Underpinning the RMA – Advancements in the Transformation of Information into Knowledge for Command and Control

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Abstract

The exercise of Command and Control will be transformed in the future by advances in the ability of the commander to gain and act upon near-perfect situational knowledge which has been distilled from diverse information sources.

The art of modern command and control has evolved over centuries of practice, modified as demanded by political and technological changes. With the near asymptotic pace of innovation in the past three decades and the geopolitical instability and realignment brought on by the decline of the former Soviet Union, evolutionary change in command and control is being replaced by major revolutionary advances. This paper outlines some of the elements of this transformation and discusses Department of Defense (DoD) and other organizations' efforts to examine, quantify and implement these advances. This process is not being conducted in a fully comprehensive manner, especially within DoD; the Joint Experimentation Process mandated by Title XII of the Defense Authorization Act of 1999 has made only superficial progress in this regard. It is the intent of this paper to discuss several of the most promising initiatives to the end that they can be assimilated by DoD into the comprehensive process realignment that is the Revolution in Military Affairs (RMA).

The main underlying theme of the RMA is that the Commander can attain near-perfect situational awareness, and will therefor be able to select precise and accurate courses of action to guarantee desired outcomes in any military situation. Near-perfect situational awareness has five distinguishing elements and is facilitated by four key enablers. Although the overall impact of current initiatives on the RMA are unclear, some major elements are becoming increasingly evident as a result of ongoing experimentation, demonstrations, and as fielding is implemented.

Introduction

The introduction of technology in the late 20^{th} century has begun a transformation of the way the United States conducts its military operations in support of national policy objectives. Although the Clausewitzian concept of the "fog of war" is still with us today, and likely to remain a fundamental part of military operations in the future, that fog is increasingly being blown clear the application of technology. Today's joint forces operate in the Global Information Environment. This framework is comprised of a worldwide collection of information sources, data bases, customers, and architectures. The range of participants is vast, including governments, the media, academic institutions, Non-Governmental Organizations, international business organizations, and an array of groups affiliated by religious, regional or ideological allegiances. While all have their own motives they each affect the environment that military commanders find themselves operating in.[i] The application of technology provides the means for our military commanders to manage the information environment and allows him to shape his battlespace more effectively than his opponent. This need to manage the ever changing information environment the commander is encountering today is driving the current Revolution in Military Affairs (RMA). Although a RMA may be the result of something other than the application of technology, history shows us that in most cases technology is the enabler. The result of the application of technology to information management issues is a reduction of uncertainty with respect to the status of our own forces and gives us significantly improved insight into both the status of enemy forces and ultimately the intent of enemy commanders.

This paper postulates that through the proper application of knowledge management the Commander can attain near-perfect situational awareness, and will be therefore able to select precise and accurate courses of action to achieve the desired outcomes in any military situation.

Elements of the Transformation

The achievement of near perfect situational awareness will be accomplished by transforming the current military command and control process from one centered around the Napoleonic staff model to a new paradigm which is enabled by information instantly available to the commander and his staff. In this new paradigm the commander and his staff will benefit from the rapid transition of data - to information - to knowledge - to understanding. This rapid movement up the cognitive hierarchy will facilitate the commander's ability to take decisive action. The five distinguishing elements of the transformation are discussed below.

Improvements in Traditional Information Gathering and Processing. Traditional Department of Defense (DoD) information gathering and processing has long been the province of the intelligence community. This segment of the government, especially within the DoD, has made major strides in the methods of acquisition, processing, analysis and dissemination of intelligence. Real and near-real time global collection ability, continuous exponential growth of processing capabilities, collaboration techniques that allow analysts a near instantaneous access to their counterparts anywhere in the world, and communications systems that provide for delivery of large quantities of processed intelligence to a customer almost immediately regardless of location on the face of the earth is now the standard expected by national and military decision makers. Today's military commander's ability to make quick and accurate decisions based of highly reliable intelligence has never been better. There is every expectation that the traditional intelligence community will continue to improve its abilities.

