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ABSTRACT

The United States Armed Forces are undergoing period of declared force transformation during which they are trying to knit together a joint capability to deliver full spectrum dominance in the battlefield. The US military has heavily invested in Information Technology (IT), seeking to build on the concept of information dominance that information-enabled businesses have harnessed to gain a competitive advantage in the marketplace. The concept of Network-Centric Warfare has been developed to be both the glue to hold together the separate military services to operate as a joint capability, and also to harness the power of the Information Age. Advocates of NCW argue that it will give the US military three key capabilities that will lead to decisive advantage on the modern battlefield: Self-Synchronization, Information Dominance, and Speed of Decision. This paper will argue that just as businesses that heavily invested in IT were surprised when the dot.com bubble burst, we as allies of the US must be careful how we modernize and transform our forces because of the risks that are inherent to NCW. The necessary pre-conditions for NCW to work on the battlefield are not in place in terms of bandwidth and interoperability, and early analysis of NCW in operations has shown that it appears counter to the concept of mission command and appears to clearly serve the theatre or operational level HQ.

"Finally, it seems that the logic of conflict, that logic which in turn dictates the essential principles of its conduct, is likewise immutable and immune to any amount of technology that is applied to or used for it" [1]

van Creveld, Technology and War, 1989

The decade of the 1990's brought with it very significant change, much of it driven by investments in Information Technology (IT). This was the time of the unparalleled growth in IT manufacturing giants such as NORTEL, ALCATEL and JDS Uniphase who saw their stock prices soar. At the same time, many smaller firms sought to deliver products and services based on IT, giving birth to 'dot.com' companies whose stock made many millionaires. Unfortunately, when the IT 'bubble' burst, many strong companies that had invested heavily in these products and services were brought to their knees, and the start up 'dot.com' companies simply ceased to exist.[2] Before the IT meltdown, however, Western militaries had started to modernize their forces by investing in technology, chiefly Information Technology, as means of leveraging commercial products, standards and practices into their forces. Have these nations bought into a capability that will be as ephemeral as a dot.com?

The United States military stands out as *primus inter pares,* not only because of the shear magnitude of their investments in IT, but also because of their attempts to create a force of *full spectrum dominance*[3] built on Information Technology. Since the concept of Network Centric Warfare (NCW) was introduced almost a decade ago, the US has set about a deliberate plan of declared force transformation[4] that will define *The American*

Way of War, centered on NCW[5]. As allies of the US, it would be prudent of us to understand the implications and limitations of NCW as it applies to the US transformation and coalition warfare, not only to best allocate our Defence dollars, but more importantly to continue to be interoperable with US military forces.

The Information Age

Since much of the current discussions of force transformation are linked to changes brought about by Information Technology, it is worthwhile here to examine how much change has occurred in society. The Tofflers write that we are currently riding on the *third wave* of change[6]. Information Technology has affected all aspects of modern society. As Smith and Roberts note, "Today in Western societies, more people are employed collecting, handling and distributing information than in any other occupation. Millions of computers inhabit the earth and many millions of miles of optical fibre, wire and airwaves link people, their computers and the vast array of information handling devices together. Our society is truly an information society, our time an Information Age."[7]

Many corporations have been quick to seize upon the advantages that information technology afforded them us in terms of its computational power. Alberts and Garstka argue that Information Technology is the *DNA* of the Information Age- the fundamental building block of dominant competitors, where the Information Age is:

1) Changing how wealth is created
2) Altering the distribution of power

3) Increasing complexity

4) Shrinking distances around the world; and

5) Compressing time, which increases the tempo of our lives[8]

Corporations that have correctly harnessed the power of the Information Age have demonstrated a decisive advantage of information dominance over their competitors, in which the Information Age companies can respond more quickly to market needs. The increasing divergence of Economy B (information based) businesses from Economy A businesses illustrates the rapid growth and value that can be achieved by embracing a new market model.[9] Cebrowski and Garstka assert that a key attribute of the new business models is a focus on network centric operations, which are characterized by information-centric interactions between computational nodes on the network. The value of the networks can then be "…derived from the content, quality and timeliness of the information moving between nodes on the network. This value increases as information moves toward 100 percent relevant content, 100 percent accuracy, and zero time delay-toward information superiority"[10] This concept of information dominance is critical and one that will be examined later in the paper within a military context.

In industry, new giants such as Wal-Mart and Deutsche Morgan Grenfell have made the shift to network-centric operations and have gained tremendous information dominance within their industry by being more agile: faster to processes information and to make better business decisions than their competitors.[11] In the Darwinian world of business, Garstka argues that those organizations that are emerging as winners are those that can be described at being *information enabled.*[12] The Economy B businesses are linked by three themes: a shift from the platform to the network for parallel processing, a

shift from viewing actors as discrete entities to part of a continuously adapting ecosystem (*system of systems*), and the importance *and will* (*italics mine*) to adapt and survive in such changing ecosystems (self synchronization).[13] Economy B businesses are built on the power gained from linking together distributed decision centers so that they are able to share their knowledge to make better decisions faster.

