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14. ABSTRACT

Network Centric Warfare has been identified as the manner in which the Joint Force will operate in the 21st Century. Six years after VADM Arthur Cebrowski proposed the road to a netted force, we are able to examine the progress toward the attainment of that goal. To achieve its goals of speed of command and self-synchronization of the forces, NCW integrates three grids into a combined picture aimed at simplifying the planning and execution processes. The information of these grids is merged into a common operating picture which is to be a coherent picture of the battlefield. Independent production and development of networks by the various branches of the military service has caused the COP to receive its information from systems which have been produced in a 'stove pipe' and don't truly integrate into the COP. The current challenge for the Joint Force is to achieve the ordered objectives with a smaller force while increasing speed and effectiveness of mission accomplishment. Network Centric Warfare must facilitate the Joint Force Commander's achievement of the Joint Vision 2020 mandate of full spectrum dominance and enable his expediency of command which is integral in the effective conduct of operations across the military spectrum. NCW architects are successfully proceeding to develop the tenets of speed of command and self synchronization by providing technologically advanced sensors and systems. However, they must not lose sight of the fact that NCW technology must enable operational art and aid in the commander's ability to synchronize fires and maneuver along with the available instruments of National Power to achieve the objective.

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NETWORK CENTRIC WARFARE – A TOOL OR HINDRANCE TO THE OPERATIONAL COMMANDER

By

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature: _____

09 February 2004

Abstract

Network Centric Warfare has been identified as the manner in which the Joint Force will operate in the 21st Century. Six years after VADM Arthur Cebrowski proposed the road to a netted force, we are able to examine the progress toward the attainment of that goal. To achieve its goals of speed of command and self-synchronization of the forces, NCW integrates three grids into a combined picture aimed at simplifying the planning and execution processes. The information of these grids is merged into a common operating picture which is to be a coherent picture of the battlefield. Independent production and development of networks by the various branches of the military service has caused the COP to receive its information from systems which have been produced in a 'stove pipe' and don't truly integrate into the COP. The current challenge for the Joint Force is to achieve the ordered objectives with a smaller force while increasing speed and effectiveness of mission accomplishment. Network Centric Warfare must facilitate the Joint Force Commander's achievement of the Joint Vision 2020 mandate of full spectrum dominance and enable his expediency of command which is integral in the effective conduct of operations across the military spectrum. NCW architects are successfully proceeding to develop the tenets of speed of command and self synchronization by providing technologically advanced sensors and systems. However, they must not lose sight of the fact that NCW technology must enable operational art and aid in the commander's ability to synchronize fires and maneuver along with the available instruments of National Power to achieve the objective.

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Technology has drastically changed the manner in which military operations are conducted, and no where is this more apparent than in the American Way of War of the 21st century. Joint Vision 2010 began the transformation process of America's Armed Forces in 1995 by providing the Joint Force with the template for operational command and control for the new age. This template for command and control (C2) revolved around four key operational concepts: Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-dimension Protection.[i] Joint Vision 2020 re-affirmed the four pillars contained within JV 2010 and further focused the aim by emphasizing the criticality of interoperability of U.S. information operations with potential allied and coalition partners.[ii] Network Centric Warfare (NCW) is not only the enabler for this revolution in military affairs which former Chief of Naval Operations ADM Jay Johnson described as a transition from platform-centric warfare to a system of collective engagement.[iii] It is a system for warfare utilized across the spectrum of military operations which enables the commander to attain full spectrum dominance.[iv]

