

CHAPTER 21

NETWORK-CENTRIC WARFARE: LEVERAGING THE POWER OF INFORMATION

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... the general unreliability of all information presents a special problem in war: All action takes place, so to speak, in a kind of twilight, which like fog or moonlight, often tends to make things seem grotesque and larger than they really are.

Whatever is hidden from full view in this feeble light has to be guessed at by talent, or simply left to chance. So once again for lack of objective knowledge one has to trust to talent or to luck.

Clausewitz¹

What is all this fuss about network-centric organizations? Is Network-Centric Warfare an “emerging theory of war” or just about technology? Is it possible to harness the power of information to gain a significant advantage in the operational environment? Scholars, politicians, appointed government officials and warfighters are lining up to take sides on the utility of information sharing and networking U.S. military forces.² The business community continues to grapple with knowledge management, business process management, information technology (IT), and enterprise networking to gain a competitive advantage in the market place.³ There is a plethora of literature documenting how IT is enabling innovation in business as well as the military.⁴ It is time to continue the dialogue and raise the awareness of the benefits of network-centric operations as an enabler to gain a competitive advantage over current and potential adversaries in the 21st century. If we agree that Clausewitz is correct about the unreliability of battlefield information, could Network-Centric Warfare concepts and capabilities improve this situation? The Department of Defense (DoD) has decided to pursue an aggressive policy to develop network centric warfare (NCW) capabilities as a “source of warfighting advantage.”

This chapter argues that DoD is on the right track to pursue advanced integrated information technology to enable warfighting in the future. This chapter does not argue that information systems and technology are the panacea to solve all the complex issues associated with warfare in the 21st century. This chapter begins with a brief discussion of the fundamental concept of network-centric warfare and the current Department of Defense policy for networking the force. Then, the chapter will investigate the potential of information and knowledge sharing on the battlefield to provide a competitive advantage against potential adversaries. There are tactical, operational, and strategic implications⁵ to sharing information and networking the force within the operational environment. This chapter would not be complete without addressing a few of the most prevalent arguments by those who caution against relying on information technology and networking. The final section will outline a few recommendations to proceed with the implementation of network-centric warfare.

Network Centric Warfare (NCW): Developing a Concept.

It should not be a secret that the world is squarely in the age of information. One only needs to view the nightly news, scan the newspapers, or pick up the latest technology books and trade journals to understand the magnitude of corporate investments in information systems. “Worldwide,

businesses spend nearly \$1 trillion a year on IT gear, software, and services – more than \$2 trillion if telecommunications services are included.”⁶ The enormity of the spending by corporations around the world on new ways to capture, store, and share information inside and outside of organizations continues to increase since the turn of the century. The Department of Defense is well aware of the potential benefits of sharing information and knowledge to generate competitive advantage.

There is a significant body of literature that addresses the benefit of sharing information on the battlefield to develop a common operating picture. It is not possible to conduct an exhaustive review of the literature related to NCW in this short article. However, it is important to review some of the seminal works that establish the fundamental underpinnings of this emerging and dynamic concept. The Office of Force Transformation, Office of Secretary of Defense, as well as the DoD Command and Control Research Program are two of the conceptual leaders developing the theory of Network-Centric Warfare. The publication from the Office of Force Transformation, *Implementation of Network-Centric Warfare*, released in January 2005, establishes the current thinking on NCW, by providing “answers to some of the fundamental questions regarding NCW as emerging theory of war in the information age.”⁷

There is a significant body of knowledge published by the Command and Control Research Program that provides the theoretical development of the concepts of Network-Centric Warfare for the Office of the Secretary of Defense.⁸ One should begin the journey to examine the potential of NCW by closely reading the book authored by Dr. David Alberts, Mr. John Garstka, and Mr. Fred Stein titled, *Network Centric Warfare: Developing and Leveraging Information Superiority*. A careful reading of the book will explain the purpose and concept of NCW, how NCW has the potential to leverage information age technologies, and a methodology to implement the concept over time.⁹ The authors proposed this early concept of NCW as a point of departure:

NCW is about human and organizational behavior. NCW is based on adopting a new way of thinking – network-centric thinking – and applying it to military operations. NCW focuses on the combat power that can be generated from the effective linking or networking of the warfighting enterprise. It is characterized by the ability of geographically dispersed forces (consisting of entities) to create a high level of shared battlespace awareness that can be exploited via self-synchronization and other network-centric operations to achieve commanders’ intent.¹⁰

The publications in 1998 set the stage for the intellectual debate on the potential of NCW as a new way to examine the conduct of war in the 21st century with networked forces and enhanced situational awareness.

