



Using the War Room Process To Explore Network-Centric Warfare

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During the last decade, the commercial world demonstrated that significant gains were possible from network-centric computing, i.e., linking computers together over networks to speed transactions, monitor sales and inventories, and identify shifts in customer trends. The Navy realized that this approach could also provide significant military gains. When the Network-Centric Warfare (NCW) concept first appeared, its potential capabilities, possible vulnerabilities, and implementation requirements were not fully understood. The Joint Warfare Analysis Department set up an NCW War Room to increase our understanding of NCW and identify its implications and opportunities for APL. This article describes the development of the NCW War Room and illustrates how insights were gained from the War (or Study) Room analysis process. We also highlight many of the questions and issues that were considered, but do not attempt to present a comprehensive or current discussion of NCW. An innovative procedure adopted in the NCW War Room was the use of a parallel electronic War Room to record the process. (Keywords: NCW, Network-Centric Warfare, War Room.)

INTRODUCTION

Historically, the Navy evolved as a service in which its ships had to be able to operate for long periods of time, alone, as self-sufficient platforms. Before the development of radio at the turn of the century, ships had no way of quickly communicating with shore bases or even with one another unless they were within sight. As a result, each ship was designed as a largely self-contained fighting unit, with its own sensors and weapon systems for self-defense and attack.

This platform-centric approach became increasingly inadequate as airborne, high-speed threats to the Fleet

began to emerge during and after WW II. With the development of high-speed, low-flying missiles, the limited warning time offered by onboard sensors was not sufficient to ensure that ownship self-defense measures would be successful. Developing a defense over the years against this air battle threat ultimately led to the Cooperative Engagement Concept (CEC), which can be viewed as an early version of Network-Centric Warfare (NCW). In CEC, the sensor inputs from a number of ships are networked together and shared, allowing one ship to use the radar sightings from other

ships over the horizon to identify incoming weapons with sufficient time to launch defensive weapons.^{1,2}

The Navy's interest in and appreciation of the value of networked systems has grown during the past 10 years. Chief of Naval Operations (OPNAV) ADM Jay L. Johnson, in an address at the U.S. Naval Institute on 23 April 1997, called this fundamental shift from platform-centric warfare to NCW the most important revolution in military affairs in the past 200 years. These networking concepts were also strongly influenced during the mid-1990s by VADM A. K. Cebrowski while he commanded the portions of the Joint Chiefs of Staff and OPNAV concerned with command, control, communications, and computers (J6/N6), ultimately leading to the concept of NCW. VADM Cebrowski's early briefing on NCW to the Navy War College on 10 June 1997 showed the top-level concept for integrating networks of sensors, platforms, and information grids (Fig. 1), and introduced the concepts of "speed of command" and "self-synchronization." However, specific definitions for these terms were not given, and other questions such as how to build and operate an NCW system were not fully explained. Would there be a single network to which everyone belonged, or would multiple, separate networks be linked together as needed? Would NCW concepts be applied primarily to the sensors and shooters, or did NCW have broader warfighting applicability?

The Joint Warfare Analysis Department (JWAD), recognizing NCW's potential implications for future warfare, decided to use a war room process to gain a better understanding of the concept and identify

opportunities for APL to assist in its development. This article describes how the War Room (or "Study Room") process was used from the fall of 1997 to the summer of 1998 to help explore NCW concepts and potential implications for APL. Our primary emphasis here is to illustrate how the War Room process works and how it can provide insight into a new concept.

THE WAR ROOM PROCESS

The War Room process is a very focused, intense effort to increase our understanding of complex problems, facilitate the visualization and assimilation of data, and understand linkages among those data. It is highly interactive and integrative, enabling a collaborative team to break down complex problems and information processes into comprehensible parts to promote structured dialogue and brainstorming. War Rooms have been used by the military and business communities for years to study new problems and develop new concepts.³

The process has five iterative steps (Fig. 2; see also the article by Heidepriem, this issue). A team, typically comprising about six members representing various areas of expertise, is established to formulate what it considers to be the key questions and issues. The next step is data collection. Published reports, books, and articles have traditionally been the primary source of data; however, paper documents have been supplanted by electric information as the primary source owing to the growth of the Internet and the World Wide Web. In the NCW War Room, printed and electronic sources were used equally.