Six years after VADM Arthur Cebrowski proposed the road to a netted force, we are able to examine the progress toward the attainment of that goal. Network Centric Warfare, in its purest form, maximizes command and control warfare and information operations by providing the Commander with an omniscient view of the battlefield and all its operational aspects. In an age of remarkable technological advancements with an abundance of information, the commander is able to assess the battlespace through a variety of multi-spectral and multi-perspective systems and derive a decision. The difficulty often encountered is the effective management of systems and information employed to streamline the decision process and maximize the capabilities of NCW. The

abundance of information available to the commander may be detrimental if not managed effectively; thus, a differentiation between useful and excess information required for a decision must be carefully made. The process used to make this distinction is an art inherent to NCW and must be exercised to prevent information overload. Recent operations in Afghanistan and Iraq, as well as those in Kosovo, have challenged the command and control doctrine of NCW components and have tested the systems developed to net the force. These operations have produced a plethora of lessons learned which are helpful in providing an evaluation on the progress of the U.S. military's transformation to a network centric force. Prioritization of sensor assignment, fusion of battlespace information into a common operation picture and communication among the forces in the battlefield are some of the lessons examined in this paper. This evaluation will focus on the command and control aspects of the various components of NCW and the supporting architecture which enables the tenets of speed of command and self-synchronization.[v]

Joint Vision 2020 provides NCW architects with a frame work on which to develop the concept. The common operation picture or "COP" attempts to provide military commanders with a powerful system of uninterrupted access to the battlefield at all levels of war; however, the COP is often built from various systems woven together through "work-arounds" and at times lacks the necessary fidelity required for the commander to truly exploit the potential of NCW in order to facilitate expedient decision making. It is argued by some that the COP combined with other near-real time communication systems such as Microsoft © Chat, coalition "Same-Time" Chat, and Battle Force Email, to name a few, may tempt the commander to micromanage a situation

thus negating the C2 doctrine of centralized planning and de-centralized execution. The commander, though, maintains overall command and supports de-centralized execution by meticulous crafting of the critical information requirements (CCIR), a process explored later in this paper. The near-real time connectivity which NCW strives to provide can be a powerful tool which will enable operational commanders and their staffs to accelerate the decision cycle. NCW's origin and its components must be reviewed in order to assess its progress. The command and control structure of the Operational and Tactical levels of war in a joint and coalition setting will also be examined to determine how NCW is addressing the Joint Vision challenges.

BACK TO BASICS

NCW affects the entire spectrum of military operations from combat to military operations other than war (MOOTW). While a vast number of individuals focus on NCW as it pertains to the conduct of war and combat operations, NCW and its capability begin well before and may affect the decision of whether or not a situation will necessitate an escalation into combat operations. The tenets of NCW are: 1) To allow our forces to develop speed of command, and 2) To enable forces to organize from the bottom up and self-synchronize to meet the commander's intent.[vi] To achieve these goals, NCW integrates three grids—sensor grid, information grid and engagement grid—into a combined picture aimed at simplifying the planning and execution processes (fig-1). An examination of these grids and their challenges follows.

THE SENSOR GRID

The first component of NCW is the sensor grid. Sensor grids rapidly generate high levels of battlespace awareness and provide the information utilized to synchronize

awareness with military operations.[vii] Unmanned vehicles such as aerial (UAV) and undersea (UUV), as well as the various space capability platforms and nets such as Cooperative Engagement Capability (CEC) provide the United States military with an unrivaled awareness of the battlespace. Their long-dwell characteristics provide the operational commanders and their staffs with an unprecedented detection capability in high threat areas.