NCW is about warfighting in the 21st century. It is about warfare in the information age. There are significant new information technologies that enable commanders to know more about the enemy, plan faster, make decisions faster, and synchronize sensors and shooters to create desired effects on the battlefield. David Alberts, in *Information Age Transformation*, conducts a thorough analysis of what warfare will entail in the 21st century; he postulates the challenges with warfare in the information domain. “As the global society enters the information age, military operations are inevitably impacted and transformed. Satellite communications, video teleconferencing, battlefield facsimile machines, digital communications systems, personal computers, the Global Positioning System, and dozens of other transforming tools are already commonplace.”¹¹ The question then becomes how to transform a military force with the appropriate capabilities to operate in this new environment. The author proposes that the following NCW tenets should guide the adoption of information technologies and transformation:

- A robustly networked force improves information sharing.
- Information sharing and collaboration enhance the quality of information and shared awareness.
- Shared situational awareness enables self-synchronization.
- These, in turn, dramatically increase mission effectiveness.¹²

Alberts presents these tenets espousing the potential benefits of information sharing, networking, and enhanced situational awareness as organizing functions to transform the force in the information age. These tenets provide a series of research questions to analyze case studies to investigate the potential benefits of a networked force.¹³

Alberts and Hayes continued to expand the idea of the inherent benefits of sharing information in a networked environment in their next book titled, *Power to the Edge: Command, Control in the Information Age*. The book argues that current command and control relationships, organizations, and systems are just not up to the task of executing warfare in the information age.¹⁴ It is critical to push essential decision-making information out to the “edges” of the organization. “*Power to the Edge* is about changing the way individuals, organizations, and systems relate to one another and work. ‘Power to the Edge’ involves the empowerment of individuals at the edge of an organization (where the organization interacts with its operating environment to have an impact or effect on that environment) or, in the case of systems, edge devices.”¹⁵ The ubiquitous nature of IT makes the vision of achieving “Power to the Edge” possible. The transition from strictly hierarchical organizational structures is already underway. The Army’s restructuring to smaller more lethal Brigade Combat Teams and Stryker Brigades takes advantage of more powerful networks to push information and thus greater situational awareness out to the edges of organizations.

The power of the network has provided new and innovative approaches to command and control organizations. One needs only to review the legendary actions of small Special Forces Teams on horseback during Operation Enduring Freedom to see the power of interdependent edge organizations networked to accomplish desired effects on the battlefield.¹⁶ Small Special Forces Teams operating with satellite communications equipment (data and voice) synchronized joint fires to attack targets. Special Forces Teams adroitly coordinated and laser designated targets for Joint Direct Attack Munitions from F-14, F-15E, B-1, and B-2 airframes during Operation ENDURING FREEDOM (OEF) with devastating results and accuracy.¹⁷ The relationship between sensors (Special Operating Forces, Predator, and Global Hawk) and shooters (AC 130, B-1, armed *Predators*, numerous USAF fighter assets) linked through a network to command and control demonstrates the potential benefits of the concept. This is but one example of the future potential of a networked force that pushes critical information to those that need it when they need to accomplish tasks in the operational environment. The U.S. military is in the early stages of understanding the full potential of network-centric warfare and sharing knowledge out to the edges of an organization i.e., *Power to the Edge* becoming a reality.

This brief NCW literature review would not be complete without mentioning the Network Centric Operations Conceptual Framework Version 2.0. There are numerous critics of NCW calling for academic rigor to be applied to this emerging concept. There is a need to develop a framework to produce metrics that can empirically measure the efficiency and effectiveness of NCW. It is important to validate where to spend finite defense dollars to achieve the greatest possible return on investment.

As a consequence, OFT [the Office of Force Transformation] and OASD-NII [Office of the Assistant Secretary of Defense, Networks & Information Integration] began collaborating on an effort to develop metrics to test hypotheses in the NCW value chain. The primary objective was to develop a rich and comprehensive set of

NCW-related metrics that could be used in experimentation and other research endeavors to gather evidence. This evidence then could be used in experimentation and other research endeavors across the DOTML-PF [doctrine, organization, training, materiel, leadership and education, personnel and facilities] spectrum. This effort resulted in the development of a Conceptual Framework for Network Centric Operations and a variety of other NCO-related research, outreach and publications.¹⁸

This document begins to address a more rigorous approach to measure the efficiency and effectiveness of NCW. This framework may provide measures of effectiveness and performance to truly measure the benefits of NCW in the future.

The Network Centric Operations Conceptual Framework (NCO-CF) proposes a series of concept definitions, attributes and metrics to measure numerous elements of NCW based on the NCO-CF:

