iii. When will it be implemented or official testing? What command (where)?	CRD points that will meet interoperability standards as set by JITC and applicable service test centers.
c. Primary (1) and Secondary (2) Mission of System:	Requirements guidance for family of systems, not the combat specific areas
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	
iii. Combat action and operations	
iv. Logistics	
v. Operational planning, COA	
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	Requirements guidance for family of systems and the network architecture; not for these six functions
i. Situational Awareness	
ii. Decision "assistance"	

iii. Collaboration	
iv. Planning	
v. Command and Control	
vi. Other - elaborate	
e. System strengths?	Provides a single point for ORD authors for developing C4I2 requirements
f. Areas focusing on to improve the system?	Annual updates to enable technology capabilities to be inserted (ex. 4-D standards for aircraft tracks)
g. Time sensitive targeting? How?	Developing guidance concepts for types of info (Survival Info i.e. SCUD impact area)
II. User	
a. Who is intended user? (JTF CDR, planner, support agency)	Producer, user, and developer focus – What the warfighter needs today
b. Orientation? Joint? Service	Joint
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	Guidance is provided in CRD
i. Deployable –move from-to: air-ship-shore?	N/A
ii. Size - Approximate number cubic feet?	N/A
ii. Set-up time- Approximate number of man-hours?	N/A
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	Yes
ii. Programming Language?	N/A
iii. Unproven technologies?	N/A
c. Presentation of information	
i. Configuration customizable to:	Guidance is provided in CRD for customization
1. Mission?	
2. Personal profile?	
3. Bandwidth considerations?	
4. Multiple appliances?	
5. Immediate alert notification capability?	Yes
ii. Situation awareness?	Guidance is supported in CRD, but N/A for CRD
1. Intuitive?	In guidance

2. Adjustable for Red-green colorblindness?	Not in guidance
3. View adjustable?	In guidance
4. Various overlays?	In guidance
5. Drill down (more info)	In guidance
6. Integrate multiple sources of information	In guidance
7. Terrestrial coverage surface representation	N/A
a. Sea?	
b. Land?	
c. Aerospace?	
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	
8. Symbology representations for:	Guidance is provided in CRD
a. Mil-Std-2525B?	No
b. Friendly and Enemy Intel Info?	
i. Size, act, loc, unit, time, eqpt	
ii. Update / project tracks	
d. Capabilities:	
i. Wireless? Wireless technologies used?	N/A – focused on getting info through. Below the CRD
ii. Tools	
1. Learning tools (faqs)	Yes in CRD
2. Office suite products (MS or StarOffice?)	Not specified
3. Search capability	Yes (and will be IDM ORD)
4. Collaboration tools	CRD discusses capabilities
a. Text sharing	
b. Graphics	
c. Voice	
d. Video	
e. Modeling and simulation	
e. Data	
i. Maintaining Integrity (security and/or updates)	Yes, Integrity 99.99-threshold (ORD requirement), 99.999-objective
ii. Infrastructure security?	Yes, guidance is provided

Table 5. GIG Criteria Information.

3. Information Dissemination Management Capstone Requirements Document

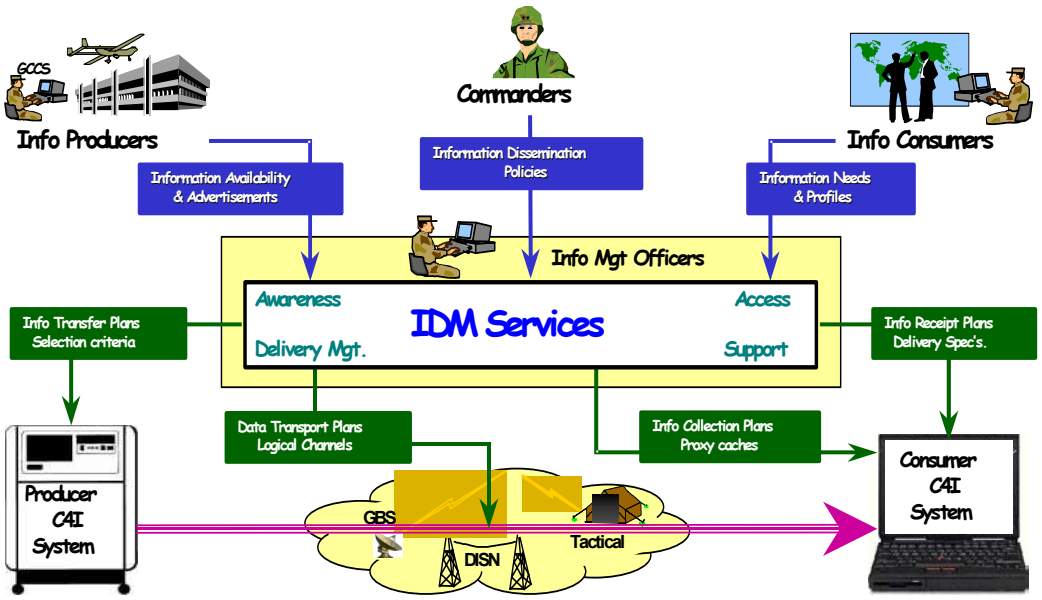

Figure 9. IDM Services Process [From: Ref 33].

a. Purpose

Information Dissemination Management Capstone Requirements Document (IDM CRD) is a collection and dissemination requirements specification, with associated management services, that directs end-to-end information flows throughout the GIG in accordance with (soon to begin setting) government and command policy. IDM CRD is intended to provide the right information, at the right place, at the right time and is essential for achieving the goals of JV2020. IDM will provide information dissemination services and standards for information interoperability and products, such as: data, audio, video, web standards, priority basics, and file structures for use across the GIG. IDM will be the principal means for managing the dissemination of information

supporting the warfighter at all levels and will be the principal means for managing the dissemination of information across the GIG.[16]

b. Background

The IDM CRD addresses awareness, access, and delivery of information:

1. Information Awareness – Cataloging (metadata), Searching, Advertising
2. Information Access - Dissemination policies and Profiling
3. Information Delivery – Retrieval, Optimizing, Prioritizing
4. IDM Support – Directory, security, operations, and schema management[17]

In summary, IDM is a set of standards, disciplines and regulations that provide guidance and enforcement for the changing face of information (text, voice, video, etc) and telecommunication systems. Additionally, these standards will increase effectiveness and efficiencies for the transfer of information because it will provide boundaries to work within.[18]

IDM divides information into two types: planning and survival. Planning information is used to determine future action by planners and decision-makers and is normally pulled from databases, web pages, or files. Survival information is time sensitive and is usually pushed over tactical networks and data links to tactical commanders and individual weapon systems.[19]

Information Dissemination Management is intended to enable the Joint Warfighter decision-maker to utilize the experience, knowledge and understanding of the situation within the spheres of influence and concern. Collecting, organizing, and presenting information reduces uncertainty for decision-makers and empowers rapid and effective decision-making.[20]

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16 JOINT STAFF/J6 NetOps CONOPS Ver 1 Draft MCEB Network Operations Panel, Washington, D.C. 20318-6000, 17 May 2001).

17 DISA's IDM IPT, Framework for Information Dissemination Management (IDM) Services, 19 Sep 1997 Paper.

18 CJCSI IDM Management Draft to Supersede CJCSI 6900.01, 24 December 1996.

19 Ibid.

20 DISA's IDM IPT, Framework for Information Dissemination Management (IDM) Services, 19 Sep 1997 Paper.

A goal for IDM is to achieve information superiority through wide-area, high-bandwidth broadcasting, such as Global Broadcast Service (GBS). IDM is intended to:

1. Support Service, joint, and coalition forces across the spectrum of conflict
2. Use a standards based approach but will not limit implementation to only those technologies where standards are available
3. Use commercial-off-the-shelf products (COTS) where applicable
4. Deliver IDM capabilities consistent with GBS deployment for efficient use of GBS
5. Assist in managing information resources, priorities, and capabilities for broadcast[21]

As per JROCM 134-01 dated 30 August 2001, the GIG and IDM CRDs are directed to be intra-supporting in their guidance for future DoD and governmental systems.

c. IDM CRD Criteria Information

I. System Name	**Information Dissemination Management (IDM) Capstone Requirements Document (CRD)**
System Description	IDM is a set of standards and disciplines that provide guidance and awareness for managing information (text, voice, video, etc) and telecommunication systems
Name, title, company	MSgt Matthew Fischer, JFCOM, J62B, (USAF) fischer@jfcom.mil (757) 836-5996
Web-site	http://www.globalsecurity.org/intell/library /reports/2001/compendium/idm.htm
Interview Date	5 June 2002
i. Previous assc'd names/tech?	Battlefield Awareness and Data Dissemination (BADD) ACTD
ii. Primary organizational sponsor? (i.e. PM?)	DARPA
iii. Funding support? Whom?	DARPA
iv. Primary requirements "driver?"	Broadcast Satellite Concepts Bosnia C2SA, GBS
v. Is it a concept, prototype,	Early Prototype (was ACTD)

21 Ibid.

ACTD or actual system?	
vi. How long has it been in development?	Since 95 (Was an ACTD from ’95 – ’00)
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	No ORD (maybe w/12 months - need JROC to make program)
b. Purpose?	Choking from info, and bandwidth constrained, IDM CRD is a set of standards to help manage and prioritize information.
i. Why build it? Capabilities?	
ii. Ultimate Goal? (GCCS segment, other, etc)	No – GCCS. IDM provides service tools and standards to deliver over GIG. It will exist on many systems – network and S/W w/ info to dispersed environments.
iii. When will it be implemented or official testing? What command (where)?	No date set
c. Primary (1) and Secondary (2) Mission of System:	
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	Secondary
iii. Combat action and operations	
iv. Logistics	
v. Operational planning, COA	Primary
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	
i. Situational Awareness	
ii. Decision “assistance”	Secondary
iii. Collaboration	
iv. Planning	Primary
v. Command and Control	
vi. Other - elaborate	
e. System strengths?	Interoperability – Army big, IDM-Tactical (like DISA but with Army flavor), Navy is buying some tools. Mission Info Mgmt – NSSA – IDM recognizes. Some tools now. SIPRNET search service at some CINCs – using cataloging and smart search with Boolean logic. W/ some plug-ins. Delivery piece – Wide Area Assured Transport

	Service.
f. Areas focusing on to improve the system?	1. Leading edge technology for the need for info security, priorities and assurance. 2. GCCS "feel." 3. Service boundaries and firewalls are limiting progression
g. Time sensitive targeting? How?	Yes – today (limited). Prioritized multi-media. Video over IP. Need to upgrade architecture.
II. User	JTF HQ - disadvantaged warfighter (platoon or company level). Product of "predator" image collection, compiles it, distributes. Channel over GBS. Info matches priority – tag data for priority. Move info based on content. BW dynamically reallocated for requirements.
a. Who is intended user? (JTF CDR, planner, support agencies,)	
b. Orientation? Joint? Service specific?	Joint. DISA choice for jointness. Army lead service. AF's JBI has IDM tools.
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	
i. Deployable –move from-to: air-ship-shore?	Yes, S/W only
ii. Size - Approximate number cubic feet?	Varies, but info is maintained at adjacent servers; set parameters through index/catalog.
ii. Set-up time- Approximate number of man-hours?	From 6 hrs to 5 days set-up. Must determine arrangement, priorities, local policies (Private/tags/public/local domains)
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	DII COE level 6 (minimum sets – sharing libraries) goal -7
ii. Programming Language?	JAVA, SQL, XML, HTTP, JavaScript, Solaris 2.5.1 (Unix) moving towards Windows
iii. Unproven technologies (i.e. XML), if so what	XML, JAVA Scripting methods for web-sites cataloging (web-crawling tools proven at older level), and IPv6
c. Presentation of information	
i. Configuration customizable to:	
1. Mission?	Yes, through profiles
2. Personal profile?	Yes
3. Bandwidth	Yes, (determined by commander's policy with

considerations?	respect to the IDM CRD)
4. Multiple appliances? (PDA, pager, computer)	Some with PDAs (w/ maps and images).
5. Immediate alert notification capability?	Yes “smart alarms” pages you.
ii. Situation awareness?	
1. Intuitive?	No because more trying to instill standards
2. Adjustable for red-green colorblindness?	No
3. View adjustable?	Depends on the “carrier” system; otherwise no.
4. Various overlays?	Depends on the “carrier” system; otherwise no.
5. Drill down (to determine more info)	Depends on the “carrier” system; otherwise no.
6. Integrate multiple sources of information	Yes, brings in multiple sources.
7. Terrestrial coverage surface representation	Depends on the “carrier” system; otherwise no.
a. Sea?	
b. Land?	
c. Aerospace?	
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	
8. Symbology representations for:	
a. Mil-Std-2525B?	No
b. Friendly and Enemy Intel Info?	No
i. Size, act, loc, unit, time, equipment	
ii. Update / project tracks	No
d. Capabilities:	
i. Wireless? Wireless technologies used?	Not applicable.
ii. Tools	
1. Learning tools (faqs, on-line training)	Yes
2. Office suite products (MS or StarOffice?)	It can support it and catalog it

3. Search capability	Yes, with IBM "data miner" documents intent and content
4. Collaboration tools	
a. Text sharing	Yes
b. Graphics	No
c. Voice	No
d. Video	No
e. Modeling and simulation	No
e. Data	
i. Maintaining Integrity (security and/or updates)	DII COE compliant, with daily, weekly, monthly backups.