Network Centric Warfare Grid

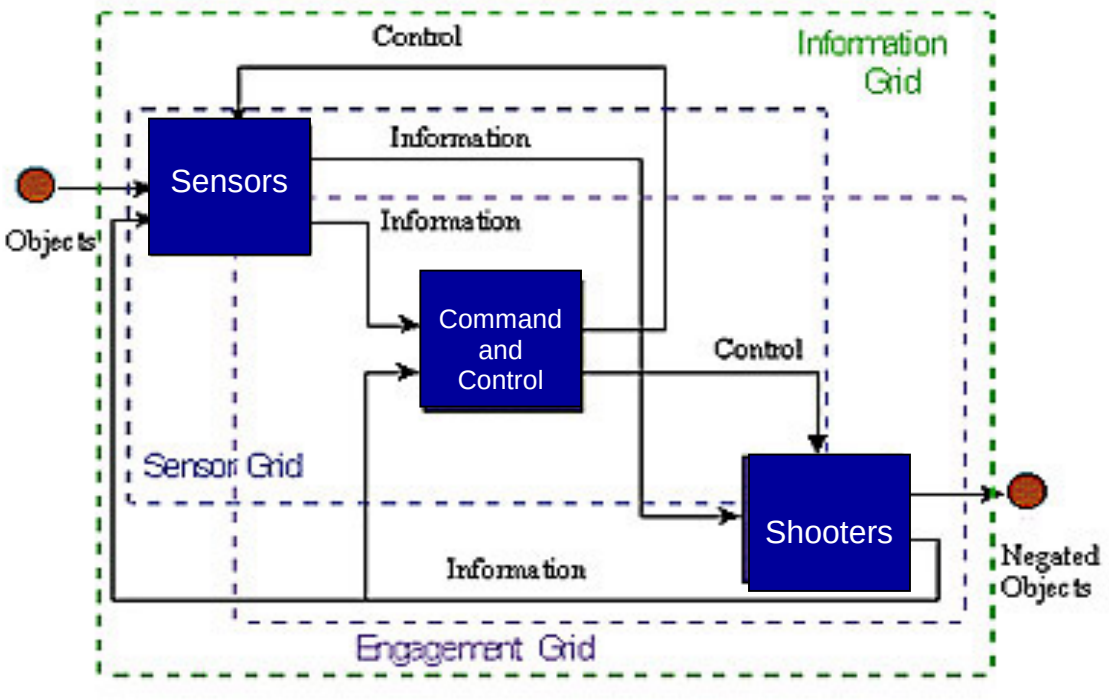

Figure-1[viii]

The challenges when utilizing these systems are the command, control and prioritization of the sensor's availability, as well as the ability of the various sensor networks to integrate their information into the COP. These issues affect the relationship of the utilization of the various sensors and their ability to enable the intelligence cycle[ix] with their information. Vehicles such as Global Hawk have vastly increased the

information gathering capability of the intelligence community. Equipped with Electro-Optic (EO) equipment and synthetic aperture radar (SAR) among other surveillance systems, the High-Altitude and Long-Endurance (HAE) UAVs are capable of providing a wide area search of up to 40,000 sq NM and are able to provide up to 1900 spot images per mission.[x] The amount of information capable of being gathered by these assets greatly increases the effectiveness of the intelligence cycle. "The intelligence cycle is the process by which information is obtained, converted into intelligence, and made available to the requester…five steps in the cycle include planning and direction, collection, processing, production, and dissemination. Understanding the intelligence cycle and how it feeds into NCW enables the Joint Forces Commander (JFC) to use reconnaissance, surveillance and target acquisition (RSTA) assets more effectively."[xi] However, this increased capability poses several challenges. The challenges of sensor integration into NCW are similar to various RSTA platforms and should be addressed. The focus here will be on unmanned vehicles and the challenges of prioritizing their mission and the distribution of their information once it has been collected.

The first challenge of the employment of these sensors is in the command and control of the vehicles and how this affects their tasking priority. These vehicles, like various other platforms, possess capabilities and sensors that make them valuable to both the intelligence and operational directorates of a unit or staff. These vehicles were originally developed with an emphasis on their intelligence capabilities, and thus, their control directly affects the intelligence cycle in the planning, direction and collection of intelligence. Joint Publication 3-55.1 is the governing authority on procedures for UAV mission assignment. The document states that the JFCs will assign missions to UAVs

through Service component commanders; it does not, however, provide clear guidance on procedures to set the tasking priorities.[xii] Prioritization of the assets is delegated to the collection manager and the RSTA cell on a JTF. Competition for these assets is keen between the Intelligence and the Operations directorates and consequently, without clear guidance on prioritization procedures, there is a risk of assigning the UAV to a mission where the vehicle's contribution will be less valuable. For example, if a sensor detects a target of opportunity during a collection mission and the target is assessed as critical, does the sensor now become an operations directorate controlled vehicle utilized for the engagement, or does it remain an intelligence asset and continue with the collection plan? A doctrinal gap exists in that there is no clear guidance on establishing the priority for such a situation, and the answer is situation or staff dependent.