A final key characteristic of the new Information Age is the rate of change. Before the information age, new products were introduced every 5-8 years, with very gradual improvements in efficiency; however, Information Technology follows a much more rapid change curve, as characterized by the now famous Moore's Law: the power of a computer (density of transistors on a chip) will double every 18 months.[14] Since the power of the individual computing nodes is greatly increased when they are networked together, a second key phenomenon in the information age is that communications bandwidth similarly continues to rapidly grow, with new terrestrial fibre optic lines offering a three-fold increase of capacity every 12 months.[15] Indeed, one of the key technical policy decisions put forth by the Clinton administration was the National Information Infrastructure (NII), or *information superhighway* program that created a networked connectivity of fibre optic lines, satellite links and telephone lines that could be accessed by most elements of US society.[16]

United States Military Transformation: Network Centric Warfare

On the basis of the rapid changes to business operations that were harnessing Information Technology, as early as 1990, the Department of Defense's Office of Net Assessment concluded that the world was entering a period of military revolution, or

Revolution in Military Affairs. [17] This concept was later incorporated into guidance to the US Military Services by then Joint Chiefs of Staff General Shalikashvili, in Joint Vision 2010, as a conceptual template for future joint war fighting with information networks as the centerpiece.[18] The US Congress followed by emphasizing the need for change calling for the Secretary of Defense, in consultation with the Chairman of the Joint Chiefs of Staff, to develop a report on the development and implementation of network-centric warfare concepts within the DoD.[19] This guidance has since been repeated and expanded upon in Joint Vision 2020: "This capability will provide the joint force a competitive advantage that will allow the force to operate freely in a global information grid. The development of this grid will provide the network-centric environment required in achieving the goal of a fully synchronized information campaign."[20] Military theorists, seeking to harness the lessons learned from industry in order to transform the US military, have developed the concept of *Network Centric Warfare* from the premise that a superior information position gives one " the ability to collect, process, and disseminate an uninterrupted flow of information, while exploiting and/or denying an adversary's ability to do the same."[21] At the same time, the US DoD is leveraging on NCW to create a joint capability that would combine the four military branches into one seamless, *joint*-war fighting force (*italics mine*).[22]

In their introduction to Network Centric Warfare, Alberts et al write, "War is a product of its age. The tools and tactics of how we fight have always evolved along with technology…warfare in the Information Age will inevitably embody characteristics that distinguish this age from previous ones. These characteristics affect the capabilities that are brought to battle as well as the nature of the environment in which conflict occurs."[23]

It is therefore logical to expect that the same relative advantages that Information Age corporations have over their competitors can be translated into a military advantage for the military. The same information technology revolution that so changed business should also radically change warfare. With better surveillance and improved information technology, military commanders should have better information about the enemy's position intentions and capabilities, lifting what has been called the *fog of war.*[24]

Admiral Cebrowski, the acknowledged *father* of NCW, describes Network Centric Warfare as a myriad of computer networking and information sharing technologies:

> *"…An information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization. In essence, NCW translates information superiority into combat power by effectively linking knowledgeable entities in the battlefield."*[25]

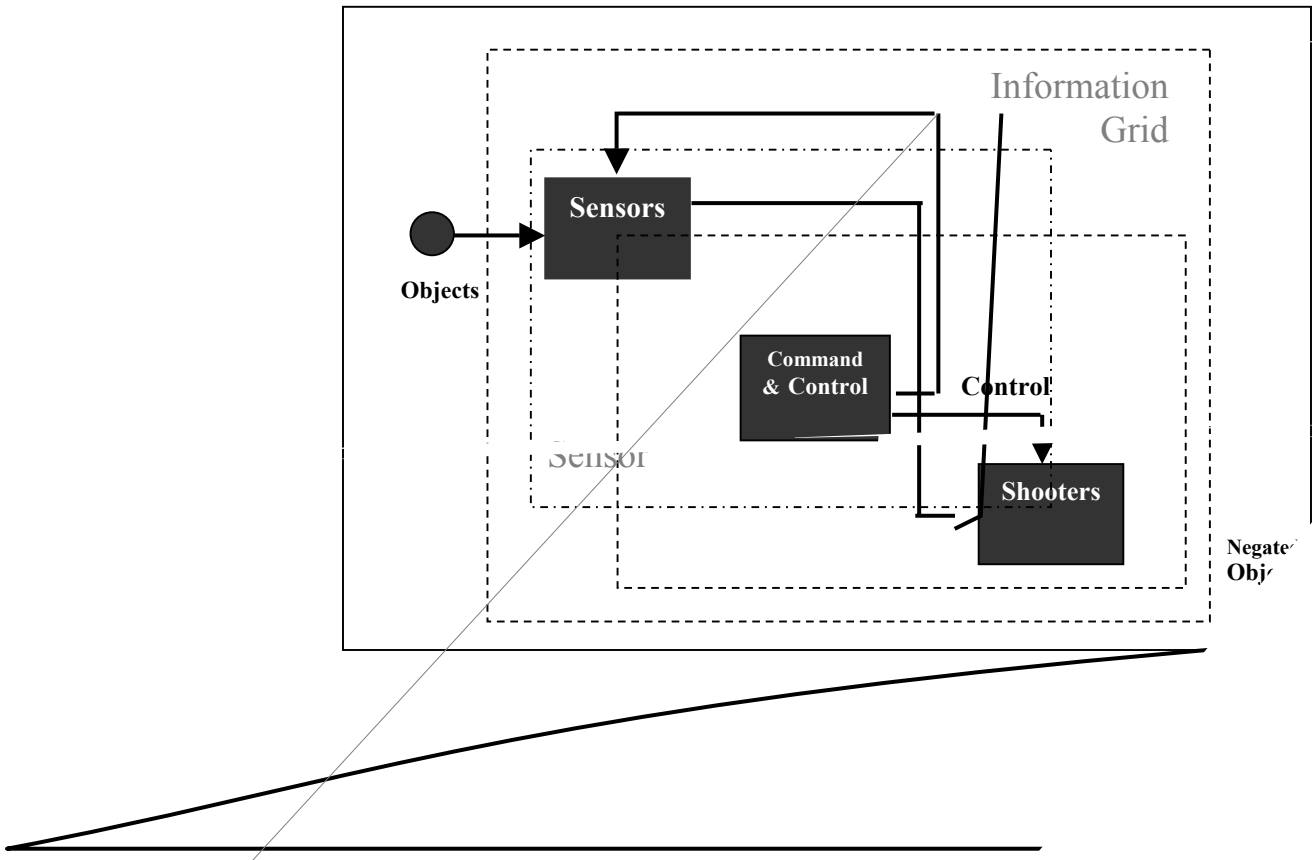
Dr Krepinevich offers that **"**NCW involves networking in three domains of warfare (the physical, information and cognitive domains) so as to generate increased combat power by better synchronizing effects in the battle space; achieving greater speed of command; (and) increasing lethality, survivability and responsiveness." [26] Similarly, naval advocates of NCW believe that this new form of warfare represents "…a fundamental shift from what we call platform-centric warfare to something we call network centric warfare and it will prove to be the most important RMA in the past 200 years."[27]