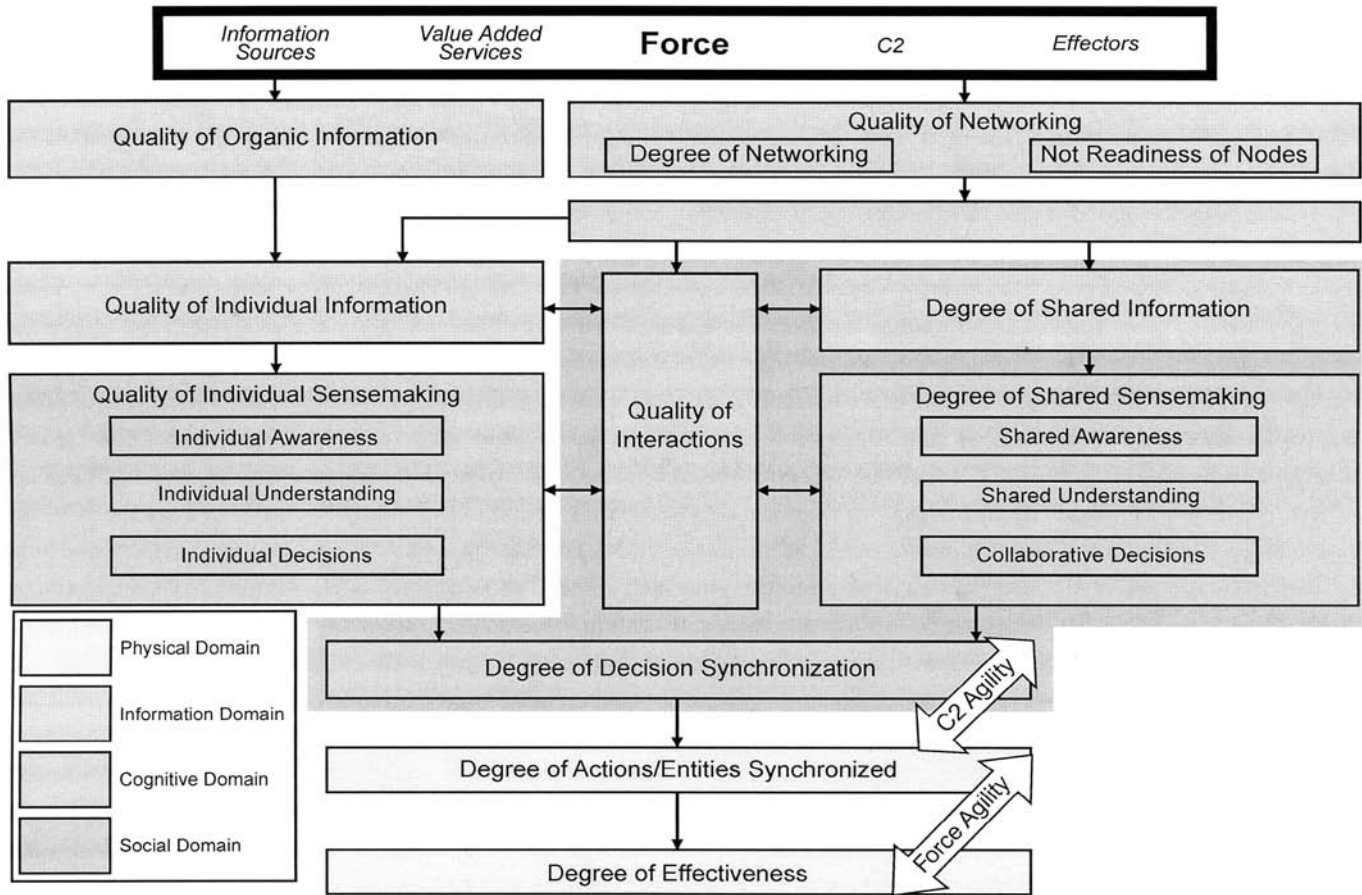


Figure 1. The Network Centric Operations Conceptual Framework.¹⁹

The NCO-CF defines each concept and attribute and recommends a quantifiable metric for each. The draft schema presented in the NCO-CF is complex and untested. It is however, a step in the right direction. This framework goes well beyond the general assertions of efficiency and effectiveness outlined in the NCW Tenets. The NCO-CF “provides basis for quantitative exploration and/or assessment of NCW hypotheses; and investment strategies and other DOTML-PF related issues.”²⁰

It will take a substantial effort to validate the attributes and metrics proposed in the NCO-CF. The metrics for many of the attributes are based on a Likert scale i.e., a scale of 1-5. There is a degree

of subjectivity involved with assigning a value to the attribute. How does one truly measure quality, consistency, currency, precision, completeness, accuracy, relevance and timeliness of information? These attributes begin to investigate, experiment, and test metrics. However, the next step must be to gather a committee of experts to further define the attributes and metrics based on more objective criteria. Another approach is to begin gathering data using the proposed attributes and metrics to determine the validity of the framework. This work has already begun with the publication of the *Network-Centric Operations Case Study: the Stryker Brigade Combat Team*.²¹ This report along with the NCW Operation Iraqi Freedom case, *A Network-Centric Operations Case Study: US/UK Coalition Combat Operations during Operation Iraqi Freedom*, as well as other cases published in 2007, points out the difficulties of applying the attributes and metrics of the NCO-CF in an empirical study.²²

The latest publication to explain the potential of NCW and NCO as an emerging theory of war is the Office of Force Transformation (OFT) publication *The Implementation of Network-Centric Warfare*. This publication by the OFT touts NCW as an “emerging theory of warfare in the information age.” The authors bring the numerous concepts associated with NCW, outlined in this compressed literature review, into a concise framework. The purpose of the framework is to begin to work the fundamental hypothesis of Network-Centric Warfare. “The working hypothesis of network-centric warfare (NCW) as an emerging theory of war, simply stated, is that the behavior of forces, i.e., their choices of organization relationships and processes, when in the networked condition, will outperform forces that are not.”²³ It is important to review this work in order to have a meaningful dialogue about the potential of Network-Centric Warfare as an emerging theory of warfare.