Incorporation of new and non-traditional information sources. Despite improvements in traditional information gathering and processing, the demise of the former Soviet Union has considerably widened the needs for information, with threats expanding from the traditional Cold War focus to a broader and varied base including non-state actors on the world stage. At the same time, the intelligence community has experienced reductions in staff and funding along with those taken throughout government, most significantly DoD. Therefore the Department of Defense finds itself with expanded information requirements in an era of declining resources to apply to the task. The result of this process is that the traditional intelligence community has narrowed its focus to concentrate on areas of denied information, leaving open source and lower priority requirements without serious scrutiny, except after the fact when major events have already transpired. This is especially problematic during a period when a high percentage of military employment is concentrated in the area of Operations Other Than War (OOTW), especially humanitarian assistance and disaster relief. These operations are usually conducted in countries that are not well covered by traditional intelligence due to the need to prioritize assets against the most dangerous rather than the most probable contingencies. In a high percentage of cases, vital information to support these operations is available through open sources. Unfortunately, the universe of available information is vast and expanding daily. Obtaining any particular element of information is often time-consuming and difficult if appropriate processes for information gathering, analysis, collaboration, and dissemination are not in place. Further, much information that is open-source (i.e. not classified) is not necessarily within the public domain or readily accessible. For this reason, DoD is actively experimenting with methods to incorporate non-traditional information collection into its organizations and processes with a view toward complementing more traditional information activities. The Virtual Information Center concept evolving from initiatives in the U.S. Pacific Command is exemplary of this type of effort.

Incorporation of Modeling, Simulation and Visualization. Improvements in the ability to develop and employ models of complex activities and to conduct highly accurate simulations of various processes have brought these disciplines to a point where they can fulfill more tactically significant roles than in years past. The exponential growth of computing power as described in Moore's Law has provided the computational power necessary to allow practical use of Modeling, Simulation and Visualization capabilities in contemporaneous situations. Models can be used to predict future events with increasing accuracy. A commander can apply various courses of action to the predicted event via simulation, review predicted outcomes against expectations and modify his course of action until the result is as closely aligned with his desired outcome as possible. The development of visualization tools provides the means for a commander and his staff to literally immerse themselves in the simulation and explore various courses of action before they must commit to one.

Improvements in Information Analysis and Filtering. The growth and maturation of the Data Mining and Data Warehousing discipline has provided an improved tool for obtaining of relevant information to feed analyses. At the same time, advances in the ability to employ automated tools to profile desired data and to filter extraneous information allows increased time for the scrutiny and interpretation of meaningful information. This process has provided analysts with more relevant and concentrated information on which to base findings and recommendations. Tools and algorithms for analysis are also improving, providing for more finely tuned and accurate answers to increasingly complex questions that must be answered before enlightened decisions can be made.

Advances in information dissemination and display. The ability to move and display information has advanced dramatically over the past decade and is predicted to continue to improve. The vast increase in the ability of the conventional voice telephone line to move data is illustrative of the evolution. At the end of the 80's a 1200 baud modem was state of the art, today a 56kb modem is the norm and is installed as standard equipment on low end computers bought at WalMart. Optical Fiber is now installed ubiquitously enabling a transition from analog to digital technology capable of delivering 52 to 155 Mbs via Synchronous Optical Networks (SONET). Satellite Terminals appear everywhere. Very Small Aperture Terminals provide the means for business and government to connect disparate elements together in real time. Display technology now provides for the large screen display of data to decision makers such that they can rapidly see and grasp information graphically that formally could only be displayed in text.

Facilitators of the Transformation

Incremental advances in traditional information gathering. We are witnessing today steady advances in the ability of the traditional intelligence communities ability to deal with information collection, analysis and dissemination. Major efforts in this regard include:

- Integrated Broadcast Service (IBS): IBS unifies existing legacy broadcast systems (e.g. TDDS, TIBS, TRIXS, NRTD) into an interactive dissemination system focusing on tactical users' information requirements.
- Global Broadcast Service(GBS)/Information Dissemination Management (IDM): IDM will be an integrated set of processes and services that provide the capabilities for the compilation, filtering, correlating, cataloging, caching, distribution, and retrieval of data at multiple levels of security while maintaining security safeguards commensurate with the information to be protected. IDM will enable:
    - Commanders to dynamically adjust information delivery and delivery priorities based on operational conditions and communications availability,
    - commanders to automate information flow policies within an area of responsibility,
    - information producers to advertise, publish, and distribute information to a widely dispersed, U.S./Allied/Coalition community,
    - authorized information users to define and set information needs (e.g., "profiles") facilitating information push and prevent information overload,
    - authorized information consumers to search information holdings and retrieve desired products, information, or data,
    - authorized information consumers to subscribe to information products published on a recurring or situation driven (ad hoc) basis, and similar data to be compiled and redundant data to be eliminated in order to present a clear, concise information picture to the consumer.