Table 6. IDM Criteria Table.

4. Family of Interoperable Operational Pictures (FIOP)

a. Purpose

The FIOP initiative is an effort to improve interoperability among service C4ISR systems.[22] The objective of the FIOP concept of operations (CONOPS) is to "define the information the warfighter needs to accomplish execution tasks during combat operations and produce the desired operational effects in support of the campaign." The warfighter is defined as any soldier, sailor, airman, or Marine (up to and including the CINC) that has information needs that cross service or functional boundaries.

JROCM 203-00. Additional tasks include determining and listing current "stove pipe" systems to "link up" and to develop web-enabled technology for improved GCCS Common Operational picture (COP).[23] The Aerospace Command & Control ISR Center (AC2ISRC) Commander is the Executive Agent for JROC.[24]

22 B. Grant West// 703-693-3621, MITRE Support to Directorate of Information, DARPA-FDT.

23 Family of Interoperable Operational Pictures (FIOP) Briefing to the Joint Requirements Board, Col. Wilson Guilbeaux, Aerospace C2 & ISR Center, 5 September 2001.

24 Family of Interoperable Operational Pictures (FIOP) Update Briefing, January 2002 CRCB, Rob Walker, COE Program Manager January 30, 2002.

The emphasis for FIOP is the concept of "actionable decision-quality, information." That is to say that while providing a view of the battlespace is certainly important, it is as important to recognize that the depiction of the battlespace must provide content to the warfighter that allows them to make a decision relevant to their mission.[25]

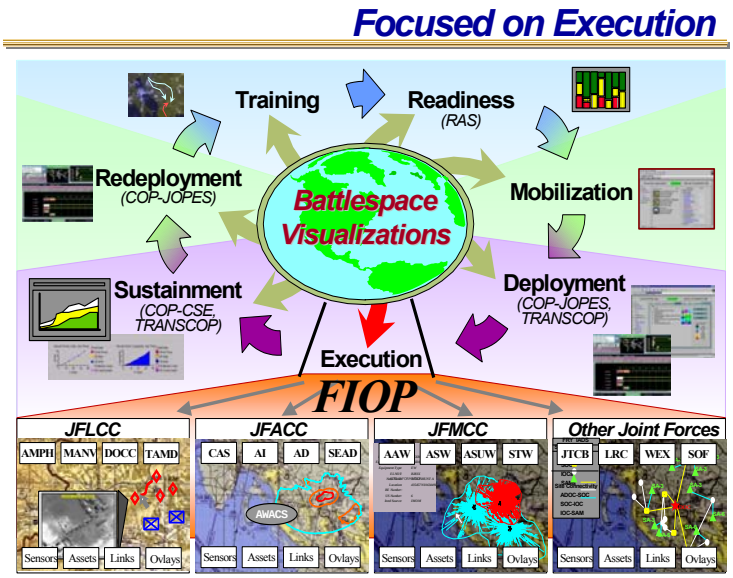

Figure 10. FIOP Integration [From: Ref 18].

b. Background

Given the magnitude of the information needs contained within FIOP, it was determined that an incremental approach to FIOP was necessary. In its early stage FIOP was to focus on the relatively constrained but complex task of combining multiple sensor/data feeds into an actionable Common Operating Picture.

Organizations participating as members of the Multi-Service Management Team (MSMT) are:

1. Aerospace Command and Control Intelligence, Surveillance and Reconnaissance (AC2ISRC) as FIOP Executive Agent, responsible for consolidating requirements FY POM submittals

25 AC2ISRC FIOP Future Efforts Briefing to Mr. Wynne, 9 April 2002.

2. Service Leads – Army, Navy, Marine, and Air Force (voting members)
3. USAF Electronic Systems Center (ESC) as FIOP Project Manager (non-voting)
4. DISA as FIOP engineer coordinator (non-voting)
5. US Joint Forces Command (JFCOM) as the warfighting CINC representative (non-voting)[26]

The FIOP plan of attack[27] is to develop capability statements and trace them to existing requirement sources. The GCCS Requirements Integration Document (RID) is the primary source of requirements and Service requirements, and in turn will help refine the GCCS RID requirements. FIOP will develop an overall roadmap for the mid-term and long-term and to accelerate existing efforts to develop new capabilities.

The first increment of the CONOPS (blue force tracking with a focus on close air support) was selected as a proof of concept with immediate warfighter value that could be accomplished within the timeframe allotted for the initial FIOP effort. As subsequent increments are identified, additional appendices containing the required information needs will be developed. The multi-service FIOP working group will identify follow-on incremental efforts. The JROC provided the following objectives for development: develop concept of operations (USAF), requirements definition (USA), and develop an implementation strategy (USMC). JROC priorities for FY02-03 are to develop: a web-enabled capability, a tactical workstation, and improve message interoperability.[28]

FIOP is a transformational effort[29] and embodies the system changes and process changes implied by Network Centric Warfare, Joint Interoperability and Agile Acquisition. FIOP is both a management structure for coordinating diverse interoperability and integration efforts in the C2ISR community and an acquisition program for implementing the spiral development process.

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26 Background Bullet Paper on FIOP by Lt Col Del Botting/AC2ISRC/A-36/5-2945/deh/14 Dec 01.

27 Family of Interoperable Operational Pictures (FIOP) Update Briefing, January 2002 CRCB, Rob Walker, COE Program Manager, January 30, 2002.

28 Joint Force Command and Control Context Overview Briefing, Information Superiority JWCA, 22 April 2002.

29 FIOP, A Management Structure and An Acquisition Program, Briefing by Gary Weissman, SAF/AQIC MSMT.

The potential for FIOP's contribution to robust interoperability reaches beyond the command center. As a sophisticated user of multiple data inputs, the FIOP program will be a generator/passer of requirements back to the individual operational pictures, networks and data sources. As producers of new information from fusion of multiple data sources, the system enhancements the FIOP program deploys will feed actionable information forward to shooters.

FIOP is not a large core organization; it is a cooperative enterprise among the services and defense agencies. As a product developer, FIOP is partnered with GCCS. As an intermediate user of multiple operational pictures and other data feeds, FIOP will pass requirements to those input processes, flowing from the requirements the CINCs impose on FIOP systems. FIOP is also a cooperative enterprise among the individual programs, ACTDs and other projects developing new C2ISR capabilities. FIOP should help them share products so overlaps are turned into synergies. As FIOP collects hands-on experience integrating new items into the C2 system, it will establish practical rules for how the new items need to work together. Working in cooperation with the responsible authorities for standards and architecture, FIOP will force establishment of standards for joint interoperability.

Support. The FIOP effort was initiated by the Office of the Under Secretary of Defense (OUSD) for Acquisition, Technology and Logistics (AT&L) to solve some of the interoperability deficiencies of command and control (C2) systems.

c. Family of Interoperable Picture Criteria Information

I. System Name	**Family of Interoperable Pictures (FIOP)**
System Description	To improve interoperability among service C4ISR systems through an all-source picture of the battlespace through fusing databases.
POC Representative information	Dan Hobbs (LtCol, ret. USAF) Ops Analyst with L3 Com Analytics Co. DSN 575-2945 or comm (757) 225-2945 Daniel.hobbs@langley.af.mil
Web-site	http://www2.acc.af.mil/ac2isrc/
Interview date	22 May 2002
i. Previous assc'd names/tech?	Borrowed GCCS-COP technology

ii. Primary organizational sponsor?	Air Force – Electronic Systems Center; headed by Sys Program Office at Wright-Patterson
iii. Funding support? Whom?	OSD (ATL) to USAF to PE (fenced for FIOP)
iv. Primary requirements "driver?"	GCCS- RID
v. Is it a concept, prototype, or actual system?	A process
vi. How long has it been in development?	2.5 yrs (since December 2000)
vii. Acquisition cycle? Where? Is there an ORD? Milestone 0 (A)?	No
b. Purpose?	Battlespace awareness, increase system interoperability. Update ADOCS partnering with J-6, JFCOM
i. Why build it? Capabilities?	
ii. Ultimate Goal? (GCCS segment, other, etc)	Provide a variety of GCCS segments
iii. When will it be implemented or official testing? What command (where)?	No specifics – each task has its own timeline (Beta site – Air Ops Center around Dec '02)
c. Primary (1) and Secondary (2) Mission of System:	
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	Secondary
iii. Combat action and operations	Primary
iv. Logistics	
v. Operational planning, COA	
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	
i. Situational Awareness	Primary
ii. Decision "assistance"	
ii. Collaboration	
iv. Planning	
v. Command and Control	Secondary
e. System strengths?	Attempt to break stovepipes for jointness
f. Areas focusing on to improve the system?	Continued interoperability
g. Time sensitive targeting? How?	Yes, through creating a "battlespace picture"
II. User	JFC

a. Who is intended user? (JTF CDR, planner, support agencies)	JFC to eventually include the Tactical Work Station
b. Orientation? Joint? Service specific?	Joint
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	Because it is based on leveraging its "system of record," the capability rests on much of that system.
i. Deployable –move from-to: air-ship-shore?	Depends on GCCS
ii. Size - Approximate number cubic feet?	Depends on the "system of records" (GCCS)
ii. Set-up time- Approximate number of man-hours?	GCCS
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	Yes
ii. Primary Program Language?	C++
iii. Unproven technologies (i.e. XML), if so what	Unsure
c. Presentation of information	
i. Configuration customizable to:	
1. Mission?	Intended to be
2. Personal profile?	Intended to be
3. Bandwidth considerations?	Intended to be
4. Multiple appliances? (PDA, pager, comp.)	Intended to be
5. Immediate alert notification capability?	Intended to be
ii. Situation awareness?	
1. Intuitive?	Intended to be
2. Adjustable for red-green color blindness?	Unsure
3. View adjustable?	Yes (ADOCS presently does)
4. Various overlays?	Yes (ADOCS presently does)
5. Drill down (to determine more info)	Yes (ADOCS presently does)
6. Integrate multiple sources of information	Intended
7. Terrestrial coverage surface representation	
a. Sea?	

b. Land?	
c. Aerospace?	
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	
8. Symbology representations for:	Will follow 2525B standards
a. Planes?	Not presently, but intended
b. Ships?	Not presently, but intended
c. Vehicles?	Not presently, but intended
f. Friendly and Enemy Intel Info?	Not presently, but intended
i. Size, act, loc, unit, time, equipment	Not presently, but intended
ii. Update / project tracks	Not presently, but intended
d. Capabilities:	
i. Wireless? Wireless technologies used?	Intended to have
ii. Tools	
1. Learning tools (faqs, on-line training)	Intended
2. Office suite products (MS or StarOffice?)	Intended
3. Search capability	Through the web browser
4. Collaboration tools	Intended
a. Text sharing	Intended
b. Graphics	Intended
c. Voice	Unsure
d. Video	Intended
e. Modeling and simulation	Unsure
e. Data	MLS

Table 7. FIOP Criteria Table.

5. Single Integrated Air Picture (SIAP)

a. Purpose

DoD has recognized that achieving a Single Integrated Air Picture (SIAP) is necessary for joint military operations in which air surveillance plays a role. Failure to achieve a SIAP could result in any or all of the following: airborne objects not detected; friendly, hostile and neutral objects misidentified; inaccurate time and positional information for objects; multiple tracks for single objects; tracks for nonexistent objects; inconsistent track-object associations. Therefore, improvements to an integrated picture that display information from different sensors will support the following: reducing the risk of fratricide; improving performance of our weapon systems; and increasing the capability to address advanced threats.

The goal of the SIAP is an air surveillance system, in which multiple sensors and platforms jointly track airborne objects in real time.[30] SIAP is intended to fuse near-real-time and real-time data from multiple sensors to allow development of common, continuous, and unambiguous tracks of all airborne objects in the surveillance area. The desired system goals are: track all airborne objects using only a one-track associated identifier in a real-time or near real-time environment with scalable and filterable capabilities.[31]

b. Background

The DoD recognized that each service has multiple "stove-piped" systems to track air threats, and there is not enough cross-communication or coordination between the systems (even within same service). DoD directed the services to begin coordinating

30 Theater Air Missile Defense (TAMD) Capstone Requirements Document (CRD).

31 System Engineering Applied to the SIAP Presentation, 25 October 2000 at www.dtic.nil/ndia/systems/Hobart.pdf.

to provide guidance regarding interoperability issues to increase effectiveness against the air threat.[32]

SIAP is sponsored by the DoD to integrate existing systems associated with presenting a picture of air tracks. The SIAP group is attempting to do this by defining guidelines to provide baseline mutual consistencies and designing a product to meet the objectives of enabling system interactivity. Within the requirements of future system structures and architectures (as defined by the JROC through GIG, TAMD, IDM, and CID CRDs), the SIAP development group is attempting to capture information from the individual "stovepiped" systems' databases and to develop a cross-relational base to allow systems to communicate with each other. This interoperability effort is being done with present systems capable of tracking an air picture.