The hypothesis stated above focuses on several critical variables prior to discussing the issue of a “networked force.” Many critics of NCW focus mainly on the technology aspect of NCW.²⁴ However, NCW is much more than the information technology. First, NCW entails examining organizational relationships and processes. Then, highly effective and efficient organizations are networked to leverage shared knowledge and information in the operational environment. A balanced and holistic assessment of NCW is called for to determine the potential of this concept on the modern battlefield.

The human behavior variable remains a crucial aspect of NCW. “The implementation of NCW is first and foremost about human behavior as opposed to information technology. While “network” is a noun, “to network” is a verb. Thus, when we examine the degree to which a particular military organization, or the Department as a whole, is exploiting the power of NCW, our focus should be on human behavior in the networked environment.”²⁵ This publication goes into considerable detail outlining the numerous benefits of networking humans to share information and knowledge. NCW is all about connecting individuals across the operational environment to leverage information age technologies to reduce the “fog and friction of war.” There is no attempt to imply that all of the fog and friction of war can be eliminated through networking forces. “This will not be the case. Rather, the issue is how one creates and exploits an information advantage within the context of the fog and friction of war.”²⁶ However, there is a case to be examined that linking warfighters together on the battlefield may increase speed of command and synchronize dispersed forces to more efficiently and effectively accomplish objectives. Therefore, although the reliance on technology is apparent when discussing the potential of NCW, it is important to examine the literature as it relates to the human dimension of the concept.

The OFT publication *Implementation of Network-Centric Warfare* goes further to outline the importance of human behavior in NCW by investigating the tenets of NCW. Figure 2 demonstrates the important relationship between the information domain, the cognitive and social domains, and the physical domains. The essence of the concept can be realized by understanding these relationships. The information domain is where data, information, and knowledge are created, manipulated and

shared among warfighters. The cognitive domain is where the data, information, and knowledge are manipulated in the mind of the warfighter. The all important social domain is where the interaction between humans occurs. "This is also the domain of culture, the set of values, aptitudes, and beliefs held and conveyed by leaders to the society, whether military or civil."²⁷ An understanding of the relationship between the information, cognitive and social domains begins to address the core principles of NCW as they relate to the physical domain i.e., mission accomplishment.