Development of new and non-traditional information sources. The development of concepts such as the Global Disaster Information Network (GDIN) and the Virtual Information Center

(VIC) are providing the means to deal with emerging sources of information. GDIN will improve the effectiveness and interoperability of global systems for sharing natural disaster information especially maps and data generated form remote and land based sensors with organizations and entities involved in coping with disasters. This would provide better early warning of natural disasters and promote more informed and effective preparedness, response, recovery and mitigation. The VIC concept was developed by USCINCPAC in collaboration with The Center of Excellence in Disaster Management and Humanitarian Assistance (COE), the Joint Staff, the Cooperative C4ISR Research Program (CCRP) and the Joint C4ISR Battle Center (JBC). It envisions a network of geographically and functionally oriented resource centers that collect, analyze and disseminate predominantly open-source information to meet their unique mission requirements. These resource centers cooperate with each other to facilitate the sharing of information and resources such that the VIC represents a collection of shared knowledge that is significantly greater than the sum of its individual parts.

Emergence of Knowledge-Based Organizations. There is a growing recognition both in and outside of the government that organizational transformation is necessary in order for us to use effectively the vast amounts of information that our information gathering, telecommunications, and computing systems are now making available at our fingertips. As the Chief of Naval Operations recently stated "We are at a crossroads in the management of information. We can choose to continue on the traditional path of more info is better, which seems to be heading us toward information overload; or, we can embark on new initiatives to change how we look at, deal with and regard information. Our knowledge management efforts must significantly improve the naval information users ability to deal with key issues in operating and sustaining our deploying forces. Our intention is to set up a coordination process that leverages local bottom-up efforts and adds value to enterprise-wide operations and business processes. … Knowledge Management has tremendous potential for changing the way we harness information in the information age." [ii] The implementation of Knowledge Management techniques will enable the cultural transformations that will be necessary to allow us to evolve into knowledge based organizations. This is not simply the application of technology to automate our traditional staff processes but rather is a fundamental change in our business process; flattening organizations, enabling individuals to act on the information at hand and empowering the organization through the application of information superiority.

Technology. There are various elements of technology that will contribute to facilitating the transformation. They include but are not limited to modeling and simulation, visualization, sensors, artificial intelligence, virtual command centers, data mining and data warehousing, and bandwidth on demand.

Modeling and Simulation. There are three domains of modeling and simulation (M&S). They are :

- The Training Domain and its three sub-categories of training simulation: exercises, education, and military operations.
- The Analysis Domain and its two sub-categories of simulation: operations and evaluation.
- The Acquisition Domain and its three sub-categories of simulation: research and development (R&D), test and evaluation (T&E), and production and logistics (P&L).[iii]

The DoD M&S Vision encompasses models and simulations ranging from high-fidelity engineering models to highly- aggregated, campaign-level simulations involving joint forces. It includes all types of models and simulations and embraces the full range of M&S interaction between the scope of the simulation, sponsoring component objectives and functional area requirements (e.g., education, training and military operations; analysis; research and development; test and evaluation; production and logistics).

Advanced M&S may integrate a mix of computer simulations, actual warfighting systems, and weapon system simulators. The entities may be distributed geographically and connected through a high-speed network. Warriors at all levels will use M&S to challenge their military skills at tactical, operational, or strategic levels of war through the use of synthetic environments representing every potential opponent in any region of the world, with realistic interactions. Acquisition personnel may use the same synthetic environments for research, development, and test and evaluation activities. M&S will increasingly be used to improve efficiency and effectiveness in engineering development and system design, manufacturing, and logistical support functions. Acquisition personnel will also use synthetic environments to support the acquisition decision-making process. Such synthetic environments will be accessible to all appropriate functional users..[iv]