The objective is to declutter and integrate the air picture, thus giving the warfighter the confidence and flexibility to engage decisively. This improved air picture is expected to: reduce the risk of fratricide, provide defense platforms the opportunity to engage beyond their self-defense zones, and provide the forces the flexibility to quickly mass and repel asymmetric threats such as cruise missiles and theater ballistic missiles – a critical capability in an environment that includes weapons of mass destruction.[33]

The JROC-validated Capstone Requirements Documents (CRDs) define Joint warfighter objectives and identify key performance parameters for Joint operations. The recently approved Theater Air and Missile Defense (TAMD), Combat Identification (CID), Information Dissemination Management (IDM) and Global Information Grid (GIG) CRDs provide the overarching requirements for the SIAP. The primary means for distributing SIAP information is by tactical data links; these links provide technology-based implementation to satisfy information exchange requirements.

Key performance parameters for SIAP include a sensor system developed to perform surveillance, detection, and tracking of air objects in the surveillance area. SIAP data will be derived from real-time and near-real data, and it will correlate air object tracks and associated information through the following imposed requirements: (1)

32 SIAP Progress, Plans, and Recommendations. Technical Report 2002-004, April 2002.

33 SIAP System Engineering Task Force Introduction Brief, 15 March 2002.

SIAP must be scaleable, filterable, and support the user in situation awareness and battle management; (2) it will provide one, and only one, track identifier code with associated characteristics; (3) and it will meet the minimal acceptable attributes and metrics as defined in the SIAP technical report.[34]

c. Single Integrated Air Picture Criteria Information

I. System Name	**Single Integrated Air Picture (SIAP)**
System Description	SIAP is the desired outcome of an air surveillance system where sensors and platforms will track airborne objects in real time. "Middleware" S/W to connect present systems to the developing GIG will be developed.
POC Representative information	CAPT Wilson J.W. (USN), Technical Director SIAP Sys Eng Task Force (or Joint SIAP Sys Eng Office) (703) 602-6441 Wilsonjw@navsea.navy.mil
Web-site	http://siap.navsea.navy.mil (requires access request from this website)
Interview date	10 June 2002
i. Previous assc'd names/tech?	None.
ii. Primary organizational sponsor? (i.e. PM?)	JROC - USD (ATL), ASD C3I
iii. Funding support? Whom?	Services
iv. Primary requirements "driver?"	JROC and 3 CRDs (Joint Theater, Air, & Missile Defense (TAMD), Combat ID, GIG)
v. Is it a concept, prototype, ACTD or actual system?	SIAP includes upgrades to existing systems. All air defense systems will build from all base versions to meet higher-level requirements for mutual consistency.
vi. How long has it been in development?	Conceptualized in '96-97 JROC approved development in '99
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	Not officially, No ORD.
b. Purpose?	Capture info in stovepiped DBs and develop a cross-relational base of communication (e.g. grid sq to lat-long to GPS, etc)

34 SIAP Progress, Plans, and Recommendations. Technical Report 2002-004, April 2002.

i. Why build it? Capabilities?	To meet the 3 CRDs and to integrate the air defense systems for interoperability, for example, integrate AWACS, Aegis, and the ground radars systems.
ii. Ultimate Goal? (GCCS segment, other, etc)	To meet stated requirements in the 3 CRDs. Eventually interface to the GCCS.
iii. When will it be implemented or official testing? What command (where)?	Negotiating with DOT&E for land and open air testing
iv. Interoperable w/ systems?	Attempting to be interoperable with all systems
c. Primary (1) and Secondary (2) Mission of System:	
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	
iii. Combat action and operations	Primary
iv. Logistics	
v. Operational planning, COA	
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	Provide assistance with expenditure of ordnance
i. Situational Awareness	Primary
ii. Decision "assistance"	
ii. Collaboration	
iv. Planning	
v. Command and Control	
vi. Other - elaborate	
e. System strengths?	
f. Areas focusing on to improve the system?	Interoperability and communication between systems
g. Time sensitive targeting? How?	Ultimately, but not presently
II. User	
a. Who is intended user? (JTF CDR, planner, support agencies,)	Cockpit, ships, ground (i.e. the tactical operators)
b. Orientation? Joint? Service specific?	Joint, USD (ATL) determines program head (usually rotates by service)
III. System Technology	

a. Physical characteristics (for expeditionary and flexibility purposes)	
i. Deployable –move from-to: air-ship-shore?	Yes
ii. Size - Approximate number cubic feet?	Varies with host technology
ii. Set-up time- Approximate number of man-hours?	Varies with implementation and present systems
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	No. DII COE does not address ordnance concerns
ii. Programming Language?	All types
iii. Unproven technologies (i.e. XML), if so what	Building architecture in UML
c. Presentation of information	
i. Configuration customizable to:	Below answers are tied to present systems.
1. Mission?	Host dependent
2. Personal profile?	Host dependent
3. Bandwidth considerations?	Host dependent
4. Multiple appliances? (PDA, pager, comp.)	Host dependent
5. Immediate alert notification capability?	Host dependent
ii. Situation awareness?	N/A to SA – program is focused on interoperability through "middleware" S/W and semantic similarities
1. Intuitive?	
2. Adjustable for red-green color blindness?	N/A
3. View adjustable?	N/A
4. Various overlays?	N/A
5. Drill down (to determine more info)	N/A
6. Integrate multiple sources of information	Yes
7. Terrestrial coverage surface representation	Answers below are host dependent
a. Sea?	Host dependent
b. Land?	Host dependent
c. Aerospace?	Host dependent
d. X-terrestrial? (Can the symbol move across different	Host dependent

terrestrial surfaces?)	
8. Symbology representations for:	Dependent on host system
a. Mil-Std-2525B?	Dependent on host system
b. Friendly and Enemy Intel Info?	Dependent on host system
i. Size, act, loc, unit, time, equipment	Dependent on host system
ii. Update / project tracks	Dependent on host system
d. Capabilities:	
i. Wireless? Wireless technologies used?	It will be. Mobile ad hoc connectivity vice fixed routers.
ii. Tools	
1. Learning tools (faqs, on-line training)	Host issue
2. Office suite products (MS or StarOffice?)	Host issue
3. Search capability	Host issue
4. Collaboration tools	Host issue
a. Text sharing	Host issue
b. Graphics	Host issue
c. Voice	Host issue
d. Video	Host issue
e. Modeling and simulation	Host issue - Maybe later
e. Data	
i. Maintaining Integrity (security and/or updates)	Host dependent
ii. Infrastructure security?	Host dependent

Table 8. SIAP Criteria Table.

6. Knowledge Web (K-Web)

a. Purpose

To design and develop customized tools to aid command-level decision-makers, using existing web technologies, the Knowledge-Web (K-Web) Project has made improvements in managing mission-relevant information. Space and Naval Warfare

Systems Center, San Diego, (SSD), has led several efforts to support the needs of senior decision makers and their support staff. The Knowledge Web concept represents an evolutionary step towards helping users turn raw data into meaningful information and knowledge – and sharing that knowledge with others.[35]

b. Background

The K-Web project was designed using a systems approach, with actual system users, where detailed requirements were incorporated into the design process. Focusing on the human user and way of thinking was a primary concern throughout the development of the K-Web. The goal of the K-Web is to improve capabilities in situation awareness, collaboration, and action management. Commercial-off-the-shelf (COTS) and government-off-the-shelf (GOTS) technologies will assist Web-enabled C2 decision-making in operational command centers so that information can be rapidly disseminated. Supporting command and control technologies are based on "knowledge engineering" with Navy, Marine Corps, U.S. Strategic Command, and other high-level command centers. The key idea with the K-Web is that "value-added information," created by a command staff, can be captured and distributed in real time, using Web pages, thereby increasing the speed and effectiveness of command.[36]

Central components of the K-Web are the creation of intuitive, summary web-pages that show operationally relevant information for key functional areas of the command. These summaries are rapidly created and disseminated using template-based authoring tools and viewed on conventional web browsers. A tactical graphics tool, called TacGraph, allows maps to be annotated with symbols and drawing objects. The annotated charts and objects are embedded with value-added information (e.g. hyper-links and text information). Both tools assist in publishing the information as an HTML document to facilitate quick dissemination while maintaining bandwidth limitations.

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35 Command 21 "K-Web" Tools at http://www-tadmus.nosc.mil/Command21Tools_R3.pdf.

36 Ibid.

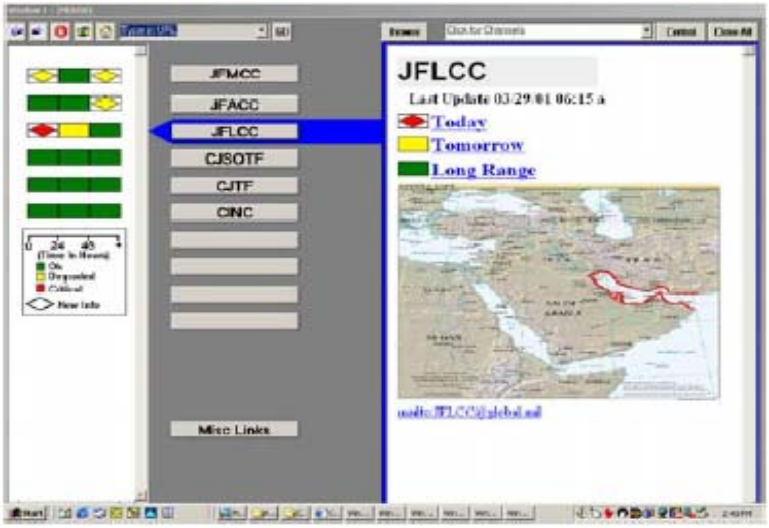

Figure 11. K-Web Sample Summary Page [Ref 47].

Figure 11 shows a sample summary page. The top-left corner displays overall status indicators that may be red, yellow, or green, indicating "show-stoppers," "caution," or "going as planned." Shapes are also used to classify information, for example, a diamond indicates new or changed information. The status indicators are intended to reflect time-based summaries for classifying information. Additionally, graphics and alerts can have HTML hyperlinks for further information.[37]

The development of the COMCARGRU THREE K-Web aboard the USS Carl Vinson suggests that there are a number of processes and protocols that still need to be addressed, such as, bandwidth management, security and accountability, wireless and K-Web content replication across fleet platforms.

c. K-Web Criteria Information

I. System Name	**K-Web (Knowledge Web)**
System Description	K-Web was built to address the need to improve capabilities in situation awareness, collaboration, and action management by processing and disseminating data faster.
Name, title, company	Morrison, Dr. Jeff, PM, SPAWAR SSC-San Diego, jmorriso@spawar.navy.mil

37 Command 21 Knowledge Web at http://www-tadmus.nosc.mil/Global01KW7-01.pdf.

	(619) 553-9070
Basic info (web site)	http://www-tadmus.spawar.navy.mil/
Date of interview	30 April 2002 and 5 June 2002
i. Previous assc'd names/tech?	TADMUS, Knowledge Wall, CINC 21
ii. Primary organizational sponsor? (i.e. PM?)	SPAWAR
iii. Funding support? Whom?	ONR
iv. Primary requirements "driver?"	Chief of Naval Operations (CNO), Web-enabled Navy (WEN), 2nd & 3rd Fleet operational requirements with carrier and cruiser battle group's inputs
v. Is it a concept, prototype, ACTD or actual system?	Actual
vi. How long has it been in development?	3 years ('99 - present)
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	No, but it is tied to GCCS-Maritime
b. Purpose?	
i. Why build it? Capabilities?	Increase speed of command
ii. Ultimate Goal? (GCCS segment, other, etc)	GCCS Segment
iii. When will it be implemented or official testing? Where?	Proposed for installation at CINCEUCOM for Mediterranean Rescuer in July 2002
c. Primary (1) and Secondary (2) Mission of System:	
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	Secondary
iii. Combat action and operations	Primary
iv. Logistics	
v. Operational planning, COA	
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	
i. Situational Awareness	Secondary
ii. Decision "assistance"	
ii. Collaboration	

iv. Planning	
v. Command and Control	Primary
vi. Other - elaborate	
e. System strengths?	Systems approach based on operational processes/ business rules/ practices. Relies on COTS, web-technologies, and providing tools to fit the warfighter
f. Areas focusing on to improve the system?	Technological – bandwidth management, connectivity to fleet, design decisions
g. Time sensitive targeting? How?	Yes, as intended. Working with Collaboration at Sea (CAS)
II. User	
a. Who is intended user? (JFC, planner, support agencies,)	JFC
b. Orientation? Joint? Service specific?	Joint but with Naval characteristics
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	
i. Deployable –move from-to: air-ship-shore?	Yes
ii. Size - Approximate number cubic feet?	Server
ii. Set-up time- Approximate number of man-hours?	Hrs
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	Yes
ii. Programming Language?	JAVA, VB, XML, C++, and Macromedia Director
iii. Unproven technologies (i.e. XML), if so what	XML
c. Presentation of information	
i. Configuration customizable:	
1. Mission?	Yes
2. Personal profile?	Yes
3. Bandwidth considerations?	Yes
4. Multiple appliances? (PDA, pager, comp.)	No
5. Immediate alert	Yes

notification capability?	
ii. Situation awareness?	
1. Intuitive?	Yes
2. Adjustable for red-green color blindness?	No
3. View adjustable?	No
4. Various overlays?	Yes
5. Drill down (to determine more info)	Yes
6. Integrate multiple sources of information	Yes
7. Representation for:	Yes below if inputted into the system
a. Sea?	Yes
b. Land?	Yes
c. Aerospace?	Yes
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	Yes
e. Mil-Std-2525B?	Yes
f. Intel Info?	
i. Size, act, loc, unit, time, equipment	If inputted
ii. Update / project tracks	If inputted
d. Capabilities:	
i. Wireless? Wireless technologies used?	No
ii. Tools	
1. Learning tools (faqs, on-line training)	Yes
2. Office suite products (MS or StarOffice?)	Yes
3. Search capability	Yes
4. Collaboration tools	Yes
a. Text sharing	Yes
b. Graphics	Yes
c. Voice	Yes
d. Video	Yes
e. Modeling and simulation	No
e. Data	
i. Maintaining Integrity	WinNT

(security and/or updates)	
ii. Infrastructure security? How?	As required

Table 9. K-Web Criteria Table.