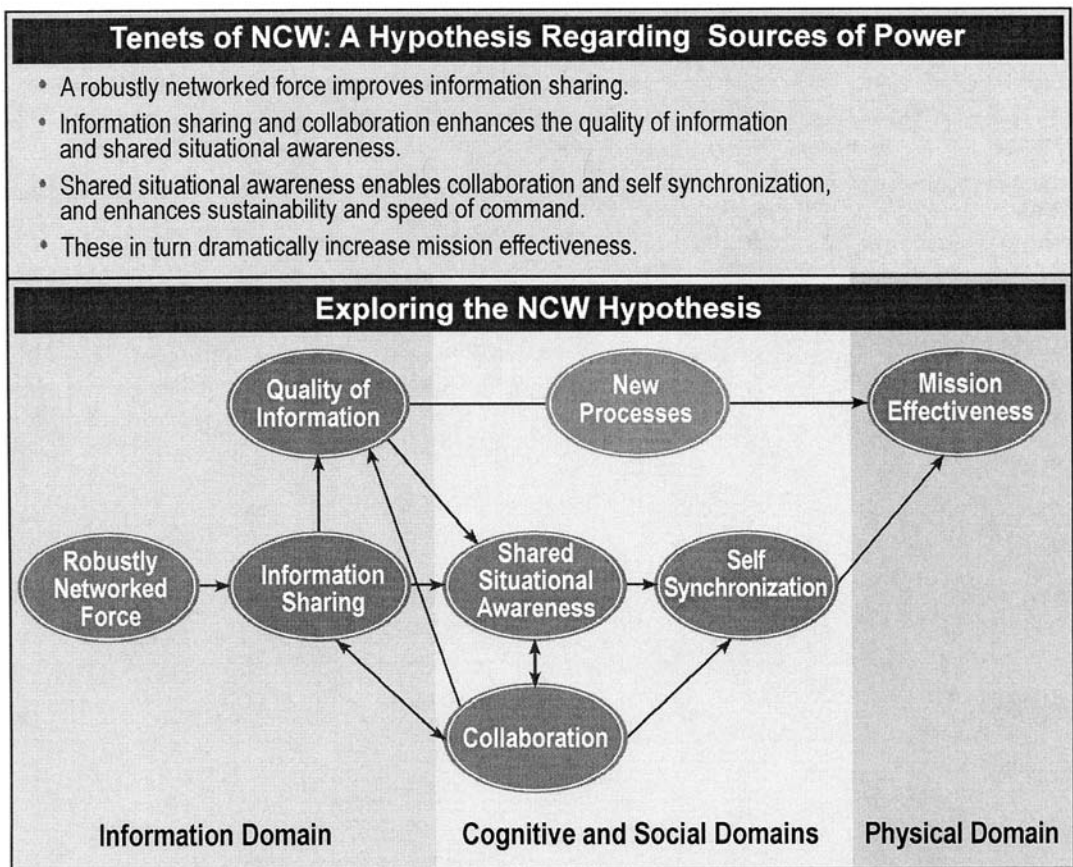


Figure 2. Tenets of NCW and the Value.

The human behavior aspect of this schema is central to understanding NCW as a "source of Warfighting advantage." The networked force enables information sharing, shared awareness, and self synchronization within the information domain. The real warfighting and decision-making functions remain in the cognitive and social domains. Is there any evidence that units are actually operating within this framework?

The Office of Force Transformation has set out to document the fact that units are already operating in a network centric operational framework. OFT is developing numerous NCO case studies that apply the NCO-CF, gather data, and analyze evidence. It is beyond the scope of this paper to review all of the case studies. However, the results of Ground Operations (Stryker Bridge Combat Team) will illustrate the potential benefits of NCW. The case study explored the hypothesis that "the NCO capabilities of the Stryker Brigade Combat Team (SBCT) would enable information and decision superiority and increase force effectiveness."²⁹ The conditions for the test were an operational environment (Small Scale Contingency) at the Joint Readiness and Training Center (JRTC) conducted in May 2003. The baseline for this study was to compare the SBCT against a non-digitized light infantry brigade. The study measured the quality of effectiveness of command and control based on the degree of situational awareness, speed of command, quality of decisions, and force self-synchronization.³⁰

The results of the study are impressive. It is important to note that 75 percent of the SBCT had networked battle command systems. A few of the most interesting findings are the following:

- Friendly vs. enemy casualty ratio decreased from a normal JRTC rotation with a light infantry brigade from 10:1 to 1:1;
- Acceleration of speed of command from 24 to three hours in engagements;
- Increase in individual/shared information quality from 10% to 80%.³¹

The results only begin to scratch the surface of potential benefits of fully networked forces. One can argue the rigor, conditions, standards, and data gathering methods for this study. However, these results should stimulate additional rigorous experiments to validate the return on investment of maneuvering a networked force. The Army has yet to fully determine the actual benefits and effectiveness of the networked SBCTs serving in Operation IRAQI FREEDOM. It will be interesting to compare the results from this JRTC study, quantitative and qualitative, to the data collected in Iraq in ongoing counterinsurgency operations. It should then be possible to acquire a better understanding of the effectiveness of a networked force in an actual combat environment. Also, there is much more work to be done to analyze the potential benefits of networked forces at the operational and strategic levels of war.

Network-Centric Warfare: The Silver Bullet?

Now that the literature review is complete, it is possible to investigate the potential of NCW. This author has not found any proponents of NCW touting that this concept is the “Silver Bullet” to solve all the problems of future warfare. Many of the same problems that have plagued warfighters in the past exist today and will exist in the future: fog and friction, competing advances in technologies, the unpredictable nature of human behavior on the battlefield, and asymmetric warfare to name only a few. The issue isn’t the existence of these challenges to modern warfare but how one exploits the advantages of information to mitigate risk and take advantage of strengths in the force to achieve objectives.³² Are the potential benefits of NCW worth the opportunity costs associated with aggressively moving forward with the implementation of this new concept?

The concept of Network Centric Warfare has already moved beyond the “bumper sticker” stage. NCW is not a fad that will go quietly into the night. There is little doubt that significant finite resources are being expended to pursue NCW capabilities. DoD spending in the area of communications and electronics is approaching the \$65 Billion level for 2007.³³ There may be changes to terminology, shifts in policy, and alterations in implementation plans. However, the core concepts that relate to leveraging the power of information will remain. DoD and senior military leaders have been consistent in their support of a networked force. Former Secretary of Defense Donald Rumsfeld concisely stated the importance a fully networked force in the *Transformation Planning Guidance*. “We must achieve: fundamentally joint, network-centric, distributed forces capable of rapid decision superiority and massed effects across the operational environment. Realizing these capabilities will require transforming our people, processes, and military forces.”³⁴ ADM Giambastiani, USN, (Retired) and former Commander U.S. Joint Forces Command stated, “A fully collaborative and networked force is an imperative, not a luxury.”³⁵ The Commandant of the U.S. Marine Corps, General Michael Hagee said, “The capability to connect disparate units spread over the battlefield will help to provide intelligence, surveillance and reconnaissance to commanders who can then call in fire support. . . . Information Technology (IT) will also be critical to Sea Basing, a key component of the Navy’s Sea Power 21 Concept.”³⁶ The Army’s Training and Doctrine commander, General William S. Wallace, stated that,