In the third step, the team analyzes and discusses the data and begins to formulate opinions and answers. They also organize the investigation into a series of topic areas, beginning with, for example, the purpose of the War Room, initial questions, and the efforts of others in the area. Information representing the topic areas is posted on large boards around the room. Typically, foam-core boards 4 × 8 ft high are used, and a war room might contain 10 to 20 such boards. The team can easily gain perspective on the problem and see the entire set of issues by scanning the room. As the team gains more insight, additional boards may be added to reflect new topics.

Initially a board might contain mostly articles from the data collection effort. As the analysis

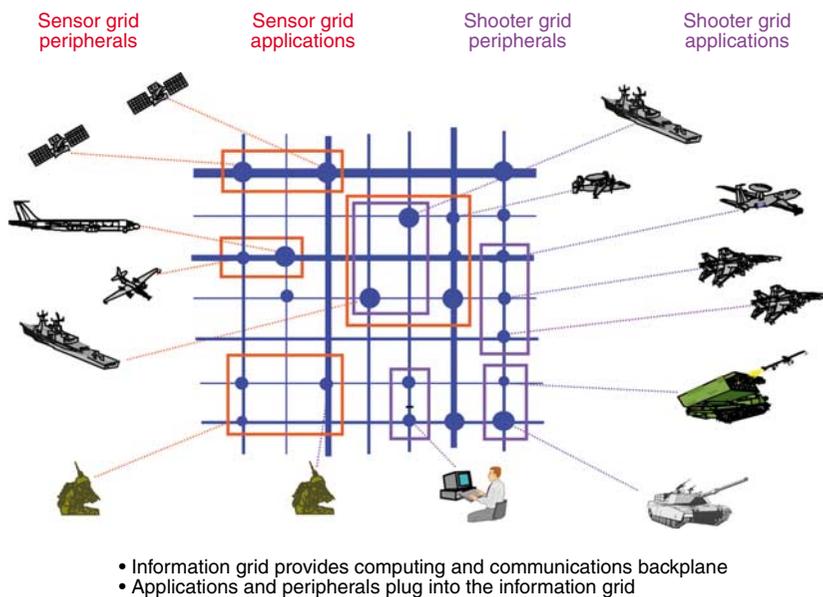


Figure 1. This viewgraph, presented by VADM A. K. Cebrowski at a Navy War College briefing on NCW (Jun 1997), shows a network-centric grid. This early view of the NCW concept left many questions unanswered.

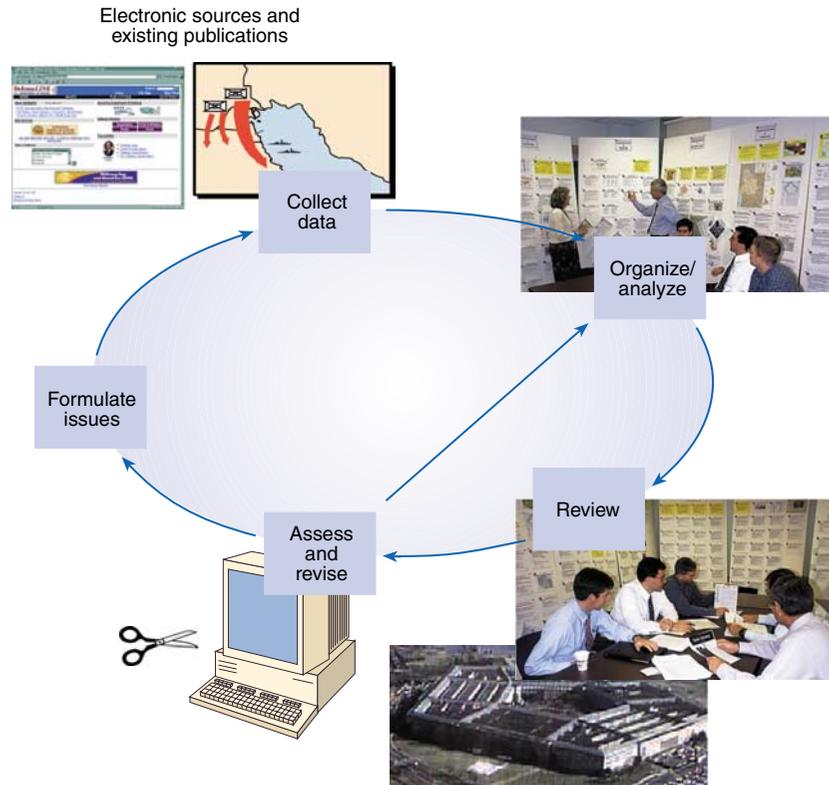


Figure 2. The multistep, iterative process applied within an APL “War Room.”

continues, these articles are gradually replaced by material generated by the team that reflect discussions, analysis, issues, and conclusions. With time, team-generated material begins to dominate. As the understanding of the topic grows, top-level summaries are placed along the top row of the board.