How great is this potential, and how will it work? It is interesting to note that Soviet military strategists considered this question a decade before their Western

counterparts and in 1980 concluded that "If two force groupings have equal combat power potential of weapons, but one has an advantage over the other in information means, the combat potential of that side will be much higher."[28] The authors of NCW similarly argue that NCW gives three defining capabilities: Self-Synchronization Information Dominance, and Speed of Decision.[29]

Self-Synchronization.

The concept and capability of a rich information grid is fundamental to self-synchronization. This grid is the nervous system of the distributed nodes on the battlefield, on which travel the essential data, information, decisions and orders that keep the forces of entropy at bay, and allow the forces to act in unison. Linked by high-speed digital communications, both terrestrial and satellite, forces can share a *Common Operating Picture (COP)* that tells them three critical things: where they are, where their forces are and where the enemy is. When given a clear Higher Commander's intent, the forces can act according to their own battle rhythm and yet be in unison with the overall battle rhythm.[30] In Figure 1 below, the logical model of the information grid is illustrated.


Information
Grid
Sensors
Objects
Command
& Control
Control
Shooters

consider. Both of these nodes are linked via the *information grid* to command and control that tasks the sensors to acquire targets and shooters to engage the acquired targets.[32]

This is best illustrated with an air force example: linked and commanded by an Airborne Warning and Control System (AWACS) platform, an allocated wing of fighters is able to access the sensor output of the AWACS without divulging their own position, deconflict between targets and allocate targets to air platforms. As the *air picture* changes, the fighters receive the updates and can dynamically respond. In a Joint Tactical Information Distribution System (JTIDS) Operational experiment conducted in the early 1990's, the USAF found F-15-Cs, working with data links (shared awareness) increased kill ratio by over 100% for both Day and Night Operations. [33] This was further validated by data collected during over 12,000 sorties and 19,000 flying hours demonstrated that the kill ratios for JTIDS equipped aircraft over non-JTIDS equipped adversaries were extremely high, increasing by over 2.5 x in offensive and defensive counter air missions.[34]

Linking the nodes in this manner allows a much more powerful combat force to be delivered than was possible in former platform based operations, in which a single observer was linked to a weapon system. Cebrowski and Garstka also posit that the net capability of NCW increases exponentially with the number of nodes interconnected, as governed by Metcalf's Law.[35] Thus, as shown in Figure 2, a network with 3 nodes has 3*(3-1) = 6 potential information interactions. As the sensor, command and shooter nodes of the system grow, their power increases exponentially.

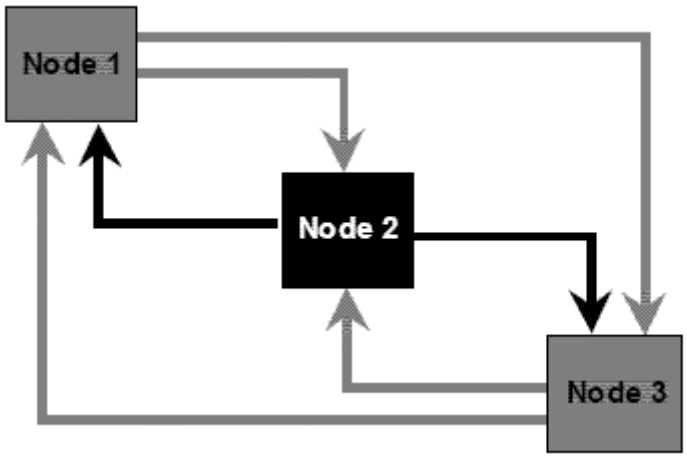


Figure 2. Internodal Connectivity[36]

Information Dominance

Figure 3 illustrates the concept of *information dominance*. At any time, decisions are made based on information that has the attributes of latency (or timeliness), relevance and accuracy. All other forces being balanced, the side with more relevant information that is more accurate and is distributed more quickly will be able to act on this information more quickly than his opponent. As shown in Figure 3, the Blue Forces are in a position of information dominance over the Red Forces and should be able to analyse the situation and decide courses of action before their opponents can do so.