The second challenge of these sensors is the processing and production of the intelligence. Converting the amount of information that is gathered by UAVs into actionable intelligence is a challenge within itself. Technological advances and increasing political instability are stressing the resources of the intelligence community. The amount of information an HAE UAV is able to provide may be unable to be exploited due to the sheer volume that would have to be processed and the lack of personnel available to process the information. During Operation Enduring Freedom in Afghanistan, the Global Hawk missions required an Air Force Intelligence team of approximately 500 personnel from various intelligence fields. The increasing demand for UAVs and advances in technology may have the potential of driving the military to a position in which too much information is being gathered and is unable to be exploited and converted into actionable intelligence. In addition, the amount of personnel required

for the exploitation of the collected information is of great concern to the services. In the Navy, for example, the amount of personnel required to control and analyze the UAV information will not be practical for any naval unit. Scarcity of available bandwidth suggests that UAVs will likely operate in a line of sight manner requiring the control and analysis components to be located in the immediate area of operations. If, for example, a UAV mission is launched from a ship, the ship may not be able to accommodate the UAV support personnel required due to restrictions on available berthing. The number of personnel in a UAV detachment may also affect the mobility of Army and Marine elements involved in similar missions.

The final challenge of these sensors is the dissemination of the collected information. The information is displayed within a network of similar sensors which has caused a cultural change within the military. Information is no longer held locally by the sensors as it was during the platform-centric period of warfare. The issue, which will be explored further in the information grid section, is the fusion of the sensor information for display to the entire force. The number and variety of sensor networks challenge NCW architects with devising a COP system which is compatible with the various sensor networks in existence.

THE INFORMATION GRID

The second component of NCW is the information grid. The information grid enables the operational architectures of the sensor and engagement grids,[xiii] and is where the COP becomes an essential component of NCW. The commander's full spectrum dominance is achieved mainly through information superiority. Military operations are much like a game of chess. In chess both opponents are able to see the other's game

pieces. Though an essential part of the game is seeing all the game pieces, it is not the key to victory. The art in achieving victory lies in the knowledge and understanding of the capabilities of the opponent's pieces. Understanding the alternatives and capabilities available to the opponent with each piece and how the movement of that piece will affect the overall outcome is the art of the game. The COP becomes the chess board in Network Centric Warfare and modernizes the art of war for the commander, allowing him to concentrate on the decision process with the confidence of full spectrum dominance of the battlespace. In theory, the COP's aim is to fuse all of the battlespace information and provide the commander with continuous access to all elements and all levels of war –strategic, operational and tactical. However, as Jomini explains, there is a difference between the theory and the practice of war.

> *One of the surest ways of forming good combinations in war should be to order movements only after obtaining perfect information of the enemy's proceedings. In fact, how can any man say what he should do himself, if he is ignorant of what his adversary is about? As it is unquestionably of the highest importance to gain this information, so it is a thing of the utmost difficulty, not to say impossibility and this is one of the chief causes of the great difference between the theory and the practice of war*.[xiv]

In practice, the fog of war is difficult to eliminate. Tenuous information will remain present regardless of advancements in technology. Effective sharing of the information across the strategic, operational and tactical levels of war will allow the force to build on the tenuous information to eventually yield actionable intelligence. Some have argued that the existing hierarchical command structure should be modified in order to streamline and speed up the decision cycle inherent to NCW. This reasoning is flawed. The existing levels of strategic, operational and tactical commands are required to ensure the achievement of doctrinal de-centralized execution of events. These levels are

necessary for the coordination and the achievement of the goals set forth by the political leadership in situations where the military becomes involved. The challenge for the COP is to merge all the necessary information into a collaborative environment where the individuals at the various levels work to eliminate the fog of war. The commander exercises the modern art of war by anticipating the elements required to yield an effective COP by meticulously crafting his critical information requirements. The commander's critical information requirements (CCIRs) yield the priority information requirements (PIRs), which are disseminated throughout the battlefield, and in turn, drive the intelligence assets. These information requirements should be drafted with sufficient detail and in such a manner that when met, they begin the decision cycle. Whether the decision is to take action or to simply monitor the situation as it develops, remains the commander's prerogative.