Review is the fourth step, where findings and conclusions are discussed and debated by War Room participants. In the early phases, this review takes place primarily among the team members. In later phases, as the War Room develops, outside visitors are invited and their thoughts are solicited.

The fifth step addresses revisions based on these reviews. Generally revisions are confined to changes to existing boards (deleting, modifying, or adding material). Sometimes the team finds its view has changed so much that the original topic areas are no longer appropriate. At this stage, the War Room may be completely rebuilt, often with totally new topic areas. The NCW War Room was rebuilt three times during the 9 months of the study. Although such redesign represents a greater understanding of the problem, it may lose the historical record of the process. Many figures from the previous version of the War Room are not used, while others are substantially changed. To preserve the history, a new technique was developed whereby an electronic version of the War Room

(discussed in more detail in the next section) was maintained in parallel to postings on the board.

This five-step cycle of the War Room process continues until an adequate understanding of the new concept is developed. The final version of the NCW War Room had 11 boards:

1. What is the purpose and organization of the room?
2. What is happening with NCW in DoD (Navy vision)?
3. What are DoD and other services saying?
4. NCW and Joint Vision 2010
5. Urban Warfare and Operational Maneuver from the Sea
6. Communications
7. Past and current systems and experiments—What can be learned?
8. APL current summary: NCW directions
9. APL analysis approach
10. Modeling NCW
11. What should APL do?

ELECTRONIC NCW WAR ROOM

Since much of the material posted in the physical War Room was in the form of hard copies of PowerPoint slides or Word documents, it was easy to simultaneously store it in an electronic War Room. Just before a major redesign of the physical War Room was done, the electronic version could be “frozen” as a permanent record of that state of insight, and a new electronic version was started to parallel new developments.

At each of these times, electronic copies of the viewgraphs in the War Room were collected. Simple, built-in procedures enabled conversion of these PowerPoint pages rapidly into html documents ready for viewing on the Web. A framework re-created the War Room’s breakdown of the major categories of information arranged on separate boards within the room. Hyperlinks made it easy for users to move among sections and to other boards from any point within a given board.

The electronic version of the War Room allowed linking to Web sites that had contributed to the development of the team’s understanding of NCW. Many of these sites provided additional avenues of investigation. Some also presented clearer views of material than could be presented on paper. Figure 3 shows a representative sample of the electronic NCW War Room media available to participants.