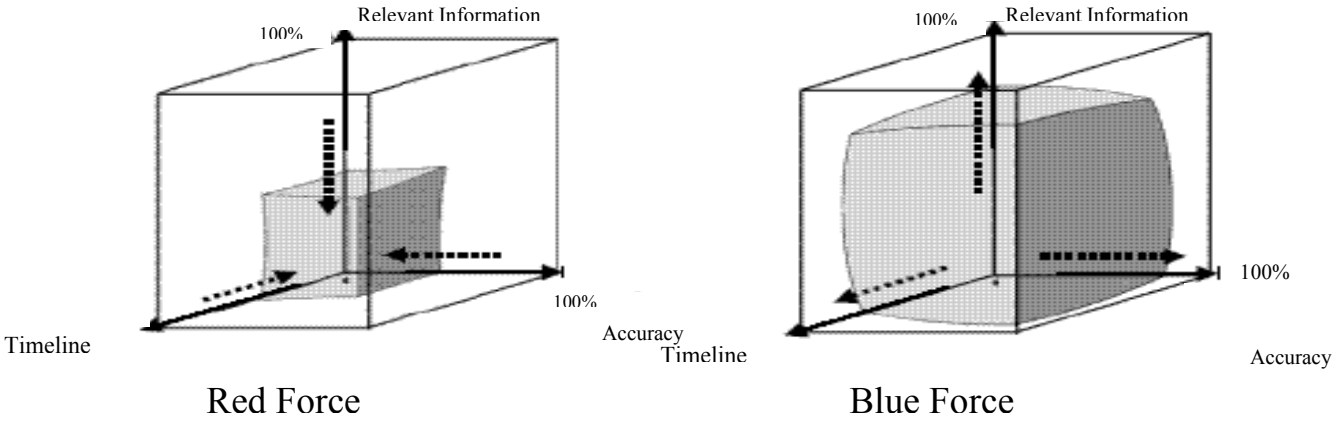


Figure 3: Information Dominance[37]

In his book Effects Based Operations, Smith argues that the driving force behind the discussion of Network Centric Warfare has been "…a revolution in information technology that has been building over the last decade and more… an interlocking set of three different technologies: one in sensors, one in information technology, and one in precision weapons technology."[38] More accurately, as Krepinevich points out in *The Military Technical Revolution*, the three areas of technological progress: sensors, precision munitions and *simulation* (italics mine) are all derived from the revolution in information technologies. [39]

The net effect of these technologies is to achieve a faster and clearer reading of the situation, and to act decisively before the enemy can respond. One of the main tenets of NCW, therefore, is that a smaller, more agile force should be able to defeat a larger, more ponderous adversary. To use the US Army's terminology, the force will "see first, understand first, act first and finish decisively at the strategic, operational and tactical levels."[40]

Speed of Command

The internodal connectivity between grids links the nodes together (sensors, commanders, and shooters) creating a shared COP and enabling a much more rapid decision cycle, self-synchronization, and action. Relating this to Boyd's OODA (Observe, Orient, Decide, Act) Loop, the sensors allow rapid collection of information, including targets. A Common Operating Picture orients the commander, who can rapidly simulate or model courses of action, choose an optimum force and weapons systems to overmatch his opponent, and then *act*. The cycle time of the OODA loop can be compressed, allowing military forces to work inside the enemy's decision cycle, effectively locking him out of options. Figure 4 illustrates the OODA loop as a step-function in which the time delay is caused the functions of *observe, orient* and *decide*, and where the combat power is brought to bear by *act.* The difference in combat power between points A and B, and the speed of the first three steps are critical to defeat an enemy[41].

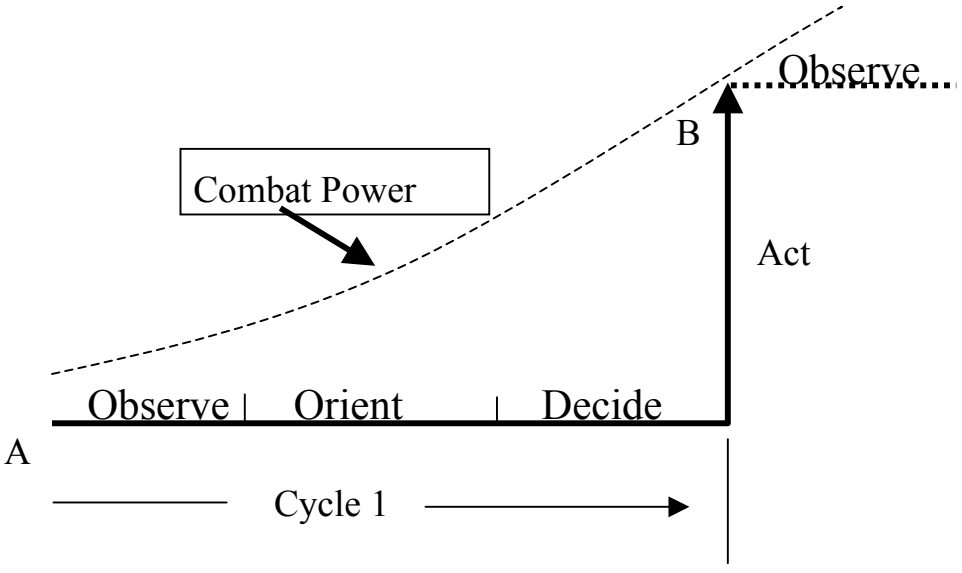


Figure 4. Speed of Command[42]

Smith argues that the function of self-synchronization further smoothes out the curve by providing sustained application of combat power. Figure 5 shows that many smaller and rapidly executed OODA loops can closely meet the theoretical curve of Combat Power.[43] If commanders have access to a Common Operating Picture in which friendly and enemy forces are represented in near real time, then their *observe, orient, decide* and *act* cycles could be much more rapid.

