Network Centric Warfare

NCW

by Dr Carlo Kopp

The stunning success of the Operation Iraqi Freedom military campaign will be seen by historians as the first full scale demonstration of the power of information age warfighting techniques. Accordingly, 'Network Centric Warfare' (NCW), often termed 'Network Enabled Warfare' (NEW) has become the newest buzz phrase to achieve prominence in Canberra Defence circles.

Network Centric Warfare is much more than that and, not surprisingly, is very demanding technologically. In terms of operational technique the power it offers comes at a price – and that is something that should not be ignored by Defence professionals.

Over the coming decade we will see the world divide into nations that employ NCW techniques, and others that do not, be it for reasons of ideology or operational/technological incapacity. It is clearly in Australia's interests that the ADF fall into the former rather than the latter category.

A commonly held view is that NCW is somehow uniquely a feature of modern air warfare or modern naval warfare. The opposite is arguably true since NCW is a combination of technology, technique and warfighting philosophy, which if anything has the potential to bring about levels of cross-Service force integration that were unthinkable a decade ago. NCW is just as valuable to the digger on the ground, as to the sailor onboard ship or the pilot in a fighter aircraft.

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NCW - Dispersing the Fog of War

In its simplest terms NCW is the military equivalent of the information revolution, which transformed the business of industry, government, education and entertainment during the previous decade. The first phase of the information revolution was in 'digitisation' or the placement of computers into large scale use for processing information; the second phase was 'networking', which amounts to connecting these computers together. Within the business/government/education/entertainment domains the information revolution has produced enormous gains in productivity, which grew as global networks expanded and increasing numbers of services became networked.

The experience observed in the civilian world was that this process was neither smooth nor painless, and many organisations came to grief through their inability to adapt. The term 'digital divide' is today popular as a description of the enormous gap between digitised/networked developed nations, and the developing world devoid of the infrastructure and skills required to make this transition.

The trauma observed a decade ago in the civilian information revolution is now evident in the transition to NCW in the military domain. The level of trauma often has as much to do with grappling with complex technology, as it is in changing the thinking processes of a great many people. It is interesting to hear those in the Defence community grumble about problems heard from industry stalwarts a decade ago.

To understand NCW we need to explore it from several perspectives. These can be summarised as:

1. The strategic and philosophical dimension.
2. The operational dimension.
3. The technological dimension.

All three perspectives are reflections of a single broader reality and focusing on any at the expense of the others is to diminish the whole.

From a strategic and philosophical perspective NCW is about the exploitation of information to compress targeting cycles in combat, and in turn to accelerate the operational tempo to the detriment of an enemy.

Virtually all warfighting is centred in individual or formation engagements, and can be characterised by a construct called the Observation-Orientation-Decision-Action (OODA) loop, devised two decades ago by Colonel John Boyd in the US. In any engagement a commander must observe the situation to gather information, that information must by analysed and understood so that the commander's situation can be understood, thereafter resulting in a decision to act in an advantageous manner, ultimately resulting in action.

Whether we are observing a soldier in a firefight, a fighter pilot in a dogfight, a frigate captain engaging an enemy warship or a bomber package commander penetrating enemy airspace, their activity patterns follow the OODA loop model. It is an inevitable part of reality and has been so since the first tribal wars of 25,000 years ago. Sadly, its proper understanding had to wait until the 1970s.

What confers a key advantage in engagements is the ability to stay ahead of an opponent and dictate the tempo of the engagement - to maintain the initiative and keep an opponent off balance. In effect, the attacker forces his opponent into a reactive posture and denies the opponent any opportunity to drive the engagement to an advantage. The player with the faster OODA loop, all else being equal, will defeat the opponent with the slower OODA loop by blocking or pre-empting any move the opponent with the slower OODA loop attempts to make.

The mechanics of operational tempo and OODA loops apply at all levels of conflict, from individual engagements up to corps or force level engagements.

The four components of the OODA loop can be split into three which are associated with processing information, and one associated with movement and the application of firepower. Observation-Orientation-Decision are 'information centric' while Action is 'kinematic' or centred in movement, position and firepower.

If we aim to accelerate our OODA loops to achieve higher operational tempo than an enemy, we have to accelerate all four components of the loop. Much of 20th Century warfighting technique and technology dealt with accelerating the 'kinetic' portion of the OODA loop. Mobility, precision and firepower increases were the result of this evolution. The steam powered navies and horse drawn armies of a century ago have been supplanted by mechanised and air mobile land forces, turbine or nuclear powered navies, followed by fleets of supersonic fighters and bombers.