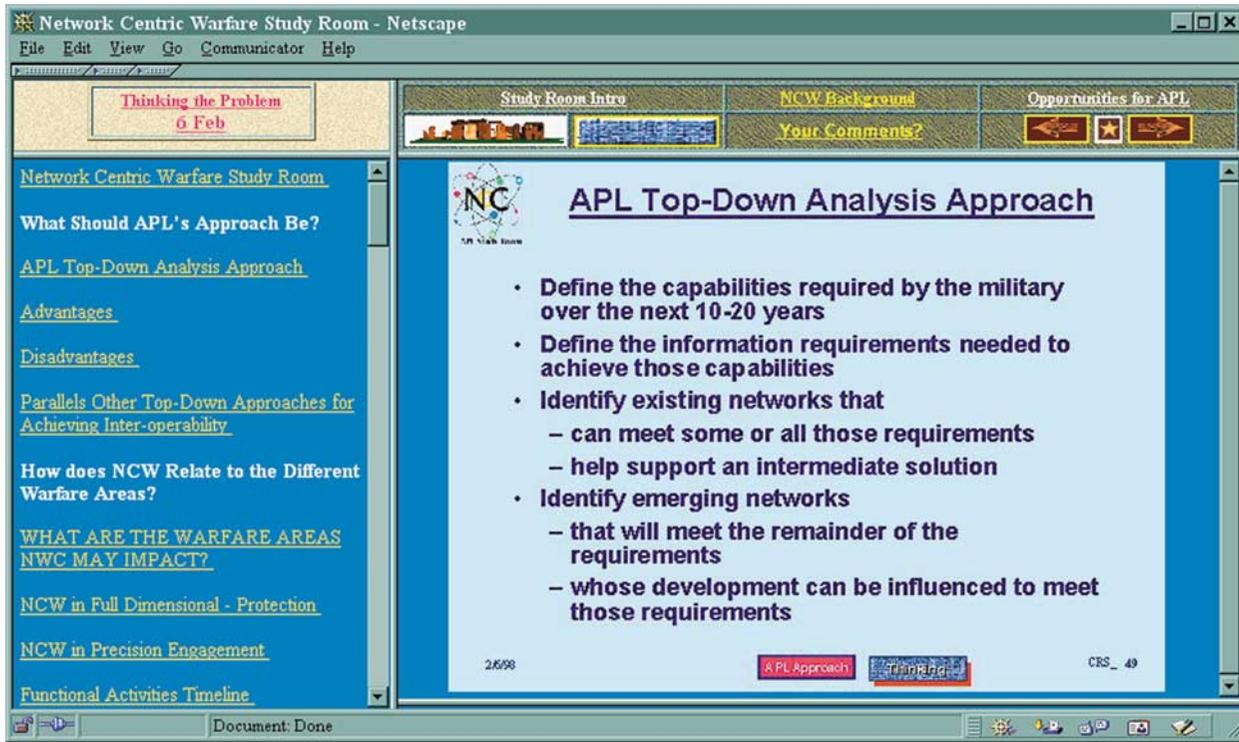


Figure 3. Electronic NCW War Room slide drilldown.

APPLICATION OF THE WAR ROOM PROCESS TO NCW

In the initial phases of development, the War Room team identified the following top-level objectives:

- Develop an understanding of NCW and what it means to naval and Joint forces
- Develop an approach to design, build, test, analyze, and use NCW systems
- Identify what may be missing from the NCW concept
- Identify applicable expertise at APL
- Determine the appropriate next steps

The biggest issue the team faced at this stage was how to organize the study effort. Three approaches were considered. The first—examine current systems and networks and determine how they would fit into a NCW environment—was rejected as too lengthy because so many military systems and networks were already in place and more were under development. The second—examine current military operations and determine how they could be helped by NCW—was rejected because it was viewed as solving today's problems rather than looking to future issues. The third approach, which was considered a top-down analysis approach, was adopted; i.e., examine future military capabilities and determine how NCW could help achieve them. As shown in Fig. 3, this approach was

to examine the capabilities required by the military over the next 10–20 years, define the information requirements needed to achieve those capabilities, and identify the required networks, both existing and emerging.

The concepts of NCW, speed of command, and self-synchronization, previously put forth by VADM Cebrowski, were discussed in the early phases of the War Room. Rather than trying to strictly define these terms, it was decided to concentrate on identifying the operational characteristics that would be associated with NCW. The team felt that speed of command had three elements: speed of decision, speed of communication of those decisions, and speed of effective implementation of those decisions. Self-synchronization was considered to be a bottom-up implementation of a plan of action rather than a top-down command synchronization of the plan, but the requirements for effective self-synchronization and the prevention of bottom-up chaos under all circumstances were unclear during early discussions.

The team decided that the capabilities required by the military over the next 10–20 years would be best described in terms of the *Joint Vision 2010* (JV2010) concept, which has four cornerstones or pillars—full dimensional protection (FDP), precision engagement (PE), dominant maneuver, and focused logistics—all resting on a base of information superiority.⁴ FDP

means that we can protect all of our forces. PE means that we can successfully strike the enemy, assess the damage, and reengage if necessary. Dominant maneuver means that we can accomplish PE with dispersed forces that can rapidly maneuver where needed, with the PE providing the effects of massed forces. Focused logistics means that we can provide logistics support where and when needed as a tailored package, without lengthy delivery times or the formation of large logistics bases that may serve as enemy targets. Finally, information superiority means that we have superior knowledge about enemy force locations and intent.

The JV2010 paradigm provides a solid foundation for addressing many questions about NCW: Does NCW only apply to the sensor-to-shooter link (the PE pillar) or to all aspects of JV2010? If so, are the requirements and benefits of NCW different for the different JV2010 pillars? Is NCW Navy-only, or does it apply to the Air Force and Army as well? If Navy-only, how does it relate to the future Joint environment?