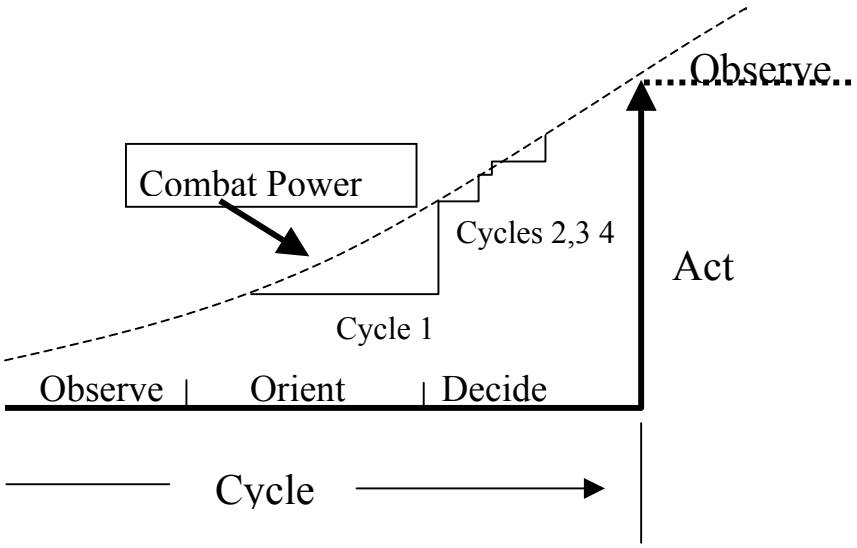


Figure 5: Harnessing Combat Power[44]

In summary, NCW gives us three critical capabilities: Self-Synchronization Information Dominance, and Speed of Decision**.** NCW is, however, heavily dependent on interoperability, bandwidth, creation of a correct Common Operating Picture and changes to doctrine. In the following sections, we will examine the recent allied/coalition operations and exercises to determine if the necessary preconditions exist, and how well NCW works on the modern battlefield.

Since the First Gulf War, the US military has steadily increased its investment in and use of sensors, precision guided munitions and command systems. Whereas only six percent of the munitions dropped in the early Gulf War were precision guided, this number climbed steadily to 35 percent in Kosovo and 60 percent for the Afghanistan campaign. The Afghanistan campaign also saw the increased use of Unattended Air Vehicles (UAVs) both equipped with multispectral capabilities and also armed with precision guided missiles.[45] Combined with all-weather surveillance platforms, the US has been able to harness precision weapons systems to good effect.

In Operation ALLIED FORCE, elements of NCW had a significant impact on the ability of the operational headquarters conducting and overseeing the battle, indeed, a number of these elements at the theatre and operational level made conduct of Operation ALLIED FORCE unique. Theatre access to real-time, full motion video surveillance of targets of interest, the reliance on reach-back technology by European Intelligence Community, daily reliance on Video Tele-conferences (VTCs) to facilitate essential warfighting coordination and Secret Internet Protocol Network (SIPRNET) data sharing were all successes.[46]

Boot writes in his early analysis of Operation IRAQI FREEDOM, the US employment of the concepts and capabilities of NCW earned them the stunning success that was a testament to the *New American Way of War*. "The United States and its allies won…so quickly (that) it must rank as one of the signal achievements in military history."[47] He asserts that the US DoD has been able to transform from attrition based to knowledge based warfare in which coalition forces, led by the United States, severely disrupted Iraqi command-and-control systems and moved much faster than Iraqi forces

could handle.[48] More soberly, Cebrowski points out that "…among the lessons learned from Operation Iraqi Freedom is a realization of how network centric warfare works operationally and the impacts this realization may have on material and force organization."[49] Lest one prematurely conclude that NCW is clearly the way ahead for coalition warfare, a more detailed analysis of the employment of NCW in operations has revealed critical deficiencies in the information grid, coalition interoperability, coalition asymmetry, centralization of command, battle rhythm and self-synchronization, and the operational art.

The Information Grid

Just as Economy B businesses were built on a robust connectivity and generous bandwidth to link together knowledgeable entities, NCW depends on a robust communications system with reach and richness in which commanders and actors at all levels can share their information, intentions and orders. As mentioned earlier, in the commercial sector the information highway trebles every twelve months; however, in the military the growth of bandwidth roughly doubled every 10 years since WW1, increasing to doubling every 2-3 years since 1990[50]. This effectively limits the military applicability of many commercial IT products and services. High demand systems such as Video Tele-Conferencing (VTC) effectively consume all available bandwidth, bringing all other information and intelligence systems between HQs to a standstill. Even within the US Forces there exists a digital divide beyond which information cannot be shared. Although the US Army implementing seamless access to information through a Tactical Internet (TI), "…the TI is the centerpiece of digitization – the digital conduit that

transports information to improve lethality, increase tempo, and enhance survivability, …[but] even with the ongoing SINCGARS[51], EPLRS[52], and MSE/TPN[53] enhancements, the channel capacity of the tactical internet is insufficient."[54] In a preliminary assessment of Information Operations in Bosnia, Allard notes "Despite the imperative of supporting the warfighter, the river of information available to US military forces in Bosnia often diminishes to a trickle by the time it reaches the soldiers actually executing peacekeeping missions. On one recent operation, a brigade commander who had requested overhead imagery of his area complained that the s*ystem* took three weeks to provide photographs that eventually turned out to be six months old.[55] This experience was repeated in Operation Iraqi Freedom, where the allocation and availability of bandwidth from support to the Theater and Operational levels of command, was *lop-sided* in relationship to the broadest requirements for intelligence information...at the tactical level. The result was a *digital desert*.[56] Even within V Corps, there was a surprising lack of connectivity brought about by the introduction of new command systems that arrived during Operation Iraqi Freedom that were not integrated onto the communications systems.[57]