THE ENGAGEMENT GRID

The final component of NCW is the engagement grid. Engagement grids exploit sensor awareness and translate that into increased combat power.[xv] The idea of a netted force suggests that a weapon will be within striking range of any target at any given time. The proliferation of precision guided munitions (PGM) and improvements in the navigational and target locating systems, support the idea that a Network Centric Force is smaller, more effective and possesses an increased lethal capability. ADM Reason, former CINCLANTFLT, predicted that a Naval force equipped with advanced strike capability "…will not need as many pieces of ordnance to provide the requisite explosive power for target destruction...[c]ombatant ships will be carrying what they need for the fight….[and] there will be a less critical requirement for replenishment ships to haul

ammunition.…Naval ships will be cheaper and simpler, more lightly manned…as components of a larger force dispersed over a wide area…[S]uch a force avoids the risk of presenting a few expensive, massive targets to WMD."[xvi]

ADM Reason's thinking did not foresee the true relationship that has emerged between the advancement of sensors and the required munitions for the achievement of the mission. Recent experimentation has shown that forces which possess increased targeting and advanced strike capability find an abundance of targets which supercedes the amount of munitions they possess,[xvii] and as a result, do not contribute to the notion of a simpler and more cost effective force. In addition, ADM Cebrowski has argued that an automation of the engagement grid process will contribute to the reduction in manpower requirements as well as a drastic reduction on the reaction time between detection of a threat and the response or engagement of said threat.[xviii] The automation of such a process seems infeasible due to the scope of the requirement. Instances will always present themselves where a minimal degree of analysis will be required, negating the feasibility of process automation. Engagement of a threat must always be conducted with a degree of risk analysis in order to mitigate the risk of an undesirable effect resulting from a course of action. Careful consideration must also be given to engage only those targets which are necessary to yield the desired effect on the battlefield instead of engaging all that is able to be classified as viable targets. Automation of this process proves to be unrealistic in that a model that takes into account all aspects required in that decision would be a Herculean task.

Network-Centric Warfare at work

A fictitious model is helpful in order to analyze the current status and overall progress of NCW (fig-2).