JV2010 AND NCW

As the team assessed NCW in terms of JV2010, differences in the way the concept might apply to each of the four pillars became apparent. The FDP pillar can be viewed as primarily defensive warfare. FDP is time-critical; with an incoming missile, you have to respond quickly to avoid being hit. FDP also requires defensive systems that are operational 100% of the time since timing of enemy attacks cannot be predicted. Consequently, an NCW system supporting FDP must be highly reliable, contain high-quality data with minimal data uncertainty/ambiguity, concentrate on the present, and have a high data rate that requires decision support tools that operate faster than real time.

The PE pillar represents the “system of systems” used to locate, identify, and attack enemy targets. PE requires responsive command and control (C²) of Joint forces, accurate target classification and location, target prioritization, and flexibility to reengage (speed of battle damage assessment). NCW support of PE requires extensive networks of sensors to resolve targeting issues and rapid, flexible communications to coordinate shooters. Because timing of our attacks can be controlled to some extent, the 100% duty cycle and time-critical requirements seen for FDP can be somewhat relaxed.

Dominant maneuver requires rapid and effective coordination among widely dispersed forces. All commanders must understand the battle situation and the Commander-in-Chief’s intent, and be able to adjust accordingly to carry out those intentions in the face of changing battle conditions. In this pillar, NCW requires a communications network that allows rapid communications among the different forces involved in the mission.

Focused logistics must provide supplies when they are needed at the right place, at the right time, and in the right amount. Commanding officers must know the location of all supplies as well as the location and status of fighting units. In this pillar, NCW systems must yield extensive connectivity among the various combat support commands, stretching from the battlefield back to the continental United States.

The team’s conclusion was that NCW applies to all four pillars of JV2010, not just the sensor-to-shooter link, and it also has the potential to offer increased support to all aspects of JV 2010. However, it was clear that NCW requirements for each pillar were different in terms of reliability, connectivity, and speed of the communications networks. There also seem to be differences among NCW requirements for different platforms. For example, FDP appears to be much more critical for naval and ground units where they cannot quickly withdraw from the battlefield if networks go down. In contrast, air units can generally quickly exit the battle area if necessary.

PYRAMID STRUCTURE OF MAJOR NCW ISSUES

As the NCW War Room continued to develop, several issues covering a wide variety of areas were identified. As the number of issues grew, the team began to look for a way to organize them. In the final phase, the team developed a pyramid structure for organizing the main issues, which helped to characterize the nature of the specific issue (e.g., whether it was a technical, organizational, or doctrinal issue; see Fig. 4). A number

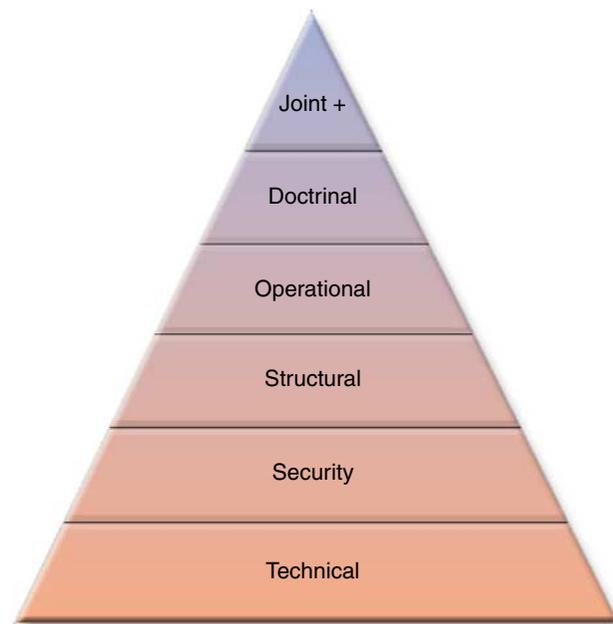


Figure 4. Major issues in NCW (see text for details).

of issues were identified at each level of this pyramid and are described here briefly. In some cases, the team was able to formulate an answer, whereas in other cases, they could not. The pyramid structure also makes it clear that NCW has many dimensions; it does not simply link together networks, information warfare, or sensor-to-shooter links. (See also Heidepriem, this issue, who describes the pyramid from a slightly different perspective.)

At the base of the pyramid are technical issues like bandwidth requirements, network protocols, and the question of whether NCW requires that everyone be on the same network. Several concerns were expressed here. How much bandwidth is required for information exchange? How do you validate the NCW system for robustness, reliability and accuracy? What are the implications of chaos theory for network system stability and predictability for the large networks that will be associated with NCW?