Visualization. The effective execution of command is essentially about information: obtaining it, determining its worth, transforming it into a useful form, doing something with it and sharing it with others. Information however, only has value if it contributes to effective decisions and actions. As von Molke said "The problem is to grasp, in innumerable special cases, the actual situation which is covered by the mists of uncertainty, to appraise the facts correctly and to guess the unknown elements, to reach a decision quickly, and then to carry it out forcefully and relentlessly."[v] This is the essence of the visualization problem. The commander or decision-maker must be able to absorb the input they are receiving from human and mechanical sensors. They must orient themselves to a situation and decide what action to take using processors and displays. Then using communications systems they must quickly and clearly communicate their decisions to those who will execute them. As Colin Powell said "The ultimate goal is simple: Give the battlefield commander access to all the information needed to win the war. And give it to him when he wants it, where he wants it and how he wants it."[vi] The challenge in visualization is to provide the most comprehensible solutions to a decision maker's problems. It must be done in such a way that employs computer intensive systems to make visualization a reality in the most unobtrusive manner possible. Visualization is the road to insight – we must take the tumultuous sea of data and tame it into a calm body of knowledge that results in rapid understanding on the part of the decision-maker.

Sensors. Sensors are merely the means by which data is collected that will be used to develop the information to be transformed into knowledge leading to understanding. Whether space based, mounted in an aircraft, attached to a Remotely Piloted Vehicle, ground based, or simply the M-1 human eyeball they collect data and report it. Sensors are ubiquitous – the thermostat which controls the comfort level in our homes and offices, the traffic camera along the highway, the weather satellite, the magnometer in the road that turns the traffic signal green, the radar that handles air traffic control at the local airport, etc. have become so common we do not even notice them. In a military sense they tell us about our adversary – human or natural.

We collect that information, some we use immediately, some we store for future use. In all cases we must categorize it, determine what we will do with it, transmit it somewhere, store it and ultimately use it or dispose of it. We can easily be overwhelmed by the data available from the sensors we already have. Sensor and data management constitutes a significant challenge but sensors and the data they provide are fundamental to the successful achievement of the RMA.

Artificial Intelligence. Artificial Intelligence will allow us to empower our computer systems to take on decision-making responsibilities for the easier and more routine problems we face on a day to day basis. This will free the decision-maker's time to concentrate on the more difficult and complex problems he faces.

Virtual Command Centers. Virtual Command Centers will provide the technology to process, interpret, integrate, and understand the messages, images, and data which inundate the commander and his staff. Virtual Command Centers will provide the commander information about the battlespace in a form that will enhance his cognitive processes. They will decrease the uncertainties, unknowns, and the fragmented pictures of the battlefield, while enhancing the Commander's ability to make decisions and direct their execution.

Data Mining and Warehousing Data. The ability to intelligently identify the data desired and to launch intelligent agents to obtain that data will be an integral part of the knowledge based future. Further, the agents will be able to learn from their own experience and be able to become more effective each time they search their resource pool of sensors, data bases, and other sources. Once the data is mined it will be warehoused in such a manner that will facilitate its being able to be found under a wide variety of search parameters.

Bandwidth on Demand. Bandwidth on Demand will become the norm. We are already seeing technology on the horizon that will provide the means to provide virtually unlimited availability of bandwidth. Developments such as pulse technology could open up capacity for radio communication eliminating today's wireless traffic jam and opening up vast new radio real estate. More than 5 years ago Bill Gates predicted that "We'll have infinite bandwidth in a decade's time."[vii] We will live in a world of bandwidth abundance which will transform the computing world because the computers will then be able to focus on managing documents on the screen, presenting desired information from databases, performing simulations and otherwise contributing to the decision-maker's ability to visualize issues.