The advantages of using a network in military operations are numerous and should be recognized. First, the network allows greater and faster collaboration among commanders and staffs at all levels, empowering them to exercise greater initiative in accordance with commander's intent. Second, the commander can receive better displays of the situation without having to send multiple requests for information to subordinates, thus allowing warfighters to focus on accomplishing their missions. Additionally, the commander can share the basis for his or her situational understanding with subordinates and staff. Finally, the network can give commanders unprecedented freedom to circulate on the battlefield among subordinate commanders and soldiers without losing essential connectivity to the information and analysis necessary for command.³⁷

General Wallace goes on to caution that "despite the enormous benefits of using a network, it would be folly to lose sight of the fact that it is still merely a tool to aid the commander in understanding and decision-making."³⁸ The question is not if DoD will proceed with NCW, but how.

The NCW Way Ahead.

The DoD has a plan for the implementation of NCW. The plan calls for a holistic approach to the implementation of NCW that investigates the potential of NCO in joint, multinational, and interagency operations. As previously discussed in this paper, there has been a significant effort to establish the theoretical underpinnings of the concept. The most recent publication, *Implementation of Network-Centric Warfare*, establishes the outline of the plan to move forward with NCW. The next part of the process was to begin to study the tenets of NCW through case studies. Additionally, the Services are working to integrate information systems, sensors, and decision-making processes and technology to leverage the capabilities of a fully networked joint force. The Air Force Command and Control Constellation network is an example of the integration of C2; ISR; tankers; space, ground, and sea-based systems; and strike platforms to achieve shared awareness in the operational environment to maximize effects.³⁹ Constellation works with FORCENet (U.S. Navy), and LandWarNet (U.S. Army) to achieve synergy on the battlefield.

It is not in the scope of this paper to examine all of the specific sub-elements of the implementation plan for NCW. However, there are several key pieces that provide a flavor for the journey ahead. It is important to remember that NCW is in fact a journey and not a particular destination. This is a dynamic process. Theories will be tested, concepts will be modified, technology will continue to advance, and budgeting priorities will shift over time. The overall path leads to a convergence of disparate sensor and command and control systems to create synergy among the numerous joint information systems. Many of the critics of NCW focus solely on the technology aspect of the concept. This is a short sighted approach to a complex transformation in thinking about warfare to leverage technology to gain a competitive advantage over potential adversaries. "Progress in implementing network-centric warfare cannot be measured solely by focusing on one dimension, such as technology or doctrine. Rather, progress must be assessed in terms of the maturity of mission capabilities, that integrate key elements of DOTMLPF (Doctrine, Organization, Training, Materiel [technology], Leadership and Education, Personnel, and Facilities)."⁴⁰

A program that highlights the potential advantages of NCW is the Force XXI Battle Command Brigade and Below (FBCB2/BFT) Blue Force Tracking systems. FBCB2/BFT was used extensively during Operation Iraqi Freedom to monitor the maneuver of U.S. Army, U.S. Marine, U.S. Special Forces, and British ground forces during the conflict. FBCB2/BFT uses the global positioning system and numerous sensors to pinpoint units on the battlefield. This capability provided unprecedented situational awareness to commanders at all levels on the battlefield. The qualitative data acquired from interviews with those on the ground validates the utility of acquiring better situational

awareness. Leaders from General Tommy Franks, U.S.A. (Ret) down to battalion and company commanders marveled at the ability to track unit progress during major combat operations.⁴¹ The data available through FBCB2/BFT allowed commanders to quickly adjust to changing operational conditions and manage complex logistical situations.⁴²

The Global Information Grid-Bandwidth Expansion (GIG-BE) program will provide the backbone to facilitate NCW in the future. It is difficult to discuss NCW without touching on the importance of the GIG-BE. GIG-BE is the technology that will facilitate numerous NCW initiatives in the years ahead. MG Marilyn Quaglotti, former Vice Director of the Defense Information Agency (DISA), described the vision for the GIG as a single secure grid providing seamless end-to-end capabilities to all warfighting, national security and support users.⁴³ DISA achieved full operational capability of the GIG-BE in December 2005.⁴⁴

It is essential to continue the development of the GIG-BE to realize the potential benefits of NCW. GIG-BE provides the necessary technology to facilitate the interaction of sensors, linked to command and control, to effectively engage shooter platforms to achieve desired effects on the battlefield. GIG-BE will provide necessary bandwidth to support requirements at all levels of war. The warfighters' ability to have access to necessary bandwidth with the appropriate integrated information systems across the services, DoD, joint, and interagency communities has the potential to truly stimulate innovative approaches to solving complex tasks across the spectrum of conflict. DoD is far from achieving this lofty goal at this time. Also, there is no guarantee that as the pieces fall into place the expectations of NCW will be achieved. However, the early indications of the potential synergy afforded by networked forces continue to form a powerful augment to continue down this path.⁴⁵ This is not to say that there is not room for caution as DoD and the Services invest large portions of their budgets in technology.

