Network centric warfare and the ADF health system

Wing Commander Peter R McLennan, PhD, MInfoSc, BE(Aero) and
Wing Commander Peter A White, AM, MEd(Health), GradDipAdmin(Data Mgt), DipMedTech

Wing Commander Peter McLennan *joined the RAAF in 1980. He was commissioned as an aeronautical engineer, and has undertaken a number of engineering, academic and management positions. He is currently Deputy Director for Strategic Planning in Air Force Headquarters.*

Wing Commander Peter A White *is a RAAF Laboratory Officer, now with the Reserve Staff Group. Head of the Australian Institute of Health and Welfare's Division of Information Management from 1992 to 2000, he played a leadership role in the development of some of Australia's key national health information resources.*

Air Power Development Centre, Tuggeranong, ACT.
Peter R McLennan, PhD, MInfoSc, BE(Aero), Deputy Director Futures Analysis. Directorate of Health Capability, Tura Beach, NSW.
Correspondence: Wing Commander P R McLennan, Air Power Development Centre, Level 3, 205 Anketell St, Tuggeranong, ACT 2900.
peter.mclennan@defence.gov.au

THE CONCEPT OF NETWORK CENTRIC WARFARE is assuming major importance for future defence capability. It continues to be the focus of numerous conferences and papers. It is one of very few growth areas within the Australian Defence Force, in terms of personnel allocation. But what exactly is network centric warfare, and does it have any implications for the ADF health system?

What is network centric warfare?

Network centric warfare (NCW) is a concept that is intended to enhance warfighting capability. It improves tactical command and control by accelerating the process of command decision-making. This is achieved by a significantly enhanced capability in the collection and distribution of intelligence. It contrasts with the historical approach in which a combatant (whether on land, sea or air) searches out adversaries, decides whether and how to attack, and then does so. NCW exploits the potential of the information age to separate these functions, and uses communications networks to link them.

In its simplest form, a networked force can be represented as three linked grids.[1] Our military elements are considered to be sensor nodes, command and control (C^2) nodes, and/or engagement ('shooter') nodes (Box).

What are the advantages of NCW?

The broad sharing of sensor information is intended to greatly increase knowledge of adversary capabilities, positions and intentions. This should allow us to target selected adversary forces more efficiently and accurately, while avoiding becoming targets ourselves. Moreover, by passing information electronically, it should be possible to achieve

Abstract

- Network centric warfare (NCW) involves linking military sensors, command and control, and engagement elements via a communications network.
- The Australian Defence Force has a plan leading to full implementation of NCW in about 2020.
- NCW is expected to change the nature of warfighting. This may have both positive and negative implications for the ADF health system.
- Telemedicine is a parallel concept to NCW. Operational and medical information may be communicated over the same networks.
- The parallels between telemedicine and NCW may shape the direction in which telemedicine is developed within the ADF, perhaps confining it to less sophisticated applications in the first instance.
- Implementation of NCW should take the needs of telemedicine into account.

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faster operations than those of the adversary, so the adversary will not have time to respond to our actions. A third advantage is that the clear distinction between the functions performed in each grid facilitates planning to minimise the extent to which our elements are exposed to threat, as sensor and C^2 elements can often be located at some distance from the highest-threat areas.

In addition to providing enhanced knowledge of adversary positions, NCW offers improved ability to monitor the location of friendly forces. This is often referred to as "blue force tracking". It allows selection of the most appropriate friendly element to deal with any threat, and helps to avoid injury by friendly fire.

To maximise its effectiveness, NCW needs fast, capacious and reliable communications networks. In addition, standard message formats must be used to ensure that information can be moved around the network quickly, concisely and in a manner that ensures that its meaning remains clear and stable. Although NCW is facilitated by such technology, the concept also has a strong human aspect. For example, it levies great demands for appropriate training, leadership, decision-making, organisation, and trust between people.