There are practical limits as to how far we can push the 'kinetic' dimension of the OODA loop because more destructive weapons produce collateral damage, and faster platforms and weapons incur ever increasing costs. Accordingly, we have seen a slow down in this domain since the 1960s. Many weapons and platforms widely used today were designed in the 1950s and may remain in use for decades to come.

The 'information centric' dimension of the OODA is the target of NCW and remains the yet to be exploited new frontier in warfighting technique.

Observation-Orientation-Decision are all about gathering information, distributing information, analysing information, understanding information and deciding how to act upon this information. The faster we can gather, distribute, analyse and understand information, the faster and arguably the better we can decide how and when to act in combat.

What digitisation and networking offer is a technological means of accelerating the Observation-Orientation-Decision components of the OODA loop. This is a philosophical and strategic dimension of this argument: exploiting information technology to accelerate operational tempo in a manner opponents cannot match.

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Whether the source of vital intelligence is a Special Forces team in a hide outside an enemy base, a satellite in orbit staring down with a 2-foot aperture thermal imaging telescope, or a fighter imaging an area with a 6-inch resolution synthetic aperture radar, that raw data is of no use until it can be processed and understood by a commander who needs to act upon it.

What digitised sensors and networks provide is a means of vastly accelerating the speed with which such information can be made available to support a decision. The ultimate aim in this game is 'realtime' access - the ability for a commander to observe from a distance an opponent's deployment and activities.

There is another dimension to networking. Transmitting information up and down the chain of command, and transmitting information from sensors to decision-makers and, in turn, to shooters is the 'conventional' aspect of this game. It amounts to accelerating the time proven techniques of command and control, and intelligence. The other dimension of the NCW paradigm is the ability to transmit information laterally, and to rapidly concentrate information from many sources.

The latter can be important in its own right, since it provides a means of discerning deeper patterns in an opponent's behaviour, and permits sharing of information at lower operational levels. It is often touted as the essence of NCW, but in reality is a facet of a more complicated problem.

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The Operational Dimension

Arguments centred in warfighting philosophy and strategy are vitally important, especially at strategic and force levels of understanding and conducting wars, but they capture only part of the bigger issue. At a basic operational level NCW yields its own benefits and challenges.

At the level of individual unit or combatant engagements, a key issue is situational awareness. This is true for a platoon about to assault an opponent's urban position, or a warship captain about to shoot a Harpoon into an opposing warship, or a fighter pilot about to pickle a bomb or squeeze off a missile.

Understanding the immediate situation is as important as understanding the broader situation. If the urban position is covered by remote and hidden sniper and machine gun positions, an otherwise optimal assault could become a costly disaster. If the enemy warship is baiting the warship commander to set him up for an air attack, or shore based cruise missile attack, positioning for a shot could lead to different and even costlier disaster. If the fighter pilot cannot see that the enemy stronghold he is about to bomb is filled with human shields, a different but no less disastrous problem could follow.

At the immediate operations level every commander is faced with the reality that an immediate situation fits into some context. Prosecuting an attack directed by his commander successfully requires an understanding of the surrounding environment. Historically that understanding was gained through a combination of intelligence provided by command, and immediate observation of the tactical situation.

The most successful warfighting forces have historically been those that have followed the 'directive control' model, where a front-line commander is given directives which set out aims or objectives, and is given maximum autonomy in planning and executing the operation. Success in execution is then a result as much of the available force at hand, as it is of the commander's understanding of the situation and his ability to exploit it to an advantage. The better the understanding of the broader environment, the greater the opportunities for a talented commander to take the initiative and gain possibly a much greater advantage than set out in his initial command directive. A good case study would be World War II Blitzkrieg advances by the Wehrmacht, the originators of the idea of directive control, or attacks by Allied pilots on high value targets of opportunity.

What NCW provides is a means of improving the autonomy of commanders in the field. A land force element commander can make much better decisions if he knows the exact disposition of the opposing force, and the disposition of reserves and supporting enemy assets. A naval commander can benefit immeasurably from knowing the whereabouts of enemy combatants within a 300 mile radius. A fighter pilot who knows the exact placement of enemy SAM and AAA batteries has many more options than a pilot flying in blind.

The ability to gather information over large areas or in focal areas of interest, digitally process it to find opposing force elements, and rapidly distribute it to front-line warfighters provides enormous advantages at every level of combat. If an infantry squad commander knows exactly which roofs are occupied by snipers his odds of success go up very significantly, and so on.

There is a darker side to the NCW paradigm (providing high speed digital communications to every front-line shooter) which enables a level of micro-management from headquarters that is unprecedented historically. The temptation for general officers in headquarters to meddle in distant engagements is considerable.