As to whether the concept requires a single, comprehensive network, the team concluded that NCW will use a "network of networks" for at least the next 10 to 20 years. Many networks are already under development, and there is no convincing case yet that a single comprehensive network is required. Even if NCW does require a single network, the technology for it is not yet in hand.

Another conclusion was that the adoption of current commercial network technologies would not fully satisfy the requirements of all DoD networks. For example, the ethernet solution to message collision, i.e., delaying messages for some random time before re-sending, is not acceptable for time-critical networks, and some DoD operations such as CEC require predictability and precise control over operations.⁵

Other questions arose about emerging DoD communication trends and the need for high-bandwidth and low-latency communications. DoD is increasing reliance on space-based and commercial systems. The newer systems offer a significant increase in bandwidth availability, but the bandwidth demands for high-resolution graphics, faster update rates, and more users and links are also increasing. "New" DoD bandwidth users include the medical community (telemedicine) and logisticians (Joint total asset visibility). Latency requirements can become important for time-critical military missions, e.g., calls for fire support, where even small delays in communications can seriously threaten mission success.

The next level in the pyramid is security, which addresses attacks against the network and network vulnerabilities. What are the vulnerabilities of NCW systems to enemy attack? Two major security issues were discussed. First, does use of a global network in NCW give the enemy a broader front on which to attack, and how would global attacks against the network be

detected? Second, would denial of services at critical times be sufficient to defeat NCW?

The structural level contains issues about information overload and whether NCW will require data push (data automatically sent to end users), data pull (data requested by end users), or a combination. Questions frequently raised by team members and visitors concerned the amount of information each person on the network would have access to and whether there was a risk of being overloaded by too much data. Would they have unrestricted access to the entire network, or would they be restricted to only portions of the network?

The team's conclusion was that NCW will require a combination of data push and pull. In short, FDP is a data push issue, dominant maneuver and focused logistics are data pull issues, and PE is either, depending on the phase of the mission. The planning phase, especially for logistics and dominant maneuver, will be heavily oriented toward data pull. For example, the location of spare parts will most likely fall in the category of data pull; there is no need to tie up bandwidth by broadcasting the location of spares as long as users can quickly pull the data when needed. The Internet paradigm will probably be used for information pull, with information posted on Web-like pages for access and intelligent agents used to continually search for relevant information sources. On the other hand, weather data will probably fall under the category of data push since these data are critical to so many military operations. Since FDP is time-critical, as discussed earlier, it will probably rely heavily on data push to avoid unnecessary time delays in requesting the needed data. PE will probably rely more on data pull in the early planning phase, but move more to data push during the execution phase.

A whole variety of other structural questions also exist. Who will control access to information? How does one control and update data stored in different databases? How does one perform data fusion and resolve data ambiguities?

The next level of the pyramid concerns operational issues. As businesses move toward network-centric operations, many processes such as re-ordering are being automated, resulting in both significant cost savings and faster responsiveness. This finding raised the question of whether some military C^2 processes would have to be automated to achieve the required speed of command. As expected, this was a controversial issue, with concerns that automated C^2 could lead to serious mistakes, such as firing on the wrong target. The issue was resolved in an early 1998 article where Cebrowski and Gartska⁶ asserted that automated C^2 is required at the lower levels to achieve the required speed. They defined speed of command as the process by which a superior information position is turned into a competitive

advantage having three parts: (1) achieving information superiority, (2) acting with speed, precision, and reach to achieve massing of effects rather than forces, and (3) locking out the enemy options. Self-synchronization was defined as the ability of a well-informed force to organize and synchronize complex warfare activities from the bottom up.

Although much insight had been obtained by the NCW War Room team through their own efforts and through contemporary publications related to NCW, many other operational questions remained. The requirements for achieving speed of command and self-synchronization were still not clear. How does self-synchronization avoid becoming bottom-up chaos? Can the visibility offered by NCW to all levels of command lead to top-down micromanagement? With the network linkages, do all command functions have to be geographically co-located, or can they be spread around the world? Can additional personnel at other geographic sites be linked into the command structure when required because of high workload demands? If the C² structure comprises personnel at different geographic sites linked together by the networks, is adaptable, reconfigurable C² essential for NCW? What happens to C² relationships in this type of environment?

The doctrinal level contains issues concerned with how one conducts operations in an NCW environment, e.g., strategy and tactics, C² architectures, and legal issues with automated C². Is doctrine adequate for the NCW environment? What are the legal implications of automating C² at lower levels, especially if they involve weapon firing decisions? How would responsibilities be tracked/assigned in a network environment? Another issue is whether NCW is a cost reducer as in the commercial world or whether it will cost more to implement? How should NCW be analyzed from an affordability perspective?