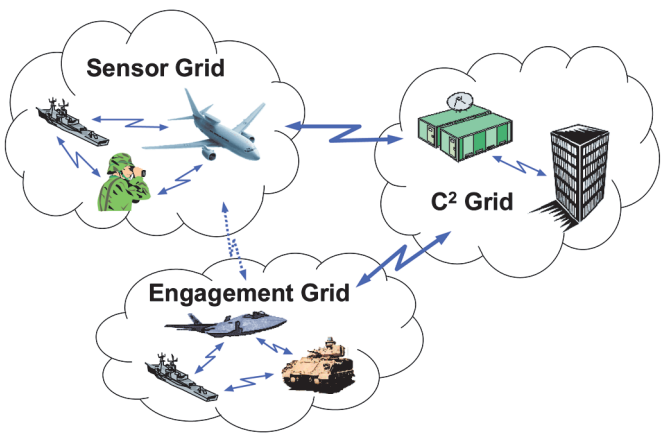
Pursuing NCW is not without risks. Failure to adequately address the human aspects could undermine the potential advantages of NCW. For example, we may become so addicted to information that we become unable to make decisions without perfect knowledge of the battlespace — an unreasonable expectation. From a technical point of view, our information networks would be obvious targets.

When will NCW be implemented?

In many regards, NCW is not really a new idea, but is resurgent. The basic principle of the separation between sensor, C^2 and engagement elements, linked by the communication of information, is ancient. In land battles of centuries past, observers on hilltops would convey their observations on the state of the battle via couriers to the general in his tent. Having used that information to decide a course of action, the general would have his intentions conveyed to the troops, again via couriers. The modern concept of NCW differs only in terms of magnitude: now we aim to integrate hundreds of elements operating in disparate environments (sea, land, air, space). These elements may be separated by thousands of kilometres, and may move at hundreds or thousands of kilometres per hour. The information flowing across each communication link is no longer limited to a few sentences, but may now comprise such bandwidth-hungry data as live video feeds. Moreover, in some situations, we aim to do this in near real time.

It will take decades before NCW is mature. However, some significant NCW-related goals have already been achieved. For example, during Operation Iraqi Freedom, the United States Air Force flew Global Hawk Uninhabited Aerial Vehicles over Iraq to gather imagery using their arrays of sensors. This information was passed via satellite communications links to the continental United States for analysis. Targeting information was then passed back to US Air Force or Army elements in Iraq, who engaged the targets. All of this took only a matter of minutes. In situations where the timeliness of information was critical, Global Hawk sensor information could be communicated directly to army elements that were closing with adversary

Network centric warfare grids



Sensors collect information on the adversary. This information is passed to the command and control (C^2) grid. Commanders within the C^2 grid may decide to engage selected adversaries, in which case tasking is passed to an appropriate element in our engagement grid.

forces. This allowed them to see what the Global Hawk had seen only seconds previously.[2]

NCW and the ADF

The ADF has a road map to guide the development and implementation of NCW. The road map describes a path from the current force through a second-generation networked force in about 2010, to arrive at a third-generation seamless NCW force in about 2020. Four main actions for guiding the ADF along this journey have been identified. These require us to:

- set NCW-related targets for the ADF in terms of each of our warfighting functions;
- establish the information network that links the sensor, C^2 and engagement grids;
- explore the human aspects of NCW and initiate appropriate changes; and
- accelerate the process of change and innovation using rapid prototyping and development.

A key issue for the ADF is interoperability with allies and coalition partners. It is highly desirable for the ADF's implementation of NCW to be compatible with those of other forces with whom we may operate. This would allow information and tasking to flow seamlessly throughout the coalition, which would remove the need for individual coalition partners to construct their own information pictures and would allow superior coordination of attacks. Beyond internal ADF networking, our priority is for a measure of interoperability with US forces.

The influence of NCW on the health system

The ADF NCW road map does not directly address health issues. However, we cannot conclude that NCW lacks relevance to the delivery of ADF health services. The relationship between NCW and health services may be viewed from two directions: the influence of NCW on the health system, and the influence of the health system on NCW.

As the main focus of NCW is on warfighting, it is easiest to assess the implications for health services supporting combat controlled by NCW. Greater knowledge about the adversary should reduce the risks to ADF forces, which should translate to reduced casualty rates. A similar outcome should follow from the ability to keep our sensor and C^2 elements further from the fighting, as fewer of our people would be exposed to maximum levels of risk.