The Genie and NCW.

Let us postulate for a moment that this chapter convinced you that the Genie representing the power of knowledge through collaboration enabled by a robust network (information system) characterized by the latest information technology is outside the bottle. The challenge is to ask for the correct wishes that would facilitate achieving the principles and tenets outlined in the NCO-CF. There are numerous potential disadvantages to NCW. One could easily ask the Genie for a worthless wish. There is a fairly substantial list of those who point out the shortcomings of NCW.⁴⁶ These authors provide a valuable service in highlighting the potential deficiencies in the theoretical underpinnings of NCW as well as outlining the opportunity costs associated with pursuing this extremely expensive transformation of the defense information architecture. The naysayers stimulate dialogue and debate and assist proponents and decision makers to better allocate scarce resources in pursuit of NCW capabilities.

The disadvantages of NCW are well documented in the literature. Numerous scholars and warfighters have taken the time to thoughtfully outline the potential pitfalls in the pursuit of NCW capabilities. It would be impossible to enumerate all of the explicit and implicit disadvantages outlined by the critics. However, it is useful to highlight a few of the major concerns that deserve further attention and study in the years ahead:

- NCW places too much emphasis on tactics and the tactical nature of war.
- U.S. advances in information technology will outpace our allies and potential coalition partners ability to operate together on the battlefield.
- More information and superior information technologies do not translate into information dominance.

- Situational awareness is not going to eliminate the fog and friction of war.
- Too much speed of command can lead to unsound decisions.⁴⁷
- NCW ignores the human dimension of warfare.
- Technology is dictating strategy. “[NCW is] driven by its self-centered concern with technology for technology sake.”⁴⁸
- NCW and its reliance on information technology fails to address the emergence of the current and future threat posed by insurgency, terrorists, Netwars, and 4th Generation Warfare.⁴⁹

The articulated disadvantages help to focus research, funding, and execution of NCW in the years ahead. Also, many of these possible negative aspects will be addressed as DoD publishes empirical evidence to refute these concerns.

The proponents of NCW recognize these potential negative aspects of NCW. DoD, headed by the Office of Force Transformation, is working to harness the power of industry, academia, and the military community at large to thoughtfully address each of these concerns with rigorous conceptual and empirical study. COL Douglas Macgregor, USA (Ret.), a well known critic of numerous aspects of Army transformation, understands the potential benefits of technology and acquiring information on the battlefield. “In the pursuit of knowledge, the U.S. Navy has broken new ground in context of network-centric warfare with its cooperative engagement capability (CEC). This system distributes raw sensor and weapons data among warfighting units, enabling them to combine and share composite data in a coordinated joint defense.”⁵⁰ This is why it is critical to proceed with the study and focused conceptualization of how technology can enable and facilitate warfighting in the 21st century.

Moving Forward: Course of Action Missouri.

It should be apparent by now that this author is an advocate of NCW. This should not imply total agreement with the concept. This author supports the continued study of how the principles of NCW will leverage information and knowledge on the battlefield. It is understandable that the academic community and even warfighters want to see solid evidence supporting the need to make large investments of scarce funding to pursue NCW capabilities. Thus, there is a requirement to develop a strategy and course of action that clearly demonstrates the return on investment to stakeholders, i.e., *Course of Action (COA) Missouri*. The designation of COA Missouri was selected based on the state of Missouri’s nickname of the “show me state.” NCW will need to clearly demonstrate value added to the warfighter. Elements of this proposed course of action are already beginning to take shape in the Office of Force Transformation. The empirical evidence and future studies begin to outline the potential of aligning the appropriate technology to support joint warfighting in a collaborative information environment. So what are the key elements of COA Missouri?

The Human Dimension of Warfare.

As previously discussed, many of the critics state that NCW does not appropriately address human behavior in warfare. The NCW literature does address the importance of the interaction of the cognitive, social, and information domains as an essential element of NCW. To address this concern, the Office of Force Transformation should focus future research and publications on the human dimension and leadership issues associated with information age warfare. There is adequate coverage in the current literature to indicate that the warfighter on the battlefield is and will remain the key to success and not the technology. However, the current case studies focus mainly on the

enabling technology related to organizational effectiveness. Future studies should examine the effects of technology on human behavior in a combat environment at the tactical, operational, and strategic levels of warfare. Academic scholars in the fields of anthropology, sociology, and psychology should work with the developers of the NCO-CF to investigate the potential benefits as well as the negative aspects of NCW in the human behavior domain. The Office of Force Transformation has established transformation chairs at all of the Senior Service Colleges and Service Academies. These scholars would be a good place to begin studies investigating human behavior and leadership challenges to warfare in the information age. The results of this work should be published and disseminated for scholarly examination, critique, and additional study.