The top level of the pyramid, Joint +, addresses the fact that NCW cannot be Navy only, but must fit into the Joint environment of Army, Air Force, and Marines as well as with other government agencies like the State Department. How we employ NCW in coalitions with our allies is another issue at this topmost level. DoD relies on allied and host nation support in areas such as intelligence, warfighting, and logistics. If this support is not NCW-compatible, it may represent the limiting factor in warfare gains. Significant issues such as technological compatibility and security in incorporating allied and host nations into an NCW environment also exist.

MOVING TOWARD NCW

The NCW War Room identified a means to move from the current qualitative NCW vision to a quantitative view. Because NCW will require the acquisition

of new Navy and Joint systems, quantitative estimates of the improvements offered by NCW will be needed to justify these acquisitions. An integrated, three-part approach is suggested (Fig. 5):

1. Conduct wargames and Warfare Analysis Laboratory Exercises (WALEXs)
2. Conduct experiments, field exercises, and demonstrations
3. Develop a modeling capability

These three steps should be done concurrently to allow feedback and "lessons learned" to be shared.

Wargames

NCW requires new concepts of operations, new doctrine, strategy, tactics, and training. Wargames and WALEXs provide good environments in which to explore and develop these areas. The Naval War College conducted a major wargame, Global 98, in the summer of 1998 to better understand what NCW meant in operational terms.

Global 98 answered many of the questions and confirmed some of the conclusions from the NCW War Room, and provided many additional insights as well.⁷ The following examples represent just a few of the findings from Global 98, sorted following the pyramid structure of Fig. 4. At the technical level, NCW must include accuracy, reliability, and ease of comprehension as key elements, as well as high data rates. At the security level, the need to protect the networks and the information on them was recognized. Connectivity was identified as an unknown issue that required more research. Many of the elements of connectivity were similar to issues at the structural level and included network capacity, an understanding of the explicit

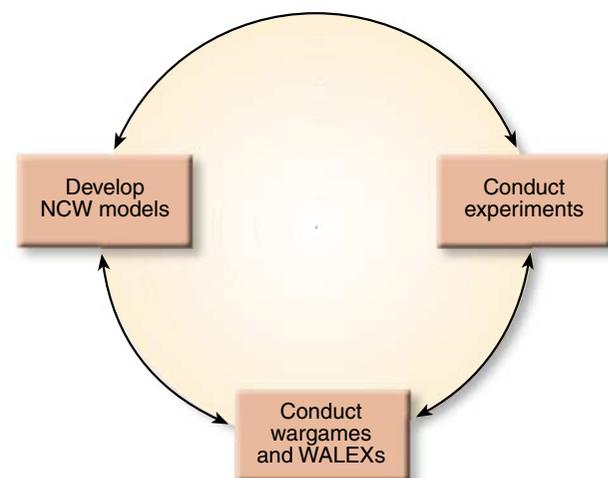


Figure 5. An integrated approach is needed to yield quantitative estimates of improvements offered by NCW. All three steps are concurrent.

value of sharing information to combat outcomes, and the relationship between government-owned and commercial systems.

At the operational level, a consensus formed that many decisions relating to weapons release would be automated. Global 98 also developed the concept of the common operational picture (COP) as a key element in NCW. The COP is not simply a static picture of the current situation, but rather an evolving picture that connects the current situation with desired outcomes and projected trends. It was also recognized during Global 98 that all participants do not have to see the same COP, but that the COP does require common databases with reliable and accessible data. The COP was seen as a key element for ensuring effective self-synchronization.

Global 98 further refined the definition of speed of command to include the communication of orders as well as a set of actions to be taken on the basis of those orders. These elements are similar to two proposed earlier by the NCW War Room team: speed of communication of decisions and speed of effective implementation of those decisions. One surprising insight from Global 98 was that speed of command can sometimes be too fast, causing the adversary to feel backed into a corner, possibly resulting in the enemy's use of weapons of mass destruction.

At the doctrinal and Joint + levels, Global 98 made it clear that NCW will be conducted jointly and with our allies and coalition partners, and that organizational and doctrinal changes will be needed.