7. Command Post of the Future (CPOF)

a. Purpose

As warfighting units become smaller, faster and more dispersed, Command Post of the Future (CPOF) is designed to increase situational awareness and cross-communication among the tactical units. The objectives are to increase speed and quality of command, and improve dissemination of information at the brigade, battalion, and company level. The goal of CPOF is to increase situational understanding at the tactical and operational level, thus shortening the commander's decision cycle.[38]

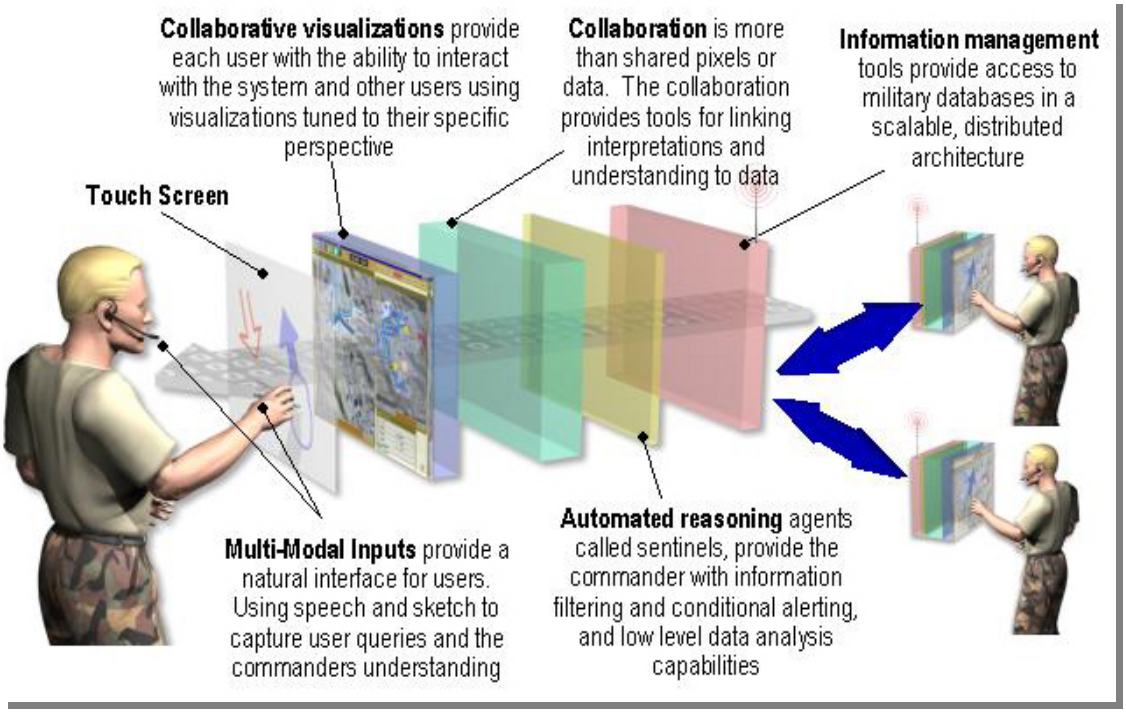

Figure 12. Functional Layers of the CPOF *BattleBoard*. [From: Ref 53]

38 Command Post of the Future Tear Sheet, DARPA.

b. Background

The central theme of network centric warfare is that ubiquitous communications and access to information are changing the way operations will be prosecuted in future conflicts. Research is being conducted as to how this new flood of information will be managed and presented to the commander. Current C2 systems are already overloaded with the volume of information they receive. The CPOF program is developing technologies that address these issues. Command and control is primarily concerned with understanding the situation, planning actions, and communicating intent in conditions of great uncertainty with stringent time constraints. For each of these command functions, CPOF is developing technologies that leverage the expertise of the commander by exploiting and augmenting natural cognitive abilities. The technologies are integrated into the commanders' *BattleBoard*, a distributed, mobile, collaborative command interface that replaces the forward deployed command post. Key technologies being developed for CPOF are: (1) an integrated visualization environment for the commander and his staff; (2) a powerful and comprehensive human-computer interaction capability using speech and gesture recognition; and (3) a robust collaborative communication environment for creating shared understanding among commanders and staff through both voice and visual interactions. In network-centric environments, collaboration and visualization technologies will need to be an integral part of every application and command process. CPOF incorporates visualization technologies that have been shown to increase situation understanding.[39]

c. Command Post of the Future Criteria Information

I. System Name	**Command Post of the Future (CPOF)**
System Description	CPOF is designed to increase SA and cross-communication among units. The objectives are to increase speed and quality of command, and improve dissemination of information.

39 IXO Website for CPOF at http://dtsn.darpa.mil/ixo/cpof.asp.

Name, title, company	Ward Page, PM, DARPA IXO, (703) 696-7443 wpage@darpa.mil
Web-site	http://dtsn.darpa.mil/ixo/cpof.asp
Interview date	3 June 2002
i. Previous assc'd names/tech?	Tech – Knowledge mgmt "Psyche", RTF (Rapid Knowledge Formation) and DARPA communicator Visualization / Info Assurance - COTS
ii. Primary organizational sponsor? (i.e. PM?)	DARPA and listening to US Army and USMC needs
iii. Funding support? Whom?	DARPA, 1998-2002
iv. Primary requirements "driver?"	Visionary DoD leaders (not CINCs nor service components). Planning 5-20 yrs out
v. Is it a concept, prototype, ACTD or actual system?	Prototype – acts like a system not in POM or through services.
vi. How long has it been in development?	4 Yr
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	No, it slows down the process
b. Purpose?	Improve tools for the commander as fighting forces get smaller, faster, more dispersed
i. Why build it? Capabilities?	Primarily to increase situational awareness, understanding and communication. 4 reasons: 1. Allow company commanders more capabilities since they have good SA on tactical situation. 2. SU – COP experimentation shows many different opinions, enemy and HHQs – thinking and guessing. 3. Improve collaboration for planning. 4. Provide a common–ground problem by developing tools so that commanders have good pattern recognition in tactical environment.
ii. Ultimate Goal? (GCCS segment, other, etc)	No. Tactical domain focus by building a Commander's tool to interface to battlefield
iii. When will it be implemented or official testing? What command (where)?	Expected testing this summer at Ft Lewis, WA by (Interim Brigade Team) Army I-Corp.
c. Primary (1) and Secondary (2) Mission of System:	
i. Admin & Personnel	
ii. Intelligence (enemy,	

friendly, neutrals)	
iii. Combat action and operations	Primary
iv. Logistics	
v. Operational planning, COA	Secondary (at the tactical level)
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	
i. Situational Awareness	Primary
ii. Decision "assistance"	
ii. Collaboration	
iv. Planning	Secondary
v. Command and Control	
vi. Other - elaborate	
e. System strengths?	Tactical focus and SA, collaboration & communication with warriors, drill down
f. Areas focusing on to improve the system?	1. Extracting info from symbology. 2. Auto decision help (auto reasoning) and bookkeeping. 3. Security. Mobile communication–more work 4. H/W security. 5. Digital security.
g. Time sensitive targeting? How?	Yes, through managing ROE problems, coordination, and visual eyes for weapons.
II. User	Tactical level; Battalion, Brigade, and Company level
a. Who is intended user? (JFC, planner, support agencies,)	Tactical user
b. Orientation? Joint? Service specific?	Joint - to start with some recent emphasis to ground commanders.
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	
i. Deployable –move from-to: air-ship-shore?	Yes, only S/W.
ii. Size - Approximate number cubic feet?	Client/Server transitioning to Peer-peer
b. Technology Issues Addressed:	
i. DII COE & Joint	Yes. Info Mgmt part of COE 4.6

Technical Architecture compliant?	Level 7 – some compliance, on-going
ii. Programming Language?	JAVA, C++, C
iii. Unproven technologies (i.e. XML), if so what	XML, message passing technology
c. Presentation of information	
i. Configuration customizable to:	
1. Mission?	Yes, system is easily tailorable
2. Personal profile?	Yes
3. Bandwidth considerations?	Limited
4. Multiple appliances? (PDA, pager, comp.)	Yes appliance based approach
5. Immediate alert notification capability?	Yes
ii. Situation awareness?	
1. Intuitive?	Yes
2. Adjustable for red-green color blindness?	No
3. View adjustable?	Yes (map, chart) 3-D
4. Various overlays?	Yes
5. Drill down (to determine more info)	Yes – mouse over (data and associations) and resolution based (to source)
6. Integrate multiple sources of information	Yes
7. Terrestrial coverage surface representation	
a. Sea?	Yes
b. Land?	Yes
c. Aerospace?	Yes
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	Yes
8. Symbology representations for:	
a. Mil-Std-2525B?	Yes – limited. Uses icons as representatives
b. Friendly and Enemy Intel Info?	
i. Size, act, loc, unit, time, equipment	Yes
ii. Update / project	Yes, but limited. Sources and verification.

tracks	Not doing the fusion or updates.
d. Capabilities:	
i. Wireless? Wireless technologies used?	Yes, IEEE 802.11b standards and some 802.11a. Tweaking to Joint Tactical Radio System
ii. Tools	
1. Learning tools (faqs, on-line training)	Written training guides. 10 page report and 1 hr to understand it
2. Office suite products (MS or StarOffice?)	Windows 2000 NT suite
3. Search capability	Yes – Appliances - basic
4. Collaboration tools	
a. Text sharing	Yes
b. Graphics	Yes
c. Voice	Yes
d. Video	Yes
e. Modeling and simulation	No – but can tap into M/S tools
e. Data	
i. Maintaining Integrity (security and/or updates)	Through configuration control
ii. Infrastructure security? How?	Through software

Table 10. CPOF Criteria Table.