Coalition Interoperability

It is not surprising that if the US forces have their own internal interoperability and bandwidth problems then these problems would become exacerbated in coalition warfare. Geraghty suggests that NCW will particularly challenge the operational commander when planning and conducting allied/coalition operations in two major areas: interoperability and command and control.[58] Interoperability, defined as "the ability of systems, units, or forces to provide services to and accept services from other systems,

units, or forces and to use the services so exchanged to enable them to operate effectively together,"[59] is the cornerstone of coalition operations. "The rapid exchange of information," she quotes, "in fact information technology itself, is one [sic] of the key enablers of NCW."[60] This interoperability occurs at many levels: the technical level, where systems connect their networks; at the staff level with the sharing of intelligence and access to classified material; and at the command level for the sharing of common intent, rules of engagement, and language.

As a bare minimum, a technical level of interoperability is necessary for the rapid exchange of information, and there must be sufficient bandwidth to provide the reach and richness of the information to those who need it. In land operations, the US Forces do not have sufficient tactical communications below Corps level to support NCW; hence the allied/coalition communications connect at the Corps HQ level. But it is here we find more problems, for despite decades of effort, the leading Western armies of NATO are not interoperable beyond the most rudimentary level.[61] The coalition armies are unable to connect to the US and their information systems cannot be integrated. Only once this is achieved, can the significant hurdle of release of classified material then be considered.

Coalition Asymmetry

Increasingly, the US is fighting alongside allies and coalition partners who have among them the full range of equipment, from modern to obsolescent. This was clearly demonstrated in Operation ALLIED FORCE where the disparity between the US and NATO forces illustrated a 'transatlantic gap' in NATO's warfighting capabilities.[62] Stuart quotes the NATO Secretary General, Lord Robertson's alarm at the situation as

"…a two-class NATO, with a precision class and a bleeding class."[63] Lord Robertson further noted that:

> *"The imbalances are growing within the Alliance, between those countries that are investing more quickly in new technologies and capabilities, and those that are proceeding at a slower pace. This is increasing posing challenges to interoperability."*[64]

Mitchell argues that the underlying trouble is that the guiding principle of NCW is to increase the speed and efficiency of operations, whereas coalitions are rarely concerned about combat efficiency. He adds "coalitions are always about scarcity—in terms of operational resources, political legitimacy, or both. The trade-off is always in terms of political influence over operational considerations; in coalitions, politics frequently trump efficiency."[65] This is further exacerbated by the inability of the US forces to share critical intelligence and information. Fed in theatre by the SIPRNET, the contents of this intelligence pipe are "US EYES ONLY", and cannot be simply shared across a coalition headquarters. [66] This would cause areas of *information blackout* that would make the planning and conduct of coalition operations much more difficult.

Centralization of Command

Since the various command and information systems are not interoperable, and can at best co-exist, the point of integration then comes to an HQ node- a hub in a system. Further, the limitations in bandwidth, VTC facilities, intelligence sharing and the confluence information systems all conspire to bring information to the top of the pyramid, rather than sharing it across the bottom. Instead of a distributed level of command across the battlefield, we find a hub in a star system where the Common

Operating Picture (COP) is built and shared. This centralizes C2 higher and higher in the chain of command. The Coalition Joint Task Force (CJTF) HQ, wherever it is deployed becomes the nexus of joint, coalition and interagency coordination, and it is here that we can see the limitations of NCW. Since these robust C2 nodes become more difficult to move, they become further separated from the fight. Linked by wide band communications, they have a synthetic view of the battlefield, or as was shown in the Operation ALLIED FORCE, a telescopic view (provided from UAVs).

Roberts and Smith note that this systematic centralization of execution level decision authority at higher echelons in the chain of command has caused a *bow wave* of decision authority. "[Each] level of war is complex, and if a decision-maker abandons his level even briefly to make decisions at a lower level, effectiveness will be lost. This problem is not new to warfare, but the vast amount of information that network-centric operations provides raises the stakes."[67] In Operation ALLIED FORCE, senior leaders inappropriately inserted themselves in tactical decisions: with the availability of live, on-scene coverage, it was quickly realized at EUCOM HQ that an insatiable desire for Predator UAV video by commanders…had been spawned. US senior operational level leadership at times overstepped its bounds and influenced decisions that should have been left to the tactical level.[68] This practice was repeated in Operation IRAQI FREEDOM. [69]

Daily Battle Rhythm and Self-Synchronization

The concept of self-synchronization implies action at various levels by commanders to keep their battle rhythm in concert with their Higher Commander's Intent and battle rhythm. In earlier wars, this intent was passed verbally or in written form, and

considerable latitude was given to commanders. During the past decade and a half, however, the sharing of Higher Commanders' Intent has been achieved largely by face-to-face interaction via VTC. Starting in the First Gulf War, VTC participants spanned the strategic, operational and tactical levels of command, greatly compressing normal command-and-control processes; however, it was impossible to document and promulgate the essential elements of the proceedings to key personnel who did not attend the VTCs. In order to compensate for the VTCs, the number of staff attending increased dramatically.[70] This forced an artificial cycle of battle rhythm that can be explained in Figure 6.