NCO-CF Attributes and Metrics.

There is little doubt the developers of the NCO-CF are in the early stages of defining rigorous attributes and associated metrics to conduct empirical studies of the model. Two of the NCW published case studies have stated that attributes and metrics must be further defined.⁵¹ The US/UK case study on NCO highlighted several insightful observations and recommendations about the NCO-CF:

- The language of the NCO-CF be changed so it is better understood by combat units and non-U.S. forces.
- Quantifying metrics related to combat operations—as was done for this case study—can be very difficult. Beyond this report, it is recommended that a focused effort be made to incorporate into the NCO-CF recommendations for improvement and lessons learned from the application of NCO-CF within various case studies.
- Certain definitions and corresponding metrics are difficult to translate into meaningful interview questions.
- Many attributes definitions and metrics are liable to variations in interpretation.
- Difficult to identify data sources.
- Weakness in consistency and completeness in descriptions, explanations, measures and metrics for each of the attributes.⁵²
- The Stryker BCT NCW Case Study called for the development of additional metrics:
 - Develop metrics that reflect the degree to which the development, maintenance, and sharing of the Common Operational Picture critically depends on the interaction of technology, training and personnel experience.
 - Current metrics don't measure the synergy between net-centric current operations and improved planning in land warfare.
 - Metrics don't exist that reflect the degree to which the Military Decision Making Process (MDMP) has been properly reengineered to exploit the potential advantages of information networks.
 - Metrics are required to reflect the degree to which process design, technology, business rules, training, personnel experience and other factors combine to either enhance or impede effective and efficient collaboration.⁵³

These observations highlight the requirement to conduct focused research to develop appropriate new attributes and metrics based on lessons learned in previous studies. This study could provide new insights and directions to develop the appropriate NCW capabilities.

Convergence of Services' Information Systems.

A further defined NCO-CF with appropriate attributes and metrics will assist in selecting the correct enabling technologies. Information technology and systems will remain the cornerstone of the enabling technologies to create the competitive advantage against U.S. adversaries in the future. Currently, there is a proliferation of waveforms, software, and hardware dispersed throughout the current DoD information system. There should be little doubt that the "to be" DoD information system supporting NCW was based on the convergence and interoperability of the enterprise architecture. Voice, video, and data communications must be seamlessly shared between the services in an interoperable information system. This is the essence of transformational communications.⁵⁴

The GIG-BE became fully operational in December 2005 providing the backbone for a DoD information system to support Joint communications and enable NCW. The services must continue to fund initiatives to integrate and upgrade their information systems. FORCENet (U.S. Navy), Constellation C2 (U.S. Air Force), and LandWarNet (U.S. Army) have the potential to move toward an interoperable Joint communications network supported by the GIG-BE. "Operationally, the foundation of transformational communications rests on four primary supports: the Transformational Satellite Communications System, or TSAT; the Global Information Grid Bandwidth Expansion, or GIG-BE; and the Warfighter Information Network Tactical system, or WIN-T; and the Joint Tactical Radio System, or JTRS."⁵⁵ The JTRS initiative provides the promise of a joint communications system that will support information sharing between the Services. The integration and convergence of Services' information systems and the abundance of disparate waveforms must remain a high priority.

Network-Centric Warfare: Proceed with Caution.

This chapter has demonstrated that NCW is much more than developing an integrated DoD information system on steroids. NCW is more than just technology. NCW is about harnessing the power of information in the operational environment. In order to argue the merits of NCW as more than just information technology it is essential to review the body of literature that supports the fundamental underpinnings of the concept. This paper has provided a brief literature review of the key documents to bring the dialogue on the merits of NCW up to date. NCW is still an emerging concept yet to be fully developed and validated. The recently published Office of Force Transformation NCW case studies begin to illustrate the potential of leveraging information and knowledge on the battlefield. However, there is still much work to be done to demonstrate benefits of NCW at the operational and strategic levels of war.

DoD should continue to aggressively pursue case studies that investigate the relationships in the NCO-CF that deal with the human dimension of warfare. The interaction between the information, cognitive, and physical domains enabled by appropriate technologies should be a priority. There should be collaboration between scholars in the fields of psychology, sociology, and anthropology to examine the implications of NCO on human behavior and leadership. Next, this essay has provided ample evidence that it is time to reexamine the attributes and metrics associated with the NCO-CF. Finally, the Services and DoD must continue to work the "network" in terms of interoperability and convergence of unique applications, waveforms, and information technologies. A clearly articulated action plan for NCW that includes these recommendations will continue to move NCW in the right direction to harness the power of information on the battlefield to support the warfighter.

ENDNOTES - CHAPTER 21

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