8. Joint Theater Logistics

a. Purpose

Joint Theater Logistics (JTL) Advanced Concept Technology Demonstration (ACTD) is one element of the Defense Applied Research Projects Agency's (DARPA) development program in the field of logistics. Designed to provide a web-based solution to managing the logistics process at the operational level, the decision support applications generated under JTL are now moving toward the completion of their development process under DARPA. The purpose of the JTL ACTD is to expedite the execution of operations by merging the logistics capabilities into the intelligence and operational planning phase. JTL will provide the JFC with near real-time collaborative

operations and logistics capabilities that will support logistics planning, execution tracking and rapid re-planning.[40]

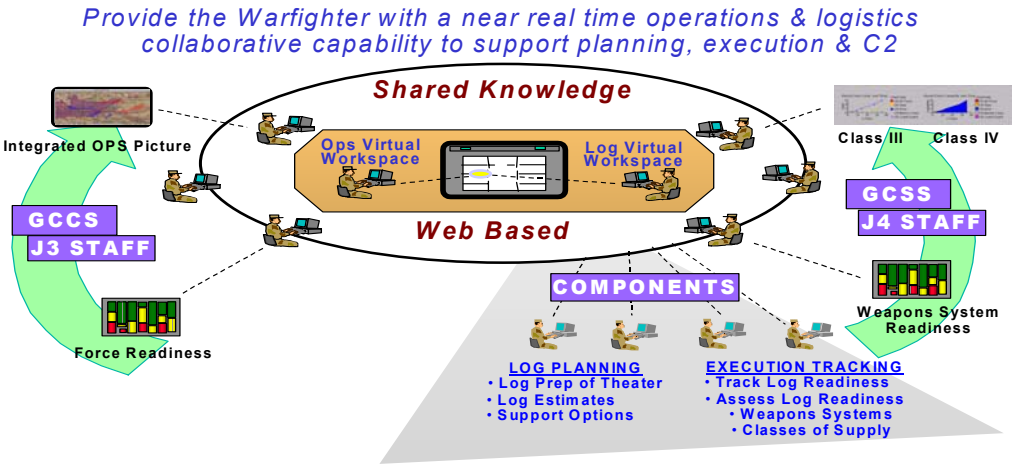

Figure 13. JTL Integrates Logistics into the Operations Planning [From: Ref 50].

b. Background

The Joint Theater Logistics system provides a web-based capability on a desktop via a simulation-client so people can work to deconflict different ideas the execution and logistics challenge. A web-based system enables worldwide access. In the past, execution planners would plan the mission and hand it to the logisticians to make it happen; however, this caused many delays. The intent of JTL to enable the logisticians to be involved earlier in the planning with the intelligence and execution planners to develop quicker and more accurate plans based off the force's capability. The JTL program is written entirely in Java; therefore, the access is simple when the Java applets are loaded to enable either an Internet Explorer or Netscape.[41]

JTL is time orientated to enable users to plan and see how that plan will progress over time. Planners will now be able to visualize important elements of any

40 JTL ACTD Demonstration III CD, March 11-15, 2002.

41 JTL Website [http://oak.man.external.lmco.com/jtl/public/].

plan. JTL provides a strong integrated visualization framework with blueprints, maps or charts being used in the online collaboration process, allowing users the facility to mark, post notes, circle a map or add data over the web from separate locations.[42]

Synchronizing maps will enable users to use different maps of the same location. The units and elements represented on the map will remain geo-registered, although the resolution would be dependent not on the JTL system but by the user's system. JTL routinely uses National Imagery and Mapping Agency (NIMA) supplied maps. Flexibility has been built into the system maps, and JTL can also use other mpas. The server would be able to provide a library of maps that can be transferred via the internet through a jpeg format to decrease bandwidth.[43]

"JTL is not data centric; data is obtained from documents such as order of battle or its database information, such as, parent child relationships with higher and lower relationships. JTL can look at the users and the equipment, and modify those for sustainment." Mason explains.[44]

c. Joint Theater Logistics Criteria Information

I. System Name	**Joint Theater Logistics (JTL)**
System Description	JTL will provide the JFC with near real-time collaborative operations and logistics capabilities that will support logistics planning, execution, tracking and rapid re-planning.
Name, title, company	Dr. Lou Mason, PM, DARPA TTO, lmason@darpa.mil Work (703) 526-6619 Cell (703) 795-7838
Web-site	https://oak.man.external.lmco.com/jtl/public/
Interview date	22 May 2002
i. Previous assoc names/tech?	Borrowed technology from Joint Logistics (JL), Command Post Of Future (CPOF), Community Of Agent Based Systems (COABS), Advanced Logistics Project (ALP)
ii. Primary organizational	DARPA - fiscal, contractor, and source selector

42 Phone Conversation with Dr. Mason on 22 May 2002.

43 JTL Website [http://www.darpa.mil/tto/programs/jtLog.html].

44 Phone Conversation with Dr. Mason on 22 May 2002.

sponsor? (PM?)	JFCOM – Operational Manager
iii. Funding support? Whom?	DARPA – 2000 - 2003
iv. Primary requirements "driver?"	JFCOM (from CINCs, services, & agencies submitting their requirements)
v. Is it a concept, prototype, or actual system?	Working prototype (ACTD to get the product out quickly)
vi. How long has it been in development?	Since Aug 2000 through Dec 2002
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	No. No ORD, no POM. ACTD to get the product out quickly.
b. Purpose?	Increase collaboration between the Ops and Log section to produce a better and faster plan
i. Why build it? Capabilities?	
ii. Ultimate Goal? (GCCS segment, other, etc)	Yes, Should provide some modules for GCCS and the Global Combat Support System (GCSS) Segment
iii. When will it be implemented or official testing? What command (where)?	'03 – pilot services for 2 years. Foothold until GCSS in FY05
c. Primary (1) and Secondary (2) Mission of System:	
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	
iii. Combat action and operations	
iv. Logistics	Primary
v. Operational planning, COA	Secondary
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	It involves all six below, but with an emphasis on planning and C2
i. Situational Awareness	
ii. Decision "assistance"	
ii. Collaboration	
iv. Planning	Primary
v. Command and Control	Secondary
vi. Other - elaborate	
e. System strengths?	Web based collaboration of content, blueprints, and markings (live objects dragged)
f. To improve areas?	Performance – improve speed (of web-based

	collaboration)
g. Time sensitive targeting? How?	No
II. User	JFC
a. Who is intended user? (JTF CDR, planner, support agencies,)	JFC
b. Orientation? Joint? Service specific?	Joint (mostly USA, USMC)
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	
i. Deployable –move from-to: air-ship-shore?	As long as connected, has auto configure and updates
ii. Size - Approximate number cubic feet?	Computer; thin-client Web based
ii. Set-up time-Approximate number of man-hours?	Minutes
b. Technology Issues Addressed:	
i. COE & Joint Technical Architecture compliant?	COE 4.7
ii. Programming Language?	JAVA
iii. Unproven technologies (i.e. XML), if so what	XML, COAB's agent technology and it's security issues
c. Presentation of information	
i. Configuration customizable to:	
1. Mission?	Yes
2. Personal profile?	Yes
3. Bandwidth considerations?	Limited
4. Multiple appliances? (PDA, pager, comp.)	Not yet
5. Immediate alert notification capability?	Yes, has "sentinels" to alert and tracker tools to provide notice.
ii. Situation awareness?	
1. Intuitive?	Yes, some 4 hrs training to understand
2. Adjustable for red-green color blindness?	No

3. View adjustable?	Yes
4. Various overlays?	Yes
5. Drill down (to determine more info)	Yes
6. Integrate multiple sources of information	Yes
7. Terrestrial coverage surface representation	
a. Sea?	Yes
b. Land?	Yes
c. Aerospace?	No
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	Yes
8. Symbology representations for:	Uses Mil-Std-2525B standards
a. Planes?	Yes
b. Ships?	Yes
c. Vehicles?	Yes
d. Troops?	Yes
e. Missiles?	Yes
f. Friendly and Enemy Intel Info?	Yes
i. Size, act, loc, unit, time, equipment	Yes
ii. Update / project tracks	No
d. Capabilities:	
i. Wireless? Wireless technologies used?	No
ii. Tools	
1. Learning tools (faqs, on-line training)	Yes
2. Office suite products (MS or StarOffice?)	No
3. Search capability	Limited
4. Collaboration tools	
a. Text sharing	Yes
b. Graphics	Yes
c. Voice	Yes

d. Video	Yes
e. Modeling and simulation	No
e. Data	
i. Maintaining Integrity (security and/or updates)	On data server
ii. Infrastructure security? How?	SIPRNET, MLS

Table 11. JTL Criteria Table.

9. Adaptive Battlespace Awareness

a. Purpose

The objective of the Adaptive Battlespace Awareness (ABA) Advanced Concept Technology Demonstration (ACTD) is to demonstrate how providing the decision maker with the common operational picture can improve performance for Time Critical Targeting (TCT) and the Combat Search and Rescue (CSAR) missions. Improved capabilities provided by the COP will include links between track information displayed in COP systems (e.g. Global Command and Control System (GCCS), GCCS-Army, GCCS-Maritime and Theater Battle Management Core Systems) and COP-related information and services. For example, filters and links will facilitate information aggregation to aid command level situational awareness, decision-making, operation execution and planning.[45] Capabilities to be improved via the ABA system include: (1) the ability to maintain a high-level COP, (2) the ability to provide component level TCT capabilities, and (3) the ability to provide JTF and component level CSAR capabilities.[46]

The ABA ACTD system will demonstrate interfaces between intelligence and operational systems to help the decision makers establish and maintain a common tactical picture (CTP). Interfaces will be developed to facilitate the display and management of critical operational data, including Order of Battle information for blue and red ground forces and ELINT Orders of Battle, and the aggregation/deaggregation of

45 ABA ACTD Management Plan, 19 July 2001.

46 Ibid.

blue force tracks. Additionally, software modules will be developed to provide the capability to tag information in the COP, and to distribute and manage this information. Another module will be developed to apply mission-specific rules and "to get" filters.

Specific capabilities to be developed for the ABA in order of priority include:

1. Interfaces among intelligence/operational systems to establish and maintain the CTP
2. Track management tools to improve the fidelity of the CTP
3. Objects supporting TCT, CSAR and aggregation/deaggregation processes
4. User tailorable templates and filters supporting TCT and CSAR tasks
5. Links to databases and automated push/pull of information relevant to the situation
6. Intuitive visual displays of information to facilitate user comprehension and readily transferable to other, select non-GCCS decision making media[47]

b. Background

The ABA ACTD has a three-year period for development, demonstration and assessment of program technologies, followed by two years of system certification, enhancement and transition. The development and assessment period supports spiral development and integration of customized templates and data filters for the COP which will be used to automate the process of identifying, tagging, tracking, and retrieving "relevant and related" supporting mission area information (e.g., unit and target geospatial information, intelligence reports, forecasted activities, etc.) A pilot service capability will be incrementally established during the development and assessment phase and maintained through the transition phase to provide selected sites with early access to those capabilities determined militarily useful.

47 Ibid.

c. Adaptive Battlespace Awareness Criteria Information

I. System Name	**Adaptive Battlespace Awareness (ABA)**
System Description	The ABA ACTD will demonstrate improvements in the COP support of Time Critical Targeting and the Combat Search and Rescue mission. It will link COP systems to related information that can be filtered for users to access and display situation data for SA, decisions and execution.
Name, title, company	MAJ Pete Beim (beimp@eucom.mil) or Corinne Brown (browncm@eucom.mil) DSN 314-430-4383 or Comm 011-49-711-680-4383, HQ USEUCOM J6-S
Web-site:	None presently
Interview date:	13 June 2002
i. Previous assc'd names/tech?	Early look at GCCS/DII COE 4.X
ii. Primary organizational sponsor? (i.e. PM?)	Tech Mgr – DISA AITS/JPO Operational Mgr – HQ USEUCOM J6/J3
iii. Funding support? Whom?	EUCOM
iv. Primary requirements "driver?"	EUCOM ABA Functional Rqmts Document
v. Is it a concept, prototype, ACTD or actual system?	ACTD
vi. How long has it been in development?	Jan 01
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	No ORD. Software with utility will transition to DII COE in FY04-05
b. Purpose?	Enhanced Situational Awareness
i. Why build it? Capabilities?	Early look at COE 4.X environment. Opportunity to effect changes.
ii. Ultimate Goal? (GCCS segment, other, etc)	Platform independent enhanced 4.X COP.
iii. When will it be implemented or official testing? What command (where)?	Spiral demos/evaluations in 2002 or 2003. MUA Jan 04. All in EUCOM theater.
c. Primary (1) and Secondary (2) Mission of System:	
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	Secondary
iii. Combat action and operations	Primary

iv. Logistics	
v. Operational planning, COA	
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	
i. Situational Awareness	Primary
ii. Decision "assistance"	Secondary
ii. Collaboration	
iv. Planning	
v. Command and Control	
vi. Other - elaborate	
e. System strengths?	User friendly (Windows environment)
f. Areas focusing on to improve the system?	Improving links, presentation, and database interfacing to the COP.
g. Time sensitive targeting? How?	Used as a scenario topic to demo COP enhancements
II. User	
a. Who is intended user? (JTF CDR, planner, support agencies,)	JTF/CINC staff
b. Orientation? Joint? Service specific?	GCCS and all service variants
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	
i. Deployable –move from-to: air-ship-shore?	As long as there is LAN access (ABA is currently running on SIPRNET but is network independent)
ii. Size - Approximate number cubic feet?	Minimum single PC w/LAN connectivity
ii. Set-up time- Approximate number of man-hours?	2-3 days
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	Yes
ii. Programming Language?	Primarily JAVA and XML
iii. Unproven technologies (i.e. XML), if so what	
c. Presentation of information	
i. Configuration customizable to:	

1. Mission?	Eventually
2. Personal profile?	Yes
3. Bandwidth considerations?	Intended
4. Multiple appliances? (PDA, pager, comp.)	No
5. Immediate alert notification capability?	Yes
ii. Situation awareness?	
1. Intuitive?	Intended
2. Adjustable for Red-green colorblindness?	No
3. View adjustable?	Yes
4. Various overlays?	Yes
5. Drill down (to determine more info)	Yes
6. Integrate multiple sources of information	Yes
7. Terrestrial coverage surface representation	Yes, depending on map displayed
a. Sea?	Surface
b. Land?	Yes
c. Aerospace?	No
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	
8. Symbology representations for:	
a. Mil-Std-2525B?	Yes
b. Friendly and Enemy Intel Info?	Yes
i. Size, act, loc, unit, time, equipment	Via adjunct data
ii. Update / project tracks	Yes
d. Capabilities:	
i. Wireless? Wireless technologies used?	No
ii. Tools	
1. Learning tools (faqs, on-line training)	No
2. Office suite products (MS or StarOffice?)	Not included but will support cut and paste with MS Office products

3. Search capability	Yes, ability to query various databases
4. Collaboration tools	No
a. Text sharing	
b. Graphics	
c. Voice	
d. Video	
e. Modeling and simulation	
e. Data	
i. Maintaining Integrity (security and/or updates)	Yes
ii. Infrastructure security? How?	N/A – security depends on existing networks

Table 12. ABA Criteria Table.