NCW and Operational Art

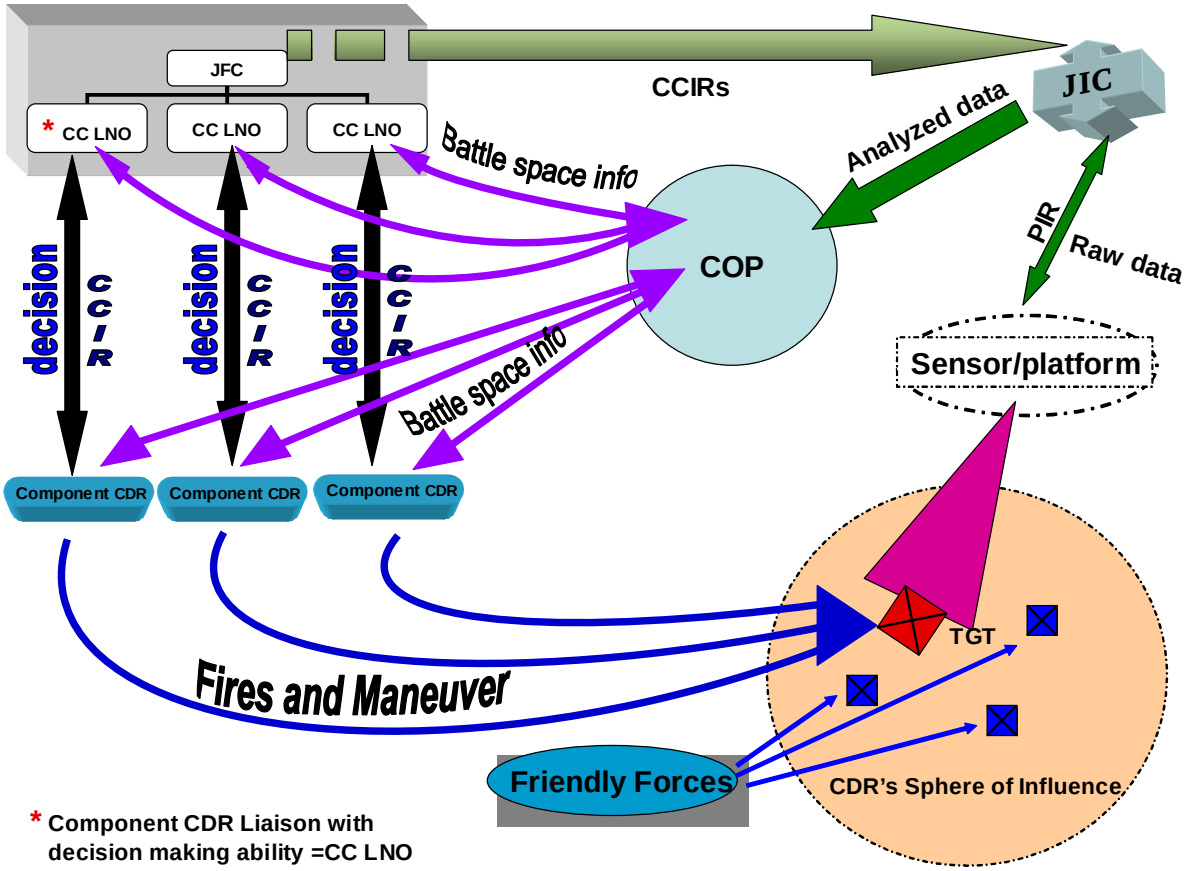

Figure-2

In this model, initial detection of a threat or target (PIR) is conducted by a sensor/platform. The detection platform relays the raw data to the analysis portion of the model. A sensor analysis cell converts the raw data into information that is transferred onto a network by a Joint Intelligence Center (JIC) and becomes available to all users within that specific sensor network. The sensor network must then merge its information

into the COP for display to the rest of the force. The integration of sensor networks into the COP poses the first item of concern to be examined. A difficulty that presents itself to commanders and their staffs, in NCW, is the access to information from the battlefield. "Information enhances leadership and magnifies the effects of maneuver, firepower, and protection."[xix] The cultural change in the military, which was the first step in the transition from Platform-centric to Network Centric Warfare, was addressed previously. Sensor information is being successfully transferred from the sensor onto a network, within seconds in some instances, and is available to a portion of the force. The next step that must be achieved is to take the information that is available to only a small portion of the force via the sensor network and integrate it into the COP to allow the rest of the force access. The achievement of this second step is met with two hurdles.

First, contact information from a sensor (sensor A) is transferred onto a network that is common to forces, which either utilize the same sensor (sensor A), or are part of a network which has access to that sensor's information. The fusion of information from the various sensor networks into a COP that contains the necessary information to achieve full spectrum dominance, and, that is accessible to the various levels of command is an ongoing challenge for architects of NCW. The Global Command and Control System (GCCS) is the official COP for the military and has been identified as the backplane for connectivity of the forces which provides near real time interface to coalition, allied and non-DoD users and systems.[xx] General Shelton, former Chairman Joint Chiefs of Staff, described GCCS as "…a comprehensive worldwide capability to provide end-to-end information processing and dissemination. It supports situational awareness, readiness assessments, course of action development, imagery exploitation,

and planning. The development of a coherent set of Battlespace Awareness capabilities for IS [Information Superiority] will result from the continued enhancement of the GCCS Common Operational Picture." The Global Information Grid or GIG is the DOD vision for providing sufficient information support to all military units and activities worldwide.[xxi] As mentioned earlier, independent research and development from the various branches of the military has caused the COP to become a system of various incompatible systems which are connected to GCCS through back-up methods.