However, NCW could have the reverse effect. The high tempo of operations permitted by NCW could increase the rate at which casualties occur, necessitating an increased surge capacity in our medical system. Moreover, NCW in enemy hands will undoubtedly increase the challenges facing the ADF response. For example, an adversary may gain better knowledge of the disposition of our forces, resulting in increased casualty levels. A third risk is that our NCW system may fail, perhaps because of successful attacks against our information grid. This could leave us blind and unable to operate effectively if we become too dependent on NCW.

This last point leads to consideration of the human aspect of NCW. Of particular interest from a medical point of view is the possibility of information overload.[3] There is a real risk that decision-makers could be overwhelmed by more information than they are able to assimilate — even when the volume of information was of their own choosing. This can result in decision-making paralysis, a psychological state in a decision-maker with the potential to jeopardise the lives of all allied combatants. Although there are technological and organisational approaches to reducing the risk of information overload, medical aspects should also be considered. For example, how do we screen potential commanders to assess their resistance to information overload? Can we monitor the health of commanders on duty to detect the onset of problems? How do we deal with the situation once detected?

The influence of the health system on NCW

Clearly, NCW may influence the future development of the ADF health system. But is there scope for the health system to influence the future development of NCW?

Like NCW itself, the idea of enhancing health services through information system networking is not new. The US military services were investigating the provision of medical services at some distance from the patient, or "telemedicine", in the early 1980s.[4]

The simplest use of networking to assist with the provision of deployed medical services is to improve access to patients' medical records. The US Army deployed such a system during Operation Iraqi Freedom; this allowed injury information collected in the field to be electronically transmitted to medical centres or hospitals, where subsequent treatment was administered.[5]

An extension of this concept is to collect and transmit condition information on all deployed personnel automatically and continuously. This could be integrated with the NCW requirement for "blue force tracking": not only the location of friendly forces, but their individual vital signs could be ascertained by means of personal status monitors. Researchers are working on miniature sensors, only a few millimetres in size, that can automatically collect and transmit information on an individual's body temperature, blood pressure, blood oxygen level, pulse rate, and electrical conductivity in the skin (which is an indicator of stress).[6]

Perhaps the most interesting aspect of telemedicine is the potential for remotely located specialists to assist with the diagnosis and treatment of patients in deployed areas. Such a system was tested by the US Army at a mobile army surgical

hospital (MASH) unit in Bosnia in 1996. A medical field worker could perform three-dimensional scans of ill or injured soldiers, and the raw information was transmitted to doctors at a military hospital in Germany. The doctors would examine that information using a simulated ultrasound probe just as if they were examining the patient directly.[7]

In general, telemedicine systems can provide access to any kind of medical specialist regardless of the location of the patient and specialist. In addition to ultrasonic equipment, a telemedicine system may include a wide-band video camera, video teleconferencing equipment, and a general-purpose endoscope for eye, ear, nose and throat examinations, all connected through a computer to a satellite communications terminal. Teleradiology and teledentistry are also realities.[8]

Remote assistance may enable better diagnosis and treatment of casualties during the critical period immediately following injury. This is especially beneficial when rapid evacuation is not feasible, and reduces the number of casualties that need to be evacuated. Moreover, the networking of patient information, coupled with the increased visibility of military assets provided by NCW, should allow for faster evacuation when necessary.

Relations between telemedicine and NCW

Are telemedicine and NCW related? Both concepts feature a separation between observation, expert decision-making, and response — all linked via an information grid. It is the information grid that links the two concepts in practical terms, as both operational and medical data may flow over the same information networks. This is the case with some of the military telemedicine systems that have already been fielded. Although this arrangement is more efficient, it does tempt network managers to sacrifice capacity for medical information flow in favour of operational needs.

The linkage between NCW and telemedicine is therefore a double-edged sword. The establishment of networks to support NCW provides opportunities for telemedicine that might not otherwise be available — but in an environment where communications bandwidth will be contested, constrained and potentially unreliable. Telemedicine applications, particularly multimedia applications combining voice, image and data transmissions, often require real-time, uninterrupted interaction between source and destination. Such requirements place heavy demands on bandwidth, and it may not be possible to consistently satisfy such demands in the NCW environment.