This is a reflection of the other side of the NCW operational equation - the human element. Humans and computers do not always mix well. Frequently humans will either reject the computer, or oppositely treat it as an infallible artifact. Both extremes reflect the reality that information processing and transmitting machines are not other humans, and the machines communicate information in very different ways.

To successfully absorb NCW into a defence force, it is vital that personnel have appropriate practical skills, but also a proper understanding of the limitations of the machinery. There is no substitute for good human judgement, as yet, and making best use of a powerful NCW apparatus requires exactly that. The combination of sensors, computers and networking equipment that makes up the NCW system is ultimately a means to an end, not an end in itself. A commander must still have the ability to rationally interpret the data provided, and to identify opportunities and to creatively exploit them to an advantage.

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NCW inherently offers at an operational level the ability to closely integrate air, land and sea forces. Surface bound forces, be they naval or ground forces, are inherently limited to their visual horizon in observing the surrounding environment, and thus see only a small portion of the larger battlespace. Air forces do not suffer this limitation. Their horizon at typical cruise altitudes is over 200 nautical miles away but they are limited by the resolution and capabilities of their onboard sensors.

The quid pro quo is inherent here: air power can provide tremendous wide area situational awareness to surface bound forces, and surface bound forces can provide air power with a detailed picture often impossible to get from 30,000 feet.

NCW provides a mechanism via which such valuable tactical information can be transmitted in either direction to gain an immediate advantage. An SAS team on the ground is apt to always perform better bomb damage assessment than a satellite in orbit. While air power holds a decisive advantage in the game of delivering heavyweight firepower quickly over large distances, and gathering large volumes of realtime information over large areas, it does not have the surgical effect of a sniper's bullet or the ability to climb into a bunker to determine if its occupants have indeed been killed by a strike.

NCW is often portrayed as being primarily of benefit to air warfare and naval warfare. The advantages to be gained by land forces are no less important. Real-time intelligence over wide and local areas is always valuable, and the ability to rapidly transmit aimpoint coordinates for a precision air attack is often the difference between winning and losing.

It is worth noting the numerous reports from Operation Iraqi Freedom indicating that US Marine Corps units accustomed to operating with organic close air support were much better able to integrate in an NCW environment with US Air Force, US Navy, US Marine Corps, RAAF and RAF fighters than were US Army units. This is a direct consequence of a Service culture which aims to break down distinctions between specialisations and a training regime centred in closely integrated all-arms operations. The lesson is that even with a superb NCW system in place, a force which is myopically centred in its own view of reality will not be able to fully exploit the opportunities offered by the technology.

The Technological Dimension

The technology supporting NCW is inherently complex, but not significantly more so than the technology used to digitise and network the civilian world.

A basic prerequisite for an NCW capability is the digitisation of combat platforms. A fighter plane, tank or warship with a digital weapon system can be seamlessly integrated in an NCW environment by providing digital wireless connections to other platforms. Without the digital weapon system, and its internal computers, NCW is not implementable. The growing gap between the US military and the EU military largely reflects the Europeans' reluctance to heavily invest in digitising their combat platforms.

Provision of digital wireless connectivity between combat platforms is a major technical challenge which cannot be understated. While civilian networking of computers can largely rely on cabled links, be they copper or optical fibres with wireless connectivity as an adjunct, in a military environment centred in moving platforms and field deployed basing, wireless connectivity is the central means of carrying information.

The problems faced in providing military networking are generally well understood, but often push the boundaries of available technology.

Key issues can be summarised thus:

1. Security of transmission is vital, since everybody does their best to eavesdrop. Therefore, digital links have to be difficult to eavesdrop and robustly encrypted to defeat any eavesdropping which might succeed. Even if a signal cannot be successfully decrypted, its detection provides an opponent with valuable information on the presence, position and often activity of the platform or unit in question.

2. Robustness of transmission is no less critical in the face of transmission impairments such as solar flares, bad weather and hostile jamming. If a signal cannot penetrate a rainshower or is blotted out by an opponent's barrage jammer, the link is broken and the NCW model also breaks down.

3. Transmission capacity is just as important, especially where digitised imagery must be transmitted. If a 10 Megabyte recce image must be sent, or a 2 Megabit/sec digitised video feed observed, a 9600 bit/sec channel will be nearly useless. A popular misconception is that 'digital data compression' solves this problem - the reality of Shannon's communication theory is very much at odds with this popular fantasy. Robustness against jamming and the overheads of encryption both work at the expense of transmission channel capacity for a given radio communications link.

4. Message and signal routing is an unavoidable evil, insofar as platforms must be able to specifically address and access other platforms or systems in an NCW environment. Just as email on a civilian network must have an address, so must a military messaging scheme.