The production and development of networks by various entities, has caused the COP to receive its information from systems which have been produced in a 'stove pipe' and don't truly integrate into the COP. A recent example of this occurred during Operation Iraqi Freedom. In an attempt to create a COP of the Coalition Forces Land Component Commander (CFLCC) forces, a work around architecture was developed to merge the displays of the Blue Force Tracking (BFT) System (formerly Combat ID) and the Marine Mounted Digital Automated Communications Terminal (MDACT) system. BFT in the Army is a component of the Force XXI Battle Command, Brigade and Below (FBCB2) which doubles as a COP system. However, FBCB2 is known to lack the ability to integrate with MDACT. Despite the goal of NCW to achieve a true COP, there was no true shared common picture activity available to the major command elements in theater.

The second hurdle to achieving the next step of the NCW transformation is the ability of the various components to communicate the information they possess. The forces and platforms in the battlefield are hamstrung in their ability to communicate with the various levels of command and their ability to monitor communications throughout the other operations which may be part of the overall campaign or operation. The

communication challenge of NCW is similar to that of display. The Command Net is the official circuit utilized to disseminate information, orders and various other items of interest. Today, a variety of on-line IRC (Internet Relay Protocol Chat) options or web-based communication methods exist which are not standardized in their usage throughout the force, nor do they possess, in some cases, a reach-back capability for post operation analysis. For example, in the Navy, systems such as Microsoft© Chat, Web-Centric ASW network (WECAN) and battle force email are utilized for communications necessary among the various levels of command. These systems are not always available to all the naval units due to a variety of reasons, such as scarcity of bandwidth, upgrade installment failures and lack of operator knowledge to correctly operate the systems. The resulting fix is a redundant communication network aimed at increasing the awareness of the force. This redundancy forces units or staffs to monitor a variety of networks which require an unnecessary increase in manpower. In addition, there is an increased risk in the possibility of missing an essential item of information necessary for mission success. Forces are transmitting essential information through these communication systems and often ignore the command net as the established channel for essential information dissemination. This problem inhibits the possibility of self-synchronization of the forces by rendering them unable to fully integrate and communicate with each other.

Continuing with the examination of our model (fig-2), the second item of concern to be examined is the decision process or speed of command. NCW's tenet of "speed of command" is often confused with the necessity for a physical action to occur. NCW's aim should not be to automate a reaction for a given situation. Instead, NCW's aim should be to facilitate the speed and accuracy with which information is made available.

The available information should be identical at all levels of command, thus minimizing the amount of coordination necessary to arrive at a decision. Operating from the same COP at all levels enables the commanders' staffs to efficiently determine whether the necessary conditions have been set for an action to occur. Professor Milan Vego, of the Naval War College, emphasizes the necessity for the decision cycle at the operational and strategic level to be expedient. The supporting C2 should be relevant, accurate, with timely intelligence and must possess reliable communications. He adds that "the objective of any attacker is to render the defender unable to respond to his actions in [a] timely fashion."[xxii]

Increasing the speed and accuracy of information enables the operational commander to utilize information superiority in the expedient formulation of a decision. Providing near-real time access to all the decisive factors and risks involved in the decision allows the commander to operate within the enemy's decision cycle, hence compressing the opponent's factor of time. The compression of the enemy's time may force the opponent to choose a flawed course of action thus providing the advantage.

As addressed earlier, some may argue that the fog of war and the uncertainty that exists in planning and execution may stimulate micromanagement from the more experienced operational to the tactical level of command. After all, Clausewitz warns that: *"War has a way of masking the stage with scenery crudely daubed with fearsome apparitions. Once this is cleared away, and the horizon becomes unobstructed, developments will confirm his earlier convictions — this is one of the great chasms between planning and execution."*[xxiii] Operating from the same operational picture increases the battlespace awareness of the force, produces a more efficient and capable

force and minimizes the existence of uncertainty and chance during planning and execution. The modernized art of war then becomes an electronic art in that by truly sharing and receiving all the battlespace information the commander is able to make an expedient and informed decision. Those who utilize the information will apply this modernized art by their ability to apply electronic filters to the information when a true COP, that is accessible to all, is achieved. Possessing access to all the information does not equate to necessity of the information, nor does it guarantee micromanagement from the higher levels of command to the lower levels. Setting electronic filters to manipulate the information and display to the user the required data is an art. Through guidance and intent, the commander provides the tools for the staff to filter the required information and ensures the preservation of the concept of centralized planning and de-centralized execution.