10. Joint Battlespace Infosphere

a. Purpose

The Joint Battlespace Infosphere is envisioned to be a 'system of systems' that will assist in managing combat information. The essence of the JBI is a globally interoperable "information space" that aggregates, integrates, fuses, and intelligently disseminates relevant battlespace information to support effective decision-making at all levels of command. The JBI will be part of a global combat information management system, established to provide individual users with information tailored to their specific functional responsibilities.[48]

The Joint Battlespace Infosphere is primarily about the managing information and how that will occur. The JBI distributes information from where it is to where it needs to be (according to the commander's policy and priorities) based on compatible descriptions of information needs and availabilities, instead of N^2 connections prepared in advance. The capabilities to deliver new *ad hoc* user-directed queries answered in minutes and hours. Significantly reduced automated information flows,

[48] JBI FAQ (Draft Version 4, dated 5 December 2000) Submitted by Robert Case of Mitre Corporation on Feb 24, 2002.

implemented in hours and days, are a primary goal. The intended outcome is to improve communications, interactions, and processes.[49]

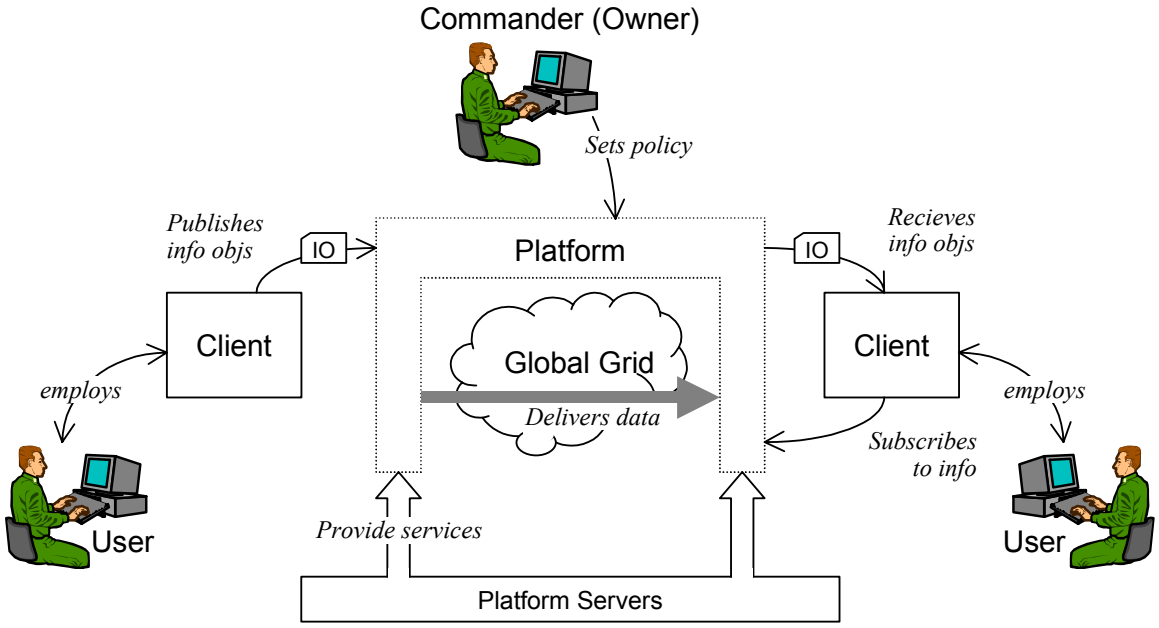

Figure 14. Very Simplified JBI architecture [From Ref 55]

b. Background

The JBI is a "vision," not a system or funded program. It will be a web of information supplied by interoperable combat information systems. The JBI platform is a set of software tools and supporting hardware acting as the globally interoperable combat information infrastructure that rides on the Global Grid. The JBI has the ability to access data from multiple sources, transform or fuse the data into information supportive of a decision, and to deliver that information to the subscriber in a format that allows it to be parsed and viewed according to the user's preferences, or simply republished as a new source of data.[50]

[49] Dr. Scott Renner of Mitre Corporation "Explaining the Joint Battlespace Infosphere" PowerPoint Presentation, 27 March 2002.

[50] JBI FAQ.

Several key technical concepts behind the JBI idea are: information will be exchanged through "publish and subscribe" methods for the user, data will be merged and transformed in useful information, "information objects" can be shared and collaborated with others, and "force templates" will be able to describe a unit's information requirements.[51]

Eliminating the obstacles of semantics and related representations of information is a primary reason for continued development. Once the services speak the same language or have systems to "interpret" those differences, interoperability will make a huge advancement. Requests for objects are delayed or deleted because of the misunderstandings and semantic differences for similar words. Effort is underway to attempt to overcome the misunderstandings and semantic differences.

Engineers are developing an open-standard Application Programming Interface (API) that should make it relatively simple for any application to interface with and use the services of the JBI. JBI will be open (standards-based) and extensible infrastructure upon which legacy and evolving information systems will operate. It is envisioned to foster interoperability of disparate information systems.

c. Joint Battlespace Infosphere Criteria Information

I. System Name	**Joint Battlespace Infosphere**
System Description	The Joint Battlespace Infosphere is envisioned to be a 'system of systems' to assist in managing combat information. The essence of the JBI is a globally interoperable "information space" that aggregates, integrates, fuses, and intelligently disseminates relevant battlespace information to support effective decision-making. The JBI is part of a global combat information management system, established to provide individual users with information tailored to their specific functional responsibilities.
Name, title, company	Jerry Dussault, Electronics Engineer Air Force Research Laboratory Rome, NY 13441 (315) 330-2067

[51] Ibid.

	Jerry.Dussault@RL.AF.MIL
Web-site	http://www.rl.af.mil/programs/jbi
Interview date	14 June 2002
i. Previous assc'd names/tech?	N/A
ii. Primary organizational sponsor? (i.e. PM?)	Air Force Research Laboratory Information Directorate (IF), Rome NY
iv. Primary requirements "driver?"	Based on 1998 and 1999 USAF Scientific Advisory Board (SAB) Studies. Concepts support JV2020 and Global Information Grid.
v. Is it a concept, prototype, ACTD or actual system?	Both a concept and limited scope prototypes.
vi. How long has it been in development?	Approximately 2 years.
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	Still in exploratory development. There is no ORD for JBI.
b. Purpose?	To develop more effective information management to deliver the right information at the right time, and by providing a more agile information-centric enterprise.
i. Why build it? Capabilities?	Allows warfighters and C2I application developers to more effectively exchange information. Provides capabilities to publish-subscribe for specific information content, global query capability, "fuselets" to better filter and aggregate information from multiple sources to enable the rapid cyber-merge of different units into a dynamic enterprise.
ii. Ultimate Goal? (GCCS segment, other, etc)	Guiding information management services for the GIG, where GCCS should be heading.
iii. When will it be implemented or official testing? What command (where)?	Goal: is to be able to support an ATD by FY05, (Technology Readiness Level 6), presently involved with discussions with many different potential early adopters of this technology.
iv. Interoperable w/ systems?	Developing an open-standard Application Programming Interface (API), that should make it relatively simple for any application to interface with and use the services of the JBI. JBI will be open (standards-based) and extensible infrastructure upon which legacy and evolving information systems will operate. It is envisioned to foster interoperability of disparate information systems.
c. Primary (1) and Secondary (2) Mission of System:	All Command and Control, and Intelligence systems are good candidates.
i. Admin & Personnel	

ii. Intelligence (enemy, friendly, neutrals)	Primary
iii. Combat action and operations	
iv. Logistics	
v. Operational planning, COA	Secondary
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	JBI is envisioned to support all the functional areas identified below in time.
i. Situational Awareness	Primary
ii. Decision "assistance"	
ii. Collaboration	
iv. Planning	
v. Command and Control	
vi. Other - elaborate	
e. System strengths?	JBI hopes to lower costs and barriers to entry (e.g., adding new C2 capabilities), flexibility, ability to customize the Information Space for each operation and each user.
f. Areas focusing on to improve the system?	Information Assurance, Scalability and Managed Quality of Service.
g. Time sensitive targeting? How?	Yes. Developing a means to better information management: how JBI can assist in more rapidly generating a TCT evidence file in support of a shoot (or no shoot) decision.
II. User	Combatant Commander to individual warfighter.
a. Who is intended user? (JTF CDR, planner, support agencies,)	All echelons; planners, execution monitoring and support functions.
b. Orientation? Joint? Service specific?	Joint Service.
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	JBI is software. Very thin clients (software), and probably a federation of servers to provide information dissemination and storage.
i. Deployable –move from-to: air-ship-shore?	Yes – Software and servers
ii. Size - Approximate number cubic feet?	N/A. Size of the federation of servers will depend upon many application-specific factors.
ii. Set-up time- Approximate number of man-hours?	TBD.
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	Targeting the next generation of COE, and to influence the direction of the JTA.

ii. Programming Language?	TBD. Open – Standard Interface is to be "Language Neutral". API will have bindings for most commonly used programming languages.
iii. Unproven technologies (i.e. XML), if so what	Unproven technologies include: Content-based Publish-Subscribe, XML and related technologies, "Fuselets," and Force Templates.
c. Presentation of information	A key objective of the JBI is to enable users to more precisely specify what information they need and to deliver only what the users need.
i. Configuration customizable to:	
1. Mission?	Envisioned to be capable of providing
2. Personal profile?	Envisioned to be capable of providing
3. Bandwidth considerations?	Envisioned to be capable of providing
4. Multiple appliances? (PDA, pager, comp.)	Envisioned to be capable of providing
5. Immediate alert notification capability?	Envisioned to be capable of providing
ii. Situation awareness?	The information management services of the JBI are intended to assist in improving situation awareness by delivering only the information needed by the users: "Decision-Quality Information." JBI is not responsible for visualizing the information - that is the responsibility of application clients of the JBI.
1. Intuitive?	TBD.
2. Adjustable for Red-green colorblindness?	Envisioned to be capable of providing
3. View adjustable?	N/A
4. Various overlays?	N/A
5. Drill down (to determine more info)	Envisioned to be capable, but JBI is not responsible for visualization, see note above.
6. Integrate multiple sources of information	Envisioned to be capable
7. Terrestrial coverage surface representation	N/A
a. Sea?	
b. Land?	
c. Aerospace?	
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	
8. Symbology representations for:	N/A

a. Mil-Std-2525B?	
b. Friendly and Enemy Intel Info?	
i. Size, act, loc, unit, time, equipment	
ii. Update / project tracks	
d. Capabilities:	
i. Wireless? Wireless technologies used?	It could be. JBI is somewhat independent of the underlying physical network topology.
ii. Tools	
1. Learning tools (faqs, on-line training)	Not yet.
2. Office suite products (MS or StarOffice?)	N/A
3. Search capability	Yes
4. Collaboration tools	Collaboration tools are a part of the JBI Vision; however, integration into prototype information management services is being developed.
a. Text sharing	
b. Graphics	
c. Voice	
d. Video	
e. Modeling and simulation	
e. Data	
i. Maintaining Integrity (security and/or updates)	Yes, information integrity is an important characteristic of the JBI.
ii. Infrastructure security? How?	Yes the JBI infrastructure will be secure. Being evaluated to determine WRT DoD requirements.

Table 13. JBI Criteria Table.

IV. SUMMARY AND CONCLUSIONS

A. SUMMARY

The ten developing CROP systems were analyzed to determine their fundamental differences and capabilities, and to provide recommendations for programs and capabilities that offer the greatest follow-on potential for continued development. The research revealed that not all the systems reviewed are CROP systems, i.e., they do not have the goal of providing better situational awareness to the decision-maker. Some systems are still in the conceptual design phase and others are guidance documents. This thesis describes the fundamental differences, goals, purposes, and developing objectives for the ten systems. In addition, system point of contact information is provided. However, absolute results concerning recommendations for follow-on programs and capabilities were inconclusive due to three primary reasons: (1) the systems have significantly different objectives; (2) the systems are very disparate in their levels of development, and thus were difficult to compare; and (3) the systems are software intensive, and actual system effectiveness cannot be measured when the software is not fully matured.