The issue of certainty of telecommunications for telemedicine was explored in a 2002 discussion paper prepared by the National Office for the Information Economy (NOIE).[9] NOIE concluded that, whereas unreliable connections can be annoying in other sectors, in health (when information is needed at the time of the issue and delays can be life threatening), reliability becomes paramount. Even in routine consultation support, it was found that medical practitioners would be unwilling to use the facilities if they did not work well every time they were required. This is especially true for high-end systems such as surgery using robotics, in which any kind of delay or outage could be catastrophic.

A compromise solution may be to emphasise less ambitious applications of telemedicine. For example, email-like asynchronous (or "store and forward") methods are significantly less demanding on bandwidth and are more tolerant of delays, and are already used for teleradiology, telepathology, teleultrasonography, teleECG and similar diagnostic support applications.[10]

Although store and forward communication strategies may not support the full potential of contemporary telemedicine, they may be more confidently deliverable in the NCW battlespace. In addition, in a bandwidth-limited environment, the use of low-bandwidth applications would enable more competing applications to share the available capacity. Low-priority data could be held for transmission during periods of reduced network activity, and high-priority data would be transmitted as quickly as possible. Ideally, critical health applications could be accorded sufficient priority on the network to allow real-time interactive telemedicine.

The risk of loss or degradation of meaning of information is perhaps greater with asynchronous communication than it is with continuous or face-to-face communication. NCW addresses such problems through the use of standard message formats. There are several initiatives within the health community that could lead to an equivalent system, such as the adoption of a controlled vocabulary (eg, SNOMED CT[11]) or data dictionary (eg, Australia's National Health Data Dictionary[12]).

The full potential of telemedicine in the battlespace is clearly profound, but is inevitably dependent on overall communication capability. As the NOIE authors found, an appreciation of the communication limits and potential of a particular environment is paramount. Exploiting the NCW electronic data capacity will require realistic assessment of needs and priorities on the part of military health planners.

Telemedicine requirements should be an important input to NCW telecommunications planning and development. The recently established Centre for Military and Veterans' Health (*see page 44*) at the University of Queensland has a charter to explore the wider field of e-health, and could play an important role in influencing NCW implementation.

Conclusion

NCW aims to enhance our warfighting capability by linking our sensors, C^2 and engagement elements via an information network. This should provide superior information and permit higher operational tempos. The ADF has a plan for the development of NCW that aims for a mature implementation by 2020.

NCW may have significant implications for the ADF health system. NCW should result in reduced casualty levels, but enemy capacity in NCW could produce the opposite effect. Moreover, NCW may pose new challenges in the area of mental health.

Telemedicine will have a large part to play in the health sector's role under NCW. Contemporary health care is multifaceted: it involves the transmission of health information from multiple disparate sources, including medical records and health monitoring of deployed personnel. It may also include access to remotely located medical specialists to assist with diagnosis and treatment. The relationship between information-rich health care and NCW is very real and suggests that the ADF's implementation of NCW should be influenced by health considerations. Even so, it remains likely that the full potential of telemedicine will not be realised in the short term. Nevertheless, the pace of development in telecommunications is remarkable, and what is impossible today may well be achievable tomorrow.

In this changing technological world, ADF health care professionals need to keep abreast of the development and implementation of NCW.

Competing interests

None identified.

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Editorial comment

McLennan and White provide a plausible methodology based on developments in the United States Department of Defense, specifically, the Theatre Medical Information Program. This is a program of programs based on a distributed database network within a specific area of operations. However, there has been significant development of e-health concepts in the Australian Defence Force in recent years, specifically those described in the JP 2060 Operational Concept Document and those described in the Operational Concept for BCSS. The importance of interoperability is also stressed in the Defence White Paper.

McLennan and White should be applauded for their attempt to bridge the information gap that exists in health informatics. Nevertheless, the implications of network centric warfare (NCW) for information security and privacy issues within health and the wider ADF community still need to be addressed.

Telemedicine is but one aspect of the NCW model of e-health that could be adopted. There are wider e-health components available, such as clinical decision support, knowledge management, patient tracking, health materiel management, and health personnel management. Telemedicine will reduce the medical footprint, but it is not a panacea for all health informatics requirements. It would form part of a technological continuum of e-health, but is only likely to be adopted after cheaper and simpler technology has been implemented.

Commander Ken Walters RAN
Head, Health Centre, HMAS *Cerberus*
Commodore Graeme Shirtley RANR
Chairman, Medical Imaging Consultative Group, ADF