Global 98 did not explicitly address NCW from the perspective of the JV2010 pillars, but it was clear that the concept was broader than just the sensor-to-shooter linkage. Logistics delivery issues were identified as potential limiting factors in achieving the speed envisioned in NCW, but information superiority and speed of command were seen as allowing a smaller force to be deployed in time to lock out enemy options, reducing the demands on the logistics system.

Experiments

Experimentation is another tool to help move toward NCW. Experiments should be designed to test specific NCW issues and provide quantitative results. It is here that models and new doctrine are also validated. For example, what happens when an operational force equipped to conduct NCW is faced with new operational situations (e.g., major portions of the network go down) or is given new types of missions? The shortcomings of experiments are that they are very expensive, very time-consuming because only a few cases can be run, limited in scope, and limited to actual conditions during the experiment.

Modeling

Modeling offers a way to help extend the value of experiments and field exercises by yielding estimates of what would have happened under a different set of conditions. It provides a road map for cost-effective systems development, helps identify critical experiments, and guides system design. No comprehensive model for NCW is in development; however, a possible modeling approach was suggested that could provide some analytical insight into NCW. As noted earlier, the NCW War Room team concluded that the concept applies to each pillar of JV2010. Models of the individual pillars exist (e.g., campaign-level, mission-level, logistics, communications models, etc.). If appropriate models of these pillars could be linked, the resulting coupled model could provide an analytic capability to examine some NCW issues such as bandwidth requirements or sensitivity to variations in the speed of command.

Figure 6 shows what these linkages between NCW and JV2010 might look like. All the pillars overlie a common C⁴ISR (C², computers, communications, intelligence, surveillance, and reconnaissance) infrastructure, with exchange of information going both ways. However, there is typically a unidirectional flow of causal effect. For example, FDP requires PE to operate. PE and dominant maneuver both require logistics support. Focused logistics and dominant maneuver both depend on FDP to stop enemy attacks. Dominant maneuver—the concept of dispersed forces with massed

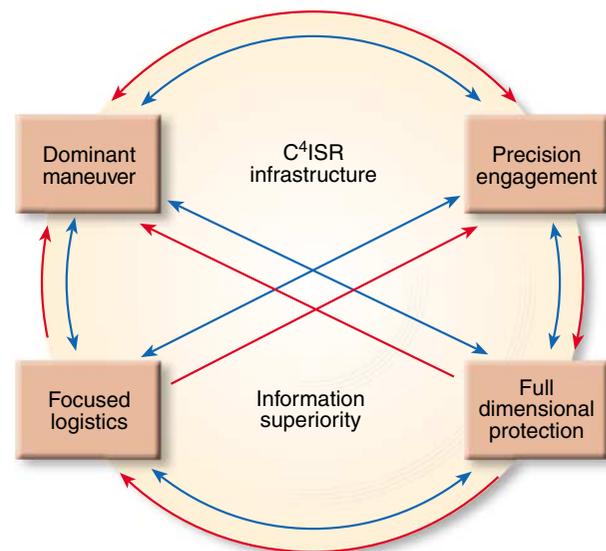


Figure 6. Modeling NCW and JV2010. Blue lines indicate information flow; red lines indicate causal effect. (C⁴ISR = command, control, communications, computers, intelligence, surveillance, and reconnaissance.)

firepower—enables PE, but it also *requires* PE. This duality accounts for the two-headed arrow between them in the figure.

SUMMARY AND FINDINGS

The War Room process provided significant insights about NCW. The concept will be fundamental in future warfighting and has the potential to offer significant gains to DoD if implemented broadly and properly across the pillars of JV2010. NCW is broader than simply sensor-to-shooter linkage and involves all the services. To define and more fully understand this new concept, an integrated approach should be followed that includes wargames, experiments, and modeling. The maintenance of a parallel electronic War Room was a new technique that proved very effective in maintaining a record of progress over time.

Many of the insights from the NCW War Room were confirmed during the Global 98 War Game, which demonstrated that NCW spans a broad range, similar to that shown in Fig. 4. Both Global 98⁷ and VADM Cebrowski, in an address to the Naval War College Faculty on 1 March 1999, have called for more wargaming and experimentation to further develop the NCW concept. Modeling has been recognized by the DoD C²

Research Program⁸ as an important tool in the process of moving toward NCW.

In summary, the War Room process has been shown to be a powerful tool for early exploration of complex concepts like NCW, providing the interactive, integrative environment needed to develop a broad perspective and understanding of the new concept. The introduction of the electronic War Room further enhances the value and strength of the process.

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