1. Different Objectives

The CROP systems' objectives varied immensely from two that consisted of formal documents identifying the need for standard architectures and protocols to one that consisted of evaluating an operational system used throughout DoD headquarters. For example, the GIG and IDM are Joint Requirements Oversight Council approved Capstone Requirements Documents directing the need for architecture and information protocols in an information grid. Those documents are supporting an Operational Requirements Document. At the other extreme, GCCS is a functioning operational system used at over 650 locations throughout the world. However, different versions of

GCCS are also slightly different from one another at most of the locations; they are similar, but not standardized. Not only do the systems have different objectives, they also have differing functions, missions, and intended users. The tables below summarize the systems and their significant differences.

2. Developmental Disparity

The differing levels of development among the systems were extreme. The disparity ranged from concepts early in development to an operational system. For example, SIAP and FIOP are still in the concept design phase. These two systems have the goal of integrating various working legacy systems and developing commonalities for interoperability. The IDM and GIG CRD are Joint Requirements Oversight Council directives for establishing a formal Operational Requirements Document for developing C2 systems. JBI is still a developing concept very early in the concept development phase. CPOF and K-Web are prototypes that have had limited official testing. For example, K-Web was successfully tested with the Carl Vinson Carrier Battle Group. JTL and ABA are four-year ACTD programs for further research. JTL is approaching the completion of its ACTD cycle, and ABA has completed one year of its cycle. Finally, GCCS is a functional DoD system employing over 10,000 workstations.

3. CROP Systems are Software Intensive

Although the systems are at various levels of development and have the goal of supporting different organizations, a challenge in this thesis was measuring their effectiveness for supporting the decision-maker's situational awareness. The developing CROP systems are software systems that are responsible for two primary events: extracting and merging data to be presented to the users and organizing it in a format that the user can understand. The actual systems are software intensive and based. Software characteristics are difficult to measure, describe and understand. Because software is "invisible" with respect to physical characteristics, it easily masks the sources of the

problem. System effectiveness is difficult to measure and verify until the system is fully developed and tested. These systems were not fully mature in their development.

4. Insights into the Developing CROP Systems

This process of analyzing the systems for greatest potential for follow-on development was inconclusive. The systems have different objectives, they are at different levels of development, and their software can mask problems until fully developed. However, the criteria in tables 15 and 16 were instrumental in extracting the significant factors capable of differentiating the systems. The criteria revealed distinguishing factors to differentiate immature systems. Although the systems could not be analyzed for greatest follow-on potential, specific insights into the ten developing CROP systems are provided.

1. **GCCS:** The Global Command and Control System is the most advanced and developed system for generation and application of national military power for high level staffs and their subordinates. GCCS has a very refined and ingenious developmental process; however, it presently tends to be command specific and does not interface with other versions. Because of the advanced level of development, many of the other programs are designing their systems, or parts of their systems, to be future GCCS segments. GCCS will be evolving through the next several years to a web-based system to become more dynamic and responsive.

2. **GIG:** The Global Information Grid is a Capstone Requirements Document providing an ideology recognizing the potential capabilities that information superiority can provide. DoD has tasked JFCOM to research concepts, architectures, systems, and protocols that will best support a networked centric force. The GIG CRD signifies the necessity of a GIG ORD to establish network and architecture standards, which have some collectively agreed upon flexibility. The GIG ORD needs to be submitted

and approved to provide significant standards, but it should be reviewed periodically to adjust for newer, more promising capabilities

3. **IDM**: The Information Dissemination Management is a Capstone Requirements Document signifying the importance of establishing information management standards. A standard should be set and approved to manage information awareness, access, delivery and support.

4. **FIOP**: The Family of Interoperable Operational Pictures uses the GCCS Requirements Identification Document to prioritize source requirements. The FIOP is a process of decomposing selected systems and determining similarities to develop system interoperability by merging multiple sensory and data feeds into a COP. The FIOP is building the underlying foundation to support several Single Integrated Pictures. Although the process is promising, determining which systems and developing system and database integration will be difficult.

5. **SIAP**: The Single Integrated Air Picture is identifying preferred system upgrades to develop a baseline of interoperable commonality. The system process of upgrading working legacy systems is smart, but the system itself will be limiting to the JFC since it focuses on the air picture. It does not address the ground and naval situational awareness.

6. **K-Web**: The Knowledge Web is a prototype system tested by a carrier battle group to increase speed of command. It has shown some promise in the naval theater for SA and collaboration, but it needs to be tested in a ground environment (which the PM is attempting).

7. **CPOF**: The Command Post of the Future is a visionary DARPA C2 prototype. It has several good potential features and will lend some capabilities as GCCS segments, and yet it appears to have some "visionary" qualities. However, it is more distant in its implementation, and integrating the data inputs into a common language and database will be difficult.

8. **JTL**: The Joint Theater Logistics ACTD has shown good initiative to integrate the "ball and chain" of operations, logistics, to accelerate tempo. Several initiatives look promising that can be incorporated into GCCS, GCSS and other developing logistics capabilities.

9. **ABA**: Adaptive Battlespace Awareness ACTD is a very young initiative being developed at EUCOM. This system was presently too immature in development to provide insight into future capabilities.

10. **JBI**: Joint Battlespace Infosphere concept is envisioned to be a "system of systems." It too is developing interoperability among present systems to best support the COP. However, linking and integrating working systems is a logical but challenging progression.

B. SUMMARY TABLES

The tables below identify major differences between the developing CROP information systems. Table 14 identifies point of contact information and web sites for the specific systems.

Tables 15 and 16 provide measurable criteria to evaluate the developing CROP systems in support of the developing GIG. These criteria provide baseline identifiers of the systems' characteristics and direction. These two tables show what they are and what they are trying to solve. Much of the other remaining criteria found in chapter three were idealistic and difficult to quantify for the systems since they were not fully developed.

CROP Sys	POC	Co./Dept	Position	Web-site	POC E-mail	POC Phone
GCCS	LTC G. Matthias	DISA	Chief Eng	http://gccs.disa.mil/gccs/	matthiag@ncr.disa.mil	703-882-1060
GIG CRD	Art Macdougall	ODU w/ JFCOM	Chief Eng	Note 1	macdouga@jwfc.jfcom.mil	757-836-5610
IDM CRD	MSgt M. Fischer	JFCOM	IDM PO	http://www.globalsecurity.org/intell/library/reports/2001/compendium/idm.htm	fischer@jfcom.mil	757-836-5996
FIOP	Dan Hobbs	L3 Com Anal Co	Op Analyst	http://www2.acc.af.mil/ac2isrc/	daniel.hobbs@langley.af.mil	757-225-2945
CPOF	Ward Page	DARPA, IXO	PM	http://dtsn.darpa.mil/ixo/cpof.asp	wpage@darpa.mil	703-696-7443
K-Web	Dr. Jeff Morrison	SPAWAR SSC	PM	http://www-tadmus.spawar.navy.mil/	jmorriso@spawar.navy.mil	619-553-9070
JTL	Dr. Lou Mason	DARPA TTO	PM	http://www.darpa.mil/tto/programs/jtLog.html	lmason@darpa.mil	703-795-7838
SIAP	CAPT J. W. Wilson	SIAP Sys Eng	Tech Dir	http://siap.navsea.navy.mil	Wilsonjw@navsea.navy.mil	703-602-6441
ABA	Maj P. Beim	HQ, USEUCOM, J6-S	PO	None	beimp@eucom.mil	011-49-711-680-4383
JBI	Jerry Dussault	AFRL	Engineer	http://www.rl.af.mil/programs/jbi	Jerry.Dussault@RL.AF.MIL	315-330-2067
Note 1: https://jdl.jwfc.jfcom.mil with Username: wg00061 Password: J1f9C9m3						

Table 14. Point of Contact Information Table.

System	System Summary	Sponsor	Funding	Requirements driver	Dev level
GCCS	Actual C2 and planning	DISA	DISA	Joint Staffs w/ Combatant Commanders	Actual system
GIG CRD	Sys architecture CRD	JFCOM	JFCOM	Combatant Commanders/ services/agencies	CRD
IDM CRD	C4 Interoperability guidance	JFCOM	DARPA	GBS, BSC2	CRD
FIOP	A process to develop system interoperability	OSD (ATL)	OSD	GCCS-RID (Req ID Doc)	Process to synthesize
CPOF	Ground C2 prototype	DARPA	DARPA	Visionary DoD leaders	Prototype
K-Web	SA and C2 System	SPAWAR	ONR	Chief, Naval Operations, Web-Enabled Navy, & fleet	Prototype system tested by a Carrier Battle Group staff
JTL	Log C2	DARPA	DARPA	JFCOM, CC, Services	Prototype/ACTD
SIAP	Sys upgrades to meet similarities for DB exchanges	JROC, USD (ATL), ASD (C3I)	JROC	JROC & 3 CRDs (CID, TAMD, GIG)	System upgrades to develop commonality for interoperability
ABA	Battlefield SA	DISA/EUCOM	DISA	EUCOM ABA Requirements Doc	ACTD
JBI	Developing similarities for interoperability	AFRL	AFRL	USAF Science Advisory Bd	Concept/limited prototype

Table 15. C2 Information Systems, Sponsor and Development Information Table.

CROP System	Dev period	Mission	Function	Intended User
GCCS	96-present	Ops/plans	C2	Combatant Commander/JFC
GIG CRD	99-present	Guidance	Planning guidance	JFC
IDM CRD	95-present	Plans/intel	Planning guidance	JFC-Platoon Cdr
FIOP	00-'07	Ops/Intel	SA	JFC
CPOF	99-present	Ops/plans	SA	Company-Battalion-Brigade levels
K-Web	99-present	Ops/Intel	C2	JFC
JTL	00-03	Logistics	C2	JFC
SIAP	01-'03	Ops	SA	Tactical operators
ABA	01-present	Ops/Intel	SA/DA	Combatant Commander/JFC
JBI	00-present	Ops/Intel	SA	JFC-small tactical user

Table 16. Information Systems and Mission/Function Information.

C. FINDINGS

The high-level findings from the research reveal three concerns. (1) Guidance standards need to be approved quickly for greater system architecture interoperability. (2) Once the protocols are established, select a lead agency to oversee and encourage system interoperability and coordination. Presently, the lack of interoperability might be attributed to the fact that there are many different organizations within the DoD that are involved in developing these systems, there is no lead agency or organization, and there is no protocol. (3) Because the glare of information might overwhelm the user, continue to develop the intuitive aspect of the human – machine interaction.

1. Set Guidance Standards

The Global Information Grid and Information Dissemination Management Capstone Requirements Documents are setting the requirements for an overarching information and network capability. These documents will establish the requirements for a globally interconnected, end-to-end, interoperable, secured system of systems that will support the National Command Authorities (NCA), warfighters, DoD personnel, intelligence community, policy makers, and non-DoD users at all levels involved in both military and nonmilitary operations. A lead agency needs to be established with foresight to establish and enforce the standards and begin guiding the developers within this new framework. These standards should be updated periodically to adjust for rapidly changing technological advances.

The Global Information Grid Operational Requirements Document (ORD) will establish baseline architecture and network standards in information and communication management principles identified in the GIG and IDM CRDs. The Information Dissemination Management CRD lays the groundwork for future management of information through the use of protocols, standards, and policies. Information processes and communications capabilities have changed dynamically over the last decade, and updated guidance and policy standards are needed to provide better interoperability and management to produce systems that will enable information superiority. A GIG ORD is

needed soon to assist in the building of an interoperable Global Information Grid; otherwise, the GIG might be the modern "Tower of Babel."

Presently, the systems are being designed to meet the Defense Information Infrastructure Common Operating Environment (DII COE) and Joint Technical Architecture (JTA) standards, but these are considered very broad in scope and without much substance. The standards need to be updated with more definitive guidance for greater adherence and yet be balanced with the capability for flexibility for future development.

2. Establish a Lead Agency to Oversee GIG Development

Many different sponsors and requirements "drivers" are involved in the developing technology. Each different system is attempting to solve the immediate problems faced in their given community. However, interoperability will be a challenge among systems. As seen from the Summary Tables above, funding comes from three Defense sources (DISA, OSD and DARPA) and two service specific agencies (ONR and AFRL). Within the Office of the Secretary of Defense (OSD), the Command, Control, Communication and Intelligence (C3I) department is involved with the GIG and the Acquisition, Technology, and Logistics OSD(ATL) department is involved with network centric warfare and information superiority. Common sense dictates that OSD(C3I) should be the sole lead for the DoD in developing C2 systems. Therefore, even at the top of the DoD, different agencies are involved in the development of new warfare systems. Standards to ensure commonality, as recommended in the GIG and IDM CRDs, need to be developed, coordinated, and implemented from a united office.

A GIG Operational Requirements Document (ORD) needs to be completed, approved, implemented, and enforced soon to ensure future interoperability. Visionary, non-biased leaders should begin to establish strong guidance and standards in this document to help meet future interoperability demands, for communication, information and network protocols. One defense agency should be the sole leader in providing funding for future development. This may help encourage greater interoperability vice

separate organizations funding separate systems. Multiple organizations involved in the development of new systems can be expedient, but can continue the unintentional development of stove-piped systems. With written guidance in place, and a community of interest involved, one program manager should oversee the interoperability development of all the emerging systems to bring about tighter coordination among the systems. The Global Command and Control System has established a process to identify requirements and advancements. A similar process and structure should be examined to encourage developing systems for interoperability and to meet the GIG and IDM standards.

