The Revolution in Military Affairs and Australia's Defence Industry Base, 1996-2006

Peter Hall and Robert Wylie

Australia's defence industry exports are modest. Hence the Australian defence industry base is predominantly shaped over time by domestic defence capability demand, commercial responses to that demand, and preference for domestic industry in defence procurement. Australian defence demand was preconditioned by the nation's geographic and economic circumstances in favour of the Revolution in Military Affairs (RMA) thinking. But in adapting that thinking to Australian circumstances defence planners embraced the less expansive concept of network centric warfare comprising command/control, sensor and engagement elements. As Australian industry has responded to both growth and change in defence procurement demand, foreign subsidiaries have come to occupy an increasingly dominant role in the sector, raising questions about how new technology will in future diffuse in the Australian defence environment.

In exploring the extent to which the Australian Defence Industry Base (ADIB) met the nation's demand for network-enabled capabilities we have focused on the period 1996-2006. While the US defence policy community began debating Revolution in Military Affairs (RMA) ideas earlier, they did not enter the Australian defence policy discourse until 1996. In that year, a specialist trade journal, the *Australian Defence Magazine (ADM),* began publishing systematic information on the largest 40 defence firms in Australia. By 2006, Australian defence planners had relinquished some of the more grandiose RMA notions in favour of a more evolutionary concept of network centric warfare (NCW) that, in the Australian context, had its antecedents in the Australian Defence Force's prior efforts to maintain a knowledge edge over regional forces. The involvement of many of Australia's top forty defence firms in knowledge edge/NCW-related business during the decade enables us to trace the impact of that business on the ADIB as a whole and to judge future trends.

The paper is organised as follows. In 'From RMA to NCW: Australia's Journey' we sketch the evolution of Australian defence thinking from pursuit of a 'knowledge edge' to focus on NCW capability. 'Australian Defence Industry Base: 1996-2006' examines the ADIB in 1996 and 2006 and identifies changes in structure and ownership during the period linked to involvement in NCW-related business. A first step towards understanding what drove these changes is taken in 'Demand for NCW-Related Capability' where we show how the pursuit of knowledge-based military advantage has been reflected in substantial defence procurement demand growth for related capability. 'Policy: Defence Industry, Procurement, and Broader Policy Constraints' briefly discusses elements of the policy environment that could have influenced decision-makers' thinking about promoting local industry involvement in meeting the demand. 'Information Capability-Related Contract Awards' briefly examines selected NCW-related contracts and, recognising that such work was in important instances awarded to firms headquartered overseas, seeks to link growth in NCW-related business to observed changes in the ADIB