Current Relevant Development Efforts

Virtual Information Center (VIC). USCINCPAC, working with The Center of Excellence in Disaster Management and Humanitarian Assistance (COE), Joint Staff (J-7, J-8), JBC and a significant number of other organizations commenced a series of academic workshops, tests and experiments in July 1997 to determine and assess new concepts applicable to the conduct of Military Operations Other Than War (OOTW). This effort was undertaken as a USCINCPAC Joint Vision 2010 experimentation initiative. Using the idea of build a little, test a little, USCINCPAC established a Political-Military Anchor Desk (PMAD). The PMAD organization was examined in September 1997 through a "Complex Humanitarian Emergency Support Test" (PAC CHEST). Results from PAC CHEST were reviewed and discussed in an October 1997 C4ISR Cooperative Research Program (CCRP) workshop, which developed the concept for a

Virtual Information Center (VIC). The VIC concept was assessed April 20-24, 1998 in an experiment sponsored by USCINCPAC, JBC, and the Center for Excellence in Disaster Management and Humanitarian Relief (COE). Many DoD activities, government agencies, non-government/private volunteer organizations and international organizations were involved in some part of the experiment development, execution or assessment. Activities that directly provided resources include:

- ♦ C4ISR Cooperative Research Program (CCRP) (ASD C3I-sponsored)
- ♦ Joint Staff J-8
- ♦ USACOM (J-2 representative supported VIC Experiment on-site at JBC)
- ♦ Defense Special Weapons Agency
- ♦ Joint Warfighting Center (JWFC)
- ♦ Modeling and Simulation Operational Support Activity (MSOSA)
- ♦ US Army Peacekeeping Institute
- ♦ Navy Environmental Health Command

This partnership leveraged resources of participating commands in forging an initial JV2010 experimentation framework and assessment methodology. The results of the VIC Experiment were forwarded by USCINCPAC 200600Z JUN 98 and were also presented at the 1998 Command and Control Research and Technology Symposium "Command and Control for the Next Millennium" sponsored by CCRP at the Naval Postgraduate School 29 June – 1 July 1998. The USCINCPAC message stated "Initial examination of the results indicates the experiment demonstrated the ability of the VIC to improve the situational awareness of the operational commander. Further, it appears that the VIC concept can provide non-traditional sources of information and contribute to the clarity of the operational picture. " It also concluded "The VIC Experiment spearheaded development of HA/DR organizational support at the CINC and CJTF level and marks progress toward achievement of Joint Vision 2010 via experimentation and examination of desired operational capabilities."

JBC, along with USCINCPAC, CCRP and others are continuing to refine and experiment with the VIC concept. The VIC has been partially operationalized within the USCINCPAC staff as a direct result of the VIC experiment. Continuing progress on this project is anticipated with thrusts in the following areas:

- Knowledge Based Organizations.
- CONOPS refinement to fully implement the VIC concept.
- Expansion and further examination of tools, especially predictive modeling and remote sensing.
- Investigating and experimenting with the spread of the concept and associated tools across all warfare level i.e. beyond OOTW.
- Exporting the concept to other AORs as applicable.
- Integration of other commands and organizations into the effort.

Command Post of the Future (CPOF). Current technology is flooding the commander with messages, images, and data which require increasing numbers of people and computers to process, interpret, integrate, and understand the incoming information streams. The CPOF system will provide the commander information about the battlespace in a form that will enhance his cognitive processes. Decreasing the uncertainties, unknowns, and the fragmented pictures of the battlefield, while enhancing the Commander is ability to make decisions and direct their execution in an environment of great uncertainty.

In building and maintaining situation awareness the system will avoid simply increasing the quantity of data provided to the commander. The system will provide information by exception rather than as the norm in a graphical form, where appropriate, to assist the Commander in finding critical vulnerabilities, project trends, and development of decision centered solutions. In order to facilitate the Commander's visualization of the battlefield CPOF will develop and integrate advanced concepts for a Command Post which will exploit recent advancements in human computer interaction technologies incorporating interactive 3D visualization, interactive 3D techniques, uncertainty presentation, temporal presentation, 3d symbology, Natural Language (NL) processing, and Knowledge Base (KB) querying technologies.

This system will additionally provide for collaborative planning using on-screen teleconferencing, shared map planning and electronic white boards.

Virtual Command Post. The US Army at CECOM is developing the "Virtual Command Post" or the "Cyber CP". The Virtual Command Post concept is examining very interesting advanced technologies. One such technology is the Electronic Sand Table that provides a stereoscopic 3-dimensional (3-D) view of the battlefield. The added dimension makes the display much more real and allows the commander to view the battlespace as it actually appears. Additionally, the commander or his staff may use what is known as Avatars to place themselves anywhere in the battlefield and gain perspective of the action from that viewpoint. This is a capability which will make C2 a completely new experience. The Virtual Command Post provides a new paradigm for Human/Computer Interface.[viii]

Virtual Command Center (VCC) The VCC is an effort to build a virtual reality based concept of a command center. The aim is to graft C2 into the Virtual Reality (VR) genre. The VCC takes the physical command center and its functionality and transforms it into a VR world using Intergraph high end graphics PC and COTS software.