Achieving a true COP and maximizing Coalition Information Superiority is extremely challenging, but essential to NCW and a requirement of the Joint Vision. The NCW systems and planning tools must be developed in a coalition environment that is compatible with the systems utilized by Allies and potential coalition members. A problem with the lack of interoperability was once again observed during Operation Iraqi Freedom. ADM Edmund P. Giambastiani Jr, Joint Forces Command (JFCOM) Commander, listed Coalition Information Sharing as an area that "fell short of expectations or [require] new initiatives to redress shortfalls."[xxiv] Planning and execution in a coalition environment is challenging. Operational security has promoted the majority of U.S. forces to operate using the SIPRNET (Secret Internet Protocol Router Network). Coalition members, as a rule, do not have access to SIPRNET which houses

the majority of the message traffic and tools necessary to achieve the objectives. Complicated processes must be used to change the classification of systems for use by non-U.S. coalition members. Simplification of the overall process can be achieved by developing the NCW systems in a coalition environment first and then changing the classification of the system to include items accessible to U.S. only personnel. Current modus operandi is to transfer tools and display systems contained within the SIPRNET for use on systems such as CENTRIX (Combined Enterprise Regional Information Exchange System) being used by CENTCOM coalition forces, LOCE (Linked Operational-Intelligence Centers—Europe network) used by NATO, or COWAN (Combined Operations Wide Area Network) used by the U.K. and Canada.

Conclusion

The challenge for the Joint Force is to achieve the ordered objectives with a smaller force while increasing speed and effectiveness of mission accomplishment. Network Centric Warfare must facilitate the Joint Force Commander's (JFC) achievement of the Joint Vision 2020 mandate of full spectrum dominance and enable his expediency of command which is integral in the effective conduct of operations across the military spectrum. Globalization and its threats, such as Global Terrorism, demand the ability of the military to quickly access all aspects of the battlespace as well as to have reliable, uninterrupted communications throughout the force and with the various governmental agencies. The architecture upon which NCW is developed must possess the flexibility to integrate and expand into inter-agency and coalition operations when required. In a technologically advanced world, the compression of forces in space and time on a concentrated battlefield mean that the outcome of a situation will have a more

profound and immediate effect on the overall conflict. After all, "…in the lateral distribution of forces, the hallmark of operational art is the integration of temporally and spatially distributed operations into one coherent whole."[xxv] The JFCs will maintain the proven capability and flexibility of the command structure by empowering their Component Commanders with the freedom of execution through the meticulous crafting of intent and guidance. NCW architects are successfully proceeding to develop the tenets of speed of command and self synchronization by providing technologically advanced sensors and systems. However, they must not lose sight of the fact that NCW technology must enable operational art and aid in the commander's ability to synchronize fires and maneuver along with the available instruments of National Power to achieve the objective.

NOTES

[i] U.S. Joint Chiefs of Staff, Joint Vision 2010, (Washington DC: 1995), 1.

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[iii] Jay Johnson, "Address," U.S. Naval Institute Annapolis Seminar and 123d Annual Meeting, Annapolis, MD, 23 April 1997. quoted in Arthur K. Cebrowski and John J. Garska, "Network-Centric Warfare: Its origin and Future," U.S. Naval Institute Proceedings (January 1998): 29.

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[v] Arthur K. Cebrowski and John J. Garska, "Network-Centric Warfare: Its origin and Future," U.S. Naval Institute Proceedings (January 1998): 32.

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[xi] U.S. Joint Chiefs of Staff, Doctrine for Reconnaissance, Surveillance, and Target Acquisition Support for Joint Operations (RSTA), Joint Publication 3-55 (Washington, DC: 14 April 1993), III-1

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[xiii] Arthur K. Cebrowski and John J. Garska, p. 33.

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