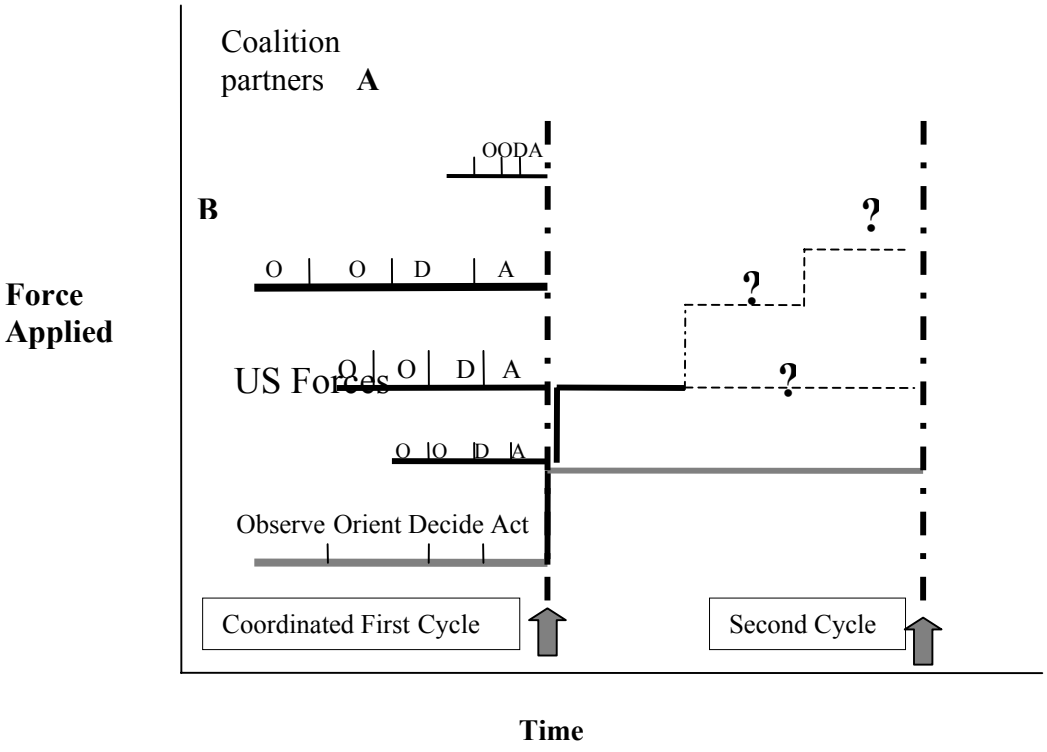


Figure 6. Synchronization of Forces[71]

Coalition commanders attended the daily VTC conference during which detailed coordination of targets, objectives and movement of forces occurred. In order to achieve the best massing of effects, the major coalition forces were controlled and their attacks and movements synchronized between the component forces, especially artillery fires and air forces. Although some elements of the coalition forces were fully capable of carrying out additional command cycles, their independent actions were limited by the requirement of the Commander CJTF to command, control and coordinate the forces. The concept of self-synchronization became even more difficult to realize when the tactical combat forces did not have the technical capability to share a Common Operating Picture. Both the *digital divide* and the *transatlantic divide* prevented relevant information from being shared to tactical level commanders. As self-synchronization between the coalition and US forces became impossible, the Commander CJTF affected control through the synchronization of the forces along phase and time lines. The questions marks on Figure 6 illustrate both the confusion and the lost opportunities of the various forces to act independently. These problems were clearly identified in Operation IRAQI FREEDOM, where the application of combat force was synched to a sequential, procedural planning mindset, not to the rhythm of a dynamical battlefield.[72]

It is also at the confluence of the information systems that the most difficult task, that of discerning the overall picture and building *situation awareness* is conducted. The resulting COP represents a bottom-up view of forces location(s) and a top-down view of targets. This COP cannot be easily shared; however, because of bandwidth limitations and incompatibility of equipment between and across the coalition forces as well as information security incompatibilities.[73] As opined earlier, the security problems

associated with sharing US EYES ONLY information also creates islands of *intelligence blackout* within a coalition theatre of operations. So too, the information and intelligence is tailored to the higher HQs, and whereas the number of HQs to be informed numbers in the tens, the numbers *users* who require information in the ground combat element number in the 10-100s of thousands. The type and character of the intelligence product also changes at each successive level to meet tailored requirements.[74] At each new level of HQ, new information and intelligence requirements are added, diluting the lower tactical requirements; consequently, a COP is produced that meets the highest level of command requirements, but no one else. If the fusion of information into intelligence is done at the highest level, where all of the information systems connect, then an increasing latency of intelligence is introduced, making the information less relevant for the battlefield commanders.

Operational Art

One of the most serious criticisms of NCW is the effect that it has on the operational art and the concept of *mission command*. Milan argues that Network-Centric Warfare reduces the art of war to tactics and targets.[75] He further states that "Tactics and targeting represent the core of NCW and most of the discussion concerns grids and targets. The essential element of command is often forgotten. The theatre commander in Operation ENDURING FREEDOM directing employment of diverse and netted forces from his main headquarters in Tampa, Florida, thousands of miles away, is not an example of the sound application of operation art. The netting of forces was used to

further centralize decision making at all levels. The Commander Central Command not only observed but actually interfered in purely tactical decisions and actions."[76]

Similarly, Kolenda points out: "Embedded in the paradigm [NCW] is the assumption that the stand-off precision munitions delivered primarily from the air and the sea forces will have maximum effect on the enemy with minimal risk to American lives and of collateral damage. A related assumption is that an omniscient view of the battlefield will make centralization of authority possible, indeed inevitable."[77] But equally, as van Creveld points out, the main reason why modern weapons are so often useless in Low Intensity Conflict (LIC) is because they are designed to fight each other. The effectiveness of electronic sensors is determined by the complexity of the environment in which they operate. They tend to work best in outer space, where there are only a few simple objects flying abroad and where there is nothing to fight over. Next, in order, come air and sea. On land, the most favorable environment is the open desert, but worst of all is complex terrain.[78] The view available at the operational HQ could be quite clear, but also manifestly incorrect.