The VCC began with Virtus WalkthroughPro and then imported the result into SENSE8's WorldUp. In order to pick up additional collaborative functionality it was switched to SENSE8's WorldToolKit. Phase 1 of the VCC ran on multicast networks. Using Sense8's World2World networking interface the VCC now runs on the Internet with up to ten simultaneous participants sharing the same VR world. VCC uses Intergraph PCs, Virtual Research HMDs and Intersense trackers.

Additional work sponsored by the National Defense University, Industrial College of the Armed Forces (ICAF) has been incorporated into the VCC. A virtual reality "decision room" has been built to aid instructors at the ICAF in teaching strategic decision making during a global crisis. The VR decision room incorporates, intelligent agents, digitized data interaction, and collaboration. VCC is more interested in displaying capability at low cost than in slick appearances. It currently has demonstrated the following:

- "Jump gates" to other locations on the World Wide Web

- A digital sand table with active force icons and jump gates to other VR worlds
- A direct feed of TV, in our case CNN
- Voice Conferencing
- Import of, and manipulation of, the COP (Common Operating Picture) from the GCCS (Global Command and Control System)
- Use of avatars, which are visual proxies for participating users as well as for computer based agents
- Access to the same command center from multiple terminals.
- Creation of planning worlds. In this case a river crossing is examined
- Use of HMD's for immersive look & feel

Later enhancements plan to explore these avenues:

- More exotic data interaction
- Intelligent Agents
- Off loading tasks onto the environment
- A process we call "intent amplification"
- An artificial intelligence shell.[ix]

Force XXI. Force XXI is the vision for the transformed Army of the 21st Century-in its entirety. The central and essential feature of this Army will be its ability to exploit information. Information and digital technologies will create such a synergistic effect among all the operating systems, organizations, and components that the Army's capability will be enhanced by an order of magnitude.

The soldier himself will be central to Force XXI because he must be equal to the sophisticated systems of the future. He or she must be intelligent, physically fit, highly motivated, educated, and well-trained in order to successfully leverage technology to its full potential. Technology will further leverage the soldier’s power through advanced training technology employing state-of-the-art simulations and training devices.

Electronic connectivity between and among all echelons in the Army will result in such speed and precision in communication that the entire organization's situational awareness and agility will far exceed that of today's forces. This greatly enhanced connectivity, speed, precision, and agility will result in significantly improved lethality, survivability, tempo, versatility, sustainability, and deployability in the force.

Force XXI is the "rolling end state" of a developmental continuum that ultimately results in a series of successively refined future brigades, divisions, and corps. It will be derived from rigorous experimentation that is iterative and linked and allows the Army to learn from experience. It will leverage the power of information from the foxhole to the departmental headquarters, and it will cause the Army to redefine how it fights, how it is organized, and how it is commanded. [x]

STOW. The Synthetic Theater of War (STOW) ACTD was jointly sponsored by the Defense Advanced Research Projects Agency (DARPA) and the United States Atlantic Command (USACOM). At the invitation of the Department of Defense, the United Kingdom's Defense Evaluation and Research Agency (DERA) joined the ACTD in 1995 as a full and active partner.

The ACTD's goal was to provide an operational demonstration of Advanced Simulated Simulation (ADS) technologies that will directly support joint training and mission rehearsal. Additionally, DARPA plans to transition the STOW technologies to the next generation of DoD simulations, e.g.the Joint Simulation System (JSIMS), and related Service simulations.

STOW ACTD objectives were to demonstrate and evaluate the capability of ADS technologies to improve the conduct of joint and component military training and to provide a simulation driven mission rehearsal capability. These objectives were accomplished by developing a prototype system and demonstrating its capabilities during a series of operational exercises. STOW demonstrated enhanced simulation fidelity based on combat resolution at the weapons system level of detail, realistic simulation of command and control behavior, advanced distributed secure networks and knowledge-based synthetic forces, with man-in-the-loop participation wherever desired.