5. Signal format and communications protocol compatibility is essential to ensure that dissimilar platforms and systems can communicate in an NCW environment. This problem extends not only to the use of disparate signal modulations and digital protocols, but also to the use of partially incompatible implementations of what is ostensibly the same signal modulation or communications protocol. The mutual incompatibility headaches we see in commercial computing are often more traumatic in the challenging military environment.

At present, nearly all military datalinks used in NCW operate at speeds that would be considered intolerable in the civilian/commercial world, reflecting the realities of wireless communications. Moreover, the military world lives with a veritable Tower of Babel in both signal modulations, operating frequencies and digital communications protocols, and variations of nominally standard protocols.

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To place this in context, Western armed forces currently deploy systems using a wide range of current and legacy signal formats and protocols, examples being:

1. Link 1 at 1200/2400 bits per second used for air defence systems, devised in the 1950s.
2. TADIL A/Link 11/11B at 1364 bits per second used for naval links and ground based SAM systems, using original CLEW DQPSK modulation, or newer FTBCB convolutional coding at 1800 bits per second. It is 1960s technology.
3. TADIL C/Link 4 at 5,000 bits per second in the UHF band, used for naval aviation, AEW&C to fighter links, and fighter to fighter links on the F-14 series. It is also 1960s technology.
4. Link 14 used for HF transmission between naval combatants at low data rates.
5. TADIL J / MIDS/JTIDS/Link 16 which is a jam resistant L-band time division spread spectrum system based on 1970s technology. While its time slot model permits some allocation of capacity, in practical terms it is limited to kilobits/sec data rates, over distances of about 250 nautical miles. JTIDS is multi-platform and multi-service and widely used for transmitting tactical position data, directives, advisories, and for defacto Identification Friend Foe. Its limitation is that it is ill suited to sending reconnaissance imagery and inherently tied to master stations which generate its timebase - reflecting its origins of three decades ago. Satellite link and higher data rate derivatives exist but retain the basic limitations of its time division technique.
6. CDL/TCDL/HIDL/ABIT which are US high speed datalinks design primarily for satellite and UAV transmission of imagery. CDL family links are typically assymetric, using a 200 kilobit/s uplink for control and management, and a 10.71, 45, 137 or 234 Megabit/s high speed uplink, specialised for the control of satellite/UAVs and receipt of gathered data. ABIT is a development of CDL operating at 548 Megabits/s with low probability of intercept capabilities.
7. Improved Data Modem (IDM) is used over Have Quick II spread spectrum radios to provide low data rate but secure transmission of targeting coordinates and imagery. It has been used widely for transmission of targeting data to F-15E/F-16C strike fighters and F-16CJ Wild Weasels. It is essentially an analogue to commercial voiceband modems.
8. Army Tactical Data Link 1 - ATDL 1 used for Hawk and Patriot SAM batteries.
9. PATRIOT Digital Information Link - PADIL used by Patriot SAM batteries.
10. Tactical Information Broadcast System - TIBS used for theatre missile defence systems.
11. PLRS/EPLRS/SADL are a family of US Army/Marine Corps datalinks used for tracking ground force units, and providing defacto Identification Friend Foe of ground units. EPRLs is also used for data transmission between ground units.
12. TCP/IP (Internet) protocol implementations running over other channels, to provide connectivity between platforms and remote ground facilities.

This veritable menagerie of datalink modulations/protocols is by no means exhaustive, but reflects the realities observed in the computer industry in the decades predating the Internet. New protocols like the Joint Tactical Radio System (JTRS) are in part intended to incorporate mechanisms for translating such legacy protocols into formats that can be sent over a common channel.

As yet there has been little effort to capitalise on the new technology of 'ad hoc' network protocols, designed for self organising networks of mobile platforms. The DARPA GLOMO program in the late 1980s saw considerable seed money invested, but did not yield any publicised dramatic breakthroughs. Ad hoc networking remains a yet to be fully explored frontier in the networking domain, one which is apt to provide a decisive technology breakthrough for NCW.

Conclusions

The ADF must clearly grapple with the emerging NCW paradigm. The payoffs in mastering it will be invaluable at operational and strategic levels, and the penalties in following many EU nations will be like military irrelevance over the longer term. With Australia's strong intellectual base in digital communications and networking, it has the potential to be very successful in NCW, providing that the problem is tackled rationally rather than in fad-driven fashion. The Department of Defence should not be shy about enlisting the aid of industry and academia in developing its NCW paradigm.

Wherein lies the biggest challenge in adopting NCW techniques? Major challenges will lie in formulating strategic doctrine and policy, in developing operational techniques and skills, and in understanding and integrating the technology into existing and future platforms and systems.

NCW is by its nature intellectually demanding, and will require more than the incantation of buzz words to implement.

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