3. Develop System Intuitiveness to penetrate the "Glare of Information"

Too much information "glaring in the fog" doesn't help one to understand the situation. The right information must be presented in the right format at the right time. However, information by itself is not always informative. Information must be presented in the right format, context, at the right time for it to be of value. Research has shown that each person can only handle so much information before they get overwhelmed. People respond to information saturation differently, but a common result is that the user's mental processing capacity decreases when they are overloaded, as witnessed lately. [Ref 23]

> Our present networks easily overwhelm users with information. Lessons from Afghanistan indicate that every echelon of command was overwhelmed with data. Processing data into something meaningful and relevant is the challenge, and future battlefield successes may hinge on our ability to effectively manage information. The development of information management tools will greatly assist commanders and their staffs in identifying, prioritizing, filtering, fusing, and displaying information in a manner that will facilitate decision-making. At the center of the information management challenge is the requirement to develop a picture of the battlespace that is scalable and relevant to leaders at all levels…the CROP. [Ref 24]

It is paramount that new systems present the information to the user in a "human-friendly" manner to prevent information overload. In addition, the systems must be capable of facilitating the user in being able to make appropriate responses. With the

amount of information increasing almost exponentially and the stress of the battlespace, commanders will need to understand the important information and the most effective means of presenting it. Research must continue to be pursued in developing of intuitive human – machine interfaces. [Ref 23]

D. SUMMARY OF THE HIGH-LEVEL FINDINGS

Interoperability needs to be addressed by a single agency utilizing the GIG and IDM standards and protocols that are currently under development. Research and development must be continued in preventing information overload to the users.

1. General Summary Findings Based on the Criteria

Criteria	General Summary Findings Based on the Criteria Questions
I.a. System Name	Name of system, program, or concept
System Description	Brief description
POC representative information	Information on how to reach the representative
Web-site	Location of website to obtain more information
Interview date	Date phone interview occurred with representative
i. Previous associated names/tech?	Many of the companies involved with building the systems have used S/W modules from previous systems to increase the capabilities.
ii. Primary organizational sponsor? (i.e. PM?)	The sponsor's organization has strong influence over the requirements of the systems.
iii. Funding support? Whom? $?	There is a relationship between $ and the user.
iv. Primary requirements "driver?"	The system requirements are commonly related to the organizational sponsor or DoD objectives.
v. Is it a concept, prototype, ACTD or actual system?	General description of the level of development.
vi. How long has it been in development?	Describes the amount of time under development, and many systems are under five years.
vii. Acquisition cycle? Where? ORD? Milestone 0 (A)?	Most systems were not in the official "acquisition cycle" because it has been determined that the better means for the DoD and contractors is the present method. It allows for more flexibility.
b. Purpose?	What is the purpose for building it
i. Why build it? Capabilities?	What significant capabilities does it have
ii. Ultimate Goal? (GCCS segment, other, etc)	Many of the ten systems did hope to be a GCCS segment (part of the block) in the future.
iii. When will it be implemented	Most systems were not mature enough in

or official testing? What command (where)?	development to be officially tested. Some have opportunities to show early capabilities.
iv. Interoperable w/ systems?	This was a difficult question to get an answer on because the S/W does not completely reveal interoperability until it is completed – and that is very difficult to see until you have used the system awhile (systems were not mature enough).
c. Primary (1) and Secondary (2) Mission of System:	What is the primary mission of the system from the seven choices below? Each system was slightly different. Many systems were focused on building a combat action and operational capability with the capability to plan.
i. Admin & Personnel	
ii. Intelligence (enemy, friendly, neutrals)	
iii. Combat action and operations	
iv. Logistics	
v. Operational planning, COA	
vi. Communications Network Management	
vii. Other - elaborate	
d. Functionality: primary (1) and secondary (2)	What is the systems primary function from the six choices below? Each system was different, but a trend was noticed that the intent was to build SA capabilities, then collaboration and decision assistance capabilities, and ultimately a C2 capability.
i. Situational Awareness	
ii. Decision "assistance"	
ii. Collaboration	
iv. Planning	
v. Command and Control	
vi. Other - elaborate	
e. System strengths?	These two questions attempted to determine what their priorities are to improve their system.
f. Areas focusing on to improve the system?	
g. Time sensitive targeting? How?	This has caught the attention of DoD, but it is too early in development.
II. User	The answers ranged from a small tactical unit (squad size) to the Combatant Commanders (CINC)
a. Who is intended user? (JTF CDR, planner, support agencies,)	
b. Orientation? Joint? Service specific?	Was the system attempting to fix a particular service problem with C2 information systems or solving a truly joint situation? Most of the systems expressed a joint orientation.
III. System Technology	
a. Physical characteristics (for expeditionary and flexibility purposes)	For many of the systems they were just software, and not large physical structures. The intent of these questions was to determine the size
i. Deployable –move from-to: air-ship-shore?	Because most were software, they were deployable. Connectivity will be more challenging.

ii. Size - Approximate number cubic feet?	Some were running on servers and some were just software that could run almost anywhere.
ii. Set-up time- Approximate number of man-hours?	Set-up time was expressed to vary from several hours to days.
b. Technology Issues Addressed:	
i. DII COE & Joint Technical Architecture compliant?	The systems intended to met the standards
ii. Programming Language?	Great variances
iii. Unproven technologies (i.e. XML), if so what	Most systems did not identify items in this risky area.
c. Presentation of information	
i. Configuration customizable to:	Many were addressing these issues.
1. Mission?	Generally, the systems were too immature.
2. Personal profile?	Generally, the systems were too immature.
3. Bandwidth considerations?	Generally, the systems were too immature.
4. Multiple appliances? (PDA, pager, comp.)	Generally, the systems were too immature.
5. Immediate alert notification capability?	Generally, the systems were too immature.
ii. Situation awareness?	All the systems knew the importance of trying to make this logical to the operators
1. Intuitive?	Most systems not mature enough to measure.
2. Adjustable for red-green color blindness?	All systems were no. This should be considered since approximately 15% of males are.
3. View adjustable?	Some systems were attempting to provide this capability to help with visualizing the situation.
4. Various overlays?	Most of the systems were attempting to provide this capability.
5. Drill down (to determine more info)	Most of the systems were attempting to provide this capability.
6. Integrate multiple sources of information	Most of the systems were attempting to provide this capability.
7. Terrestrial coverage surface representation	Most systems said that the symbology could cross surfaces displayed, and for some, it was up to the input of the operators.
a. Sea?	
b. Land?	
c. Aerospace?	
d. X-terrestrial? (Can the symbol move across different terrestrial surfaces?)	
8. Symbology representations for:	Most systems used the standards as set forth in Mil-Std-2525B for universality and commonality. Some system representatives said they could "drill down" to obtain more facts, but it could not be measured. The
a. Mil-Std-2525B?	
b. Friendly and Enemy Intel Info?	

i. Size, act, loc, unit, time, equipment	systems are too immature at this time.
ii. Update / project tracks	
d. Capabilities:	
i. Wireless? Wireless technologies used?	Some systems were looking into this capability.
ii. Tools	Tools varied from system to system, but since most were software products and not physical and network devices, the systems did not focus on this capability since another product could.
1. Learning tools (faqs, on-line training)	Most were working to provide some assistance
2. Office suite products (MS or StarOffice?)	Generally not provided since this capability will already be provided on the system.
3. Search capability	Most were going to use internet browsers to find search engines.
4. Collaboration tools	The capabilities varied greatly in this area, but all the systems recognized that collaboration was important to future warfighting systems.
a. Text sharing	
b. Graphics	
c. Voice	
d. Video	
e. Modeling and simulation	
e. Data	
i. Maintaining Integrity (security and/or updates)	Most were initially going to use MLS (multi-level security), but it appeared that the priorities were more on interoperability and communication initially, and security would be better addressed later.
ii. Infrastructure security? How?	Most systems did not recognize the need because they recognized that the network and infrastructure was not best handled through software, and these are software systems.

Table 17. General Summary Findings Based on Criteria.

APPENDIX – GLOSSARY

AC2ISRC	Aerospace Command and Control, Intelligence, Surveillance and Reconnaissance Center
ABA	Adaptive Battlespace Awareness
ACTD	Advanced Concept Technology Demonstration
AFB	Air Force Base
AFOTEC	Air Force Operational Test and Evaluation Center
AFRL	Air Force Research Labs
AITS-JPO	Advanced Information Technology Services/Joint Program Office
ALP	Advanced Logistics Project
AODB	Air Operations Database
AOC	Air Operations Center
AOR	Area of Responsibility
ATD	Advanced Technology Demonstration
BADD	Battlespace Awareness and Data Dissemination
BDA	Battle Damage Assessment
C++	Computer Language
C2	Command and Control
C2ISR	Command and Control Intelligence Surveillance and Reconnaissance
C4I	Command, Control, Communications, Computers and Intelligence
CAOC-X	Combined Air Operations Center-eXperimental
CC	Component Commander (CINC)
CID	Combat IDentification
CIE	Collaborative Information Environment
CINC	Commander in Chief
CoABS	Community of Agent Based Systems
COI	Critical Operational Issue
CONOP	Concept of Operations
CONUS	Continental United States
COP	Common Operational Picture
CPOF	Command Post of the Future

CRD	Capstone Requirements Document
CROP	Common Relevant Operational Picture
CSAR	Combat Search and Rescue
CST	COP Synchronization Tools
CTP	Common Tactical Picture
DARPA	Defense Advanced Research Project Agency
DB	Database
DCGS	Distributed Common Ground System
DDB	Dynamic Database
DII COE	Defense Information Infrastructure Common Operational Environment
DISA	Defense Information Systems Agency
DoD	Department of Defense
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership, Personnel and Facilities
DUSD AS&C	Deputy Under Secretary of Defense for Advanced Systems and Concepts
EBO	Effects Based Operations
ESC/DI	Electronic Systems Center Commander Defense Infrastructure Directorate
EIPB	Enhanced Intelligence Preparation of the Battlespace
ETCC	European Theater Command Center
FIOP	Family of Interoperable Operational Pictures
FRD	Functional Requirements Document
GBS	Global Broadcast System
GCCS	Global Command and Control System
GCCS-A	Global Command and Control System-Army
GCCS-AF	Global Command and Control System-Air Force
GCCS-M	GCCS-Maritime
GCCS-I3	GCCS-Integrated Imagery and Intelligence
GCSS	Global Combat Support System
GIG	Global Information Grid
HHQ	Higher Headquarters
IATO	Interim Authority to Operate

IAS	Intelligence Analysis System
IBS	Intelligence Broadcast System
IC	Intelligence Community
ICSF	Integrated C4I Software Framework
IDM	Information Dissemination Management
IPT	Integrated Product Teams
IT	Information Technology
JBI	Joint Battlespace Infosphere
JEFX	Joint Expeditionary Forces Experiment
JFC	Joint Force Commander
JFCOM	United States Joint Forces Command, Norfolk, VA
JP	Joint Publication
JROC	Joint Requirements Oversight Council
JTF	Joint Task Force
JTL	Joint Theater Logistics
JV 2020	Joint Vision 2020
JTT	Joint Targeting Toolbox
K-Wall	Knowledge Wall
K-Web	Knowledge Web
MOE	Measure of Effectiveness
MOP	Measure of Performance
MOOTW	Military Operations Other Than War
MNS	Mission Need Statements
MUA	Military Utility Assessment
NCW	Network Centric Warfare
NERF	Naval Emitter Reference File
NOTIF	Notification Services
OM	Operational Manager
ONR	Office of Naval Research
OODA	Observe, Orient, Decide, Act
ORD	Operational Requirements Documents
OSD	Office of the Secretary of Defense
OSIC	Operationally Significant Intelligence Change

PM	Program Manager
POM	Program Objective Memorandum
RDO	Rapid Decisive Operations
RID	Requirements Identification Document
RMA	Revolution in Military Affairs
ROE	Rules of Engagement
SA	Situational Awareness
SIAP	Single Integrated Air Picture
SPAWAR	Space and Naval Warfare Systems Command
SPAWARSYSCEN	SPAWAR Systems Center
TBMCS	Theater Battle Management Core System
TDL	Tactical Data Links
TMS	Track Management Services
TST	Time Sensitive Targeting
TM	Technical Manager
UAV	Unmanned Arial Vehicle
USA	United States Army
USAF	US Air Force
USCINCEUR	US Commander in Chief, Europe
USEUCOM	US European Command
USAFE	US Air Forces Europe
USMC	United States Marine Corps
USN	US Navy
XDBI	eXtensible DataBase Interface
XIS	Extensible Information Systems
XM	Transition Manager
XML	eXtensible Markup Language

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