How does NCW affect the levels of war? Dahl argues that NCW will lead to a compression of the levels of war and that the tools and methods of planning and synchronization must change in order to keep up with the tempo in a non-linear battlefield.[79] Although this appears to be intuitive, the theory of 'flattening' organizations has only successfully been applied in the business sector. Experimentation to date, especially in the land forces has revealed that the intermediate levels of HQ remain important for the conduct of operations.[80]

Advocates of NCW have pointed to the tremendous growth in productivity spurred by IT investment and argue that a similar effect can accrue to the military. As White points out, however, productivity growth between 1974 and 1999 remained at 1.4%.[81] This mismatch between IT investment and productivity indicates, "[that] we can see the computer age everywhere except in the productivity statistics." White explains that this paradox of expectations of productivity growth from the information age is due to the latent delay of the development of applications to use the new innovations. He points out that "no single innovation can itself make significant advances in productivity, because by the time widespread application of that technology is established, there is not longer a paradox or revolution."[82] A similar latent delay of capability from technology to capability is evident within the Western Alliance, as there has not been coalition or even component warfare doctrine written on Network-Centric Warfare. The reason for this may be more fully understood using the analogy of vectors where the two vectors of doctrine and technology have their own speed and direction. The problem that we currently face with IT and NCW is that we have a very fast technology velocity vector but also a much slower doctrinal velocity vector that are not heading on the same path. Unless these vectors are aligned in speed and direction we will never be able to harness the changes and power that technology delivers to us.

Conclusion

Is NCW something that we as Allies should invest in? In the past 13 years, the USA has gone to war and fought major campaigns three times. In each event, they have achieved overwhelming tactical and operational success based on a military superiority, both in terms of numbers and technology. The quick and decisive victories are not

necessarily victories for Network-Centric Warfare, as it is premature to validate a concept that was used against but a numerically and technically inferior enemy. The lessons learned in these joint and coalition operations, however, indicate that NCW is causing a profound effect on the Operational Art, but not necessarily a desirable one.

The rich connectivity of intersecting grids of information, sensors and shooters does not exist except at the highest level. The synchronization of effects by the operational commanders run the battle rhythm of their subordinate commanders, rather than allowing self-synchronization to occur. The operational commanders are drawn into tactical decisions, abrogating a delegation of authority to tactical commanders and acting in a manner that is counter to the doctrine of *mission command.* Technical and political barriers exist to interoperability that prevents the true collaboration in planning and operations of coalition forces even though it appears that future operations will be increasingly JIM (Joint, Interagency, and Multinational).[83] But the success of NCW even within the US military is not a forgone conclusion. In a report to Congress on the progress of NCW, the DoD wrote, "…major identified impediments to progress that are technical, cultural, organizational, and administrative that include:

a. Lack of secure, robust connectivity and interoperability,

b. Intolerance of disruptive innovation,

c. Lack of understanding of key aspects of human and organizational behaviors, and

d. Lack of NCW-related technology investments."[84]

The US military appears to be pushed forward by the momentum of IT investments in technology and the direction of Joint Vision 2020 into Network-Centric Warfare. Investment continues even though the necessary alignment of doctrine, concepts and organization has not yet occurred. This course may irrevocably change the current concept of *Coalitions of the Willing* to *US Only* endeavors as its allies and coalition partners fall further behind in the modernization of their forces and cannot interoperate with their US counterparts

Although very significant technological change has occurred within the US military, its effects are seen only at the highest level and seem to have brought with it a significant cost to allied interoperability. As future wars will be fought with Allies, this is a serious weakness. No formal doctrinal changes have yet occurred in the Joint Services, or in the US Army. Additionally, the expected structural flattening of command levels has not yet occurred as these intervening levels have been shown to have a value that does not have an equivalent in the business world.

The application of Network-Centric Warfare has shown that there are practical limitations to a transformation using Information Technology. Limitations of bandwidth, a lack of interoperability, both joint and coalition, and the constraints of sharing intelligence indicate that a careful path forward must be chosen. As allies of the United States, we must similarly carefully choose our way forward to ensure that essential interoperability at the tactical level, between our deployed forces is achieved. To this end, we must continue to track the acquisitions, developments and doctrinal changes in the Air Force, Army and Navy, and adjust our force capabilities accordingly. At the same time, we must work on the *trust* relationships between the US and ourselves in

order to ensure that information and intelligence can be freely exchanged at the strategic level. While we cannot afford the luxury of the level of investment that the US is placing on IT, neither can we afford the risk.

Coalition operations are, as a minimum, a two-way contract in which there must be give and take on both sides. The US must be willing to give access to their information systems if they wish to share information and must keep coalition operations in mind as new information systems are developed. For our part, we must be willing to consider options other than 'built in Canada' for our new new inforcmm and i(form)Tj12 0 0 124499.56015 3

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[52] Enhanced Position Location Reporting System (EPLRS)is a digital data system used by US Marines and US Army for reporting own force locations to higher command.

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