Critical technologies relevant to STOW will be used to create a synthetic battlespace consisting of high resolution terrain, tactically significant environmental effects, behaviorally accurate computer generated forces and Command Agents, and a simulation infrastructure compliant with the DoD High Level Architecture (HLA) and Run Time Infrastructure (RTI).[xi]

Joint Experimentation. The United States Atlantic Command (USACOM) has been designated by the Department of Defense as the Executive Agent for the conduct of Joint Warfighting Experimentation. USACOM is tasked to explore new joint warfighting concepts and capabilities and determine the doctrine, organization, training and education, materiel, leadership, and people (DOTMLP) implications for change. These experiments are to support the Chairman of the Joint Chiefs of Staffs *Joint Vision 2010* (*JV 2010*) and future CJCS joint warfighting visions. Successful joint warfighting experimentation relies on the active participation and support of the Services, combatant commands, Office of the Secretary of Defense (OSD), and Defense agencies. Joint warfighting experimentation is necessary to identify and assess those interdependent areas of joint warfare that will leverage Service warfighting capabilities to transform the conduct of future US Armed Forces operations. The Chairman of the Joint Chiefs of Staff established the conceptual template for future joint warfighting with publication of *Joint Vision 2010* and the *Concept for Future Joint Operations*. These and future CJCS vision and concept documents will guide joint warfighting experimentation.[xii]

PACOM CINC-21. CINC-21, formerly known as HQ 21 is a USCINCPAC initiative to use the construction of a new USCINCPAC Headquarters Building at Camp Smith as a catalyst for re-examination of the staff's organization and processes as well as to engineer the supporting infrastructure, tailored to 21st Century missions. The objectives include:

- Implementation of secure knowledge-centric decision support and information management
- Implementation of advanced methods for commanding the theater information enterprise
- Demonstration of a distributed "virtual" command presence
- Demonstration of improved processes for operations with coalition, interagency and NGO organizations.

Key technology enablers include advanced tools for information collection, processing, and dissemination including:

- Improved situational awareness through visualization

- Collaboration, decision support, and information correlation technologies
- Modeling and Simulation
- Language translators for coalition operations

CINC-21 is expected to result in an improved ability of the CINC's extended staff to track and manage multiple crises, enable synchronized understanding of operations between the CINC and CJTF, and increase the ability to predict and optimize the end-to-end information enterprise. Other current PACOM development efforts also support the vision and dove-tail with the CINC-21; including: the operationalization of the Virtual Information Center and development of VIC technology tools under the ONR/SPAWAR VICTOR program. As the program develops, other PACOM thrusts will likely be incorporated, including GENOA and the Advanced Course of Action Analysis system. Additionally, major programs such as GBS/IDM, currently being installed for initial operation in the PACOM AOR, will be integrated into the PACOM plan.

Implications of the Transformation

Doctrine. Today's doctrine focuses on existing capability, while emerging concepts will force us to address the future and define the RMA. Development of a process that will manage the migration of good ideas in new concepts into joint doctrine at the right time is required to accompany the advances in the Transformation of Information into Knowledge. This migration must coincide with related changes, such as organizational or materiel changes, but be early enough to support required joint training and education.

Enriched Knowledge will improve commanders' battlespace awareness so they can affect the adversary's actions and employ their forces more effectively, efficiently, and with increased tempo. In non-combat operations, the same awareness will allow mission focus and concentration of efforts.

Operating with allies and coalition partners is necessary today and will continue well into the future. The United States' rapid advances in information technology have an associated implication with regard to operations with other governments. As we make considerable investment in this technology most nations in the world, friend or foe, will be unable to match that investment, especially in the absence of a viable threat as an impetus for fiscal commitment to military funding. This will reduce our ability to achieve interoperability with our partners in any given operation. Information we share with allies and coalition partners may be used in ways other than we intend. We should ensure that we protect ourselves from potential harm that might be caused by an inappropriate release of information. These implications must be addressed within the US military and with our allies and potential coalition partners.

With increased availability of near-real-time information, we need to understand how to speed analysis, prioritization, and fusion. Competing types and sources of information could generate information overload. We also need to examine how improvements in data processing can move us from awareness of current conditions, toward the ability to predict future conditions.

Organization. Innovative operational concepts will drive how organizations are structured and what functions are performed at each level. The trend toward smaller, flatter organizations, accelerated by an improved knowledge environment will improve command and control.

Development of the knowledge environment should fundamentally alter the composition and organization of staffs. There may be fundamental changes in the use of analysts in developing knowledge system content, and traditional functions performed by C4ISR directorates will be subsumed into an infrastructure-centered discipline.

Near-real-time connectivity, as well as more decentralized C2, will allow rapid exploitation of short-lived opportunities presented by adversaries. Organizations will need to be more adaptable to change, and information systems more flexible, interoperable, adaptive, and responsive to rapid changes in the commander's intent.

Training. Changes in doctrine, organizations, and operational concepts are in progress and future changes will occur at an ever increasing rate. This will challenge our capacity for training programs to keep pace. Training programs must be developed in consonance with the introduction of new information systems. Training and education in the future can leverage the information age and much more effectively use remote approaches to train large groups of geographically dispersed people. New training and simulation capabilities may enable "just in time" en route training for forces activated or deployed on short notice.

Material. Commercial off-the-shelf (COTS) technology will lead to lower costs and shorter development and acquisition times. A degree of vulnerability is associated with this commercial linkage in that potential adversaries have access to the same technology and systems.

Future C4ISR systems and architectures will evolve. To gain maximum advantage from these new capabilities, the human-machine interface will require continuous refinement, especially in presenting information to decision makers to allow them to review and understand large quantities of this information.

Leadership. For information superiority to yield its full potential, military decision making should be central to how we educate future leaders. With a clearer picture of the future battlespace, commanders will be able to prosecute their operations more efficiently. They will also have the battlespace awareness to see and grasp opportunities to modify the plan in real time to gain a decisive advantage. Future commanders must balance their improved awareness with the continuing need to use their experience, judgment, and instincts, and to take appropriate risks, in their exercise of command.

Personnel. The success of the RMA will rely on high-quality and well-trained people. The intellectual acumen, physical skills, and motivation of the soldier, sailor, airman, and Marine will be even more important as we move into the 21st century. The information age places a high premium on persons that have a technical aptitude. Changes in recruiting, training, and developing people; how units operate and organize; and how organizations doctrinally will drive changes in professional development. Although how career paths and professional development processes may look in the future is unclear, implications will exist for the career warriors.[xiii]

Conclusion

The RMA will be distinguished by a profound change in the conversion of information to knowledge for Command and Control. Essential elements of this transformation are currently becoming discernable and are facilitated by several thrusts in technology, combined with other trends in technology and information handling. Several projects and experiments are being conducted throughout DoD aimed at different facets of this transformation. Implications of this revolutionary transformation are becoming clearer and affect a wide range of DOTMLP issues.

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[i] *Concept for Future Joint Operations*, Chapter 5, Commander, Joint Warfighting Center, Fort Monroe, VA, 1998
[ii] Chief of Naval Operations Message 171704Z Feb 99
[iii] http://www.msosa.dmso.mil/helpdesk/helpdesk-faq.asp?a=s4&b=view&c1=152
[iv] http://dmso.mil
[v] Helmuth von Moltke, "Moltke on the Art of War: Selected Writings," Hughes, Daniel (Ed). Novato, Calif.: Presidion Press, 1993 p. 138.
[vi] Gen. Colin L. Powell, "Information Warriors," BYTE Magazine, July 1992), p. 370.
[vii] Bill Gates PC Magazine, Oct. 11, 1994
[viii] http://www.ausa-ft-mon.org/ausatip9.htm
[ix] http://www.disa.mil/D8/iw/index/vcc.html
[x] http://www.monmouth.army.mil/cecom/lrc/forcexxi/general.html
[xi] http://friends.acq.osd.mil/at/stow.htm
[xii] Joint Experimentation Implementation Plan, CINCUSACOM ltr 1650 Ser 8U J00/017 dtd 14 July 98
[xiii] Common Relevant Operating Picture (CROP) White Paper (Draft), USACOM J92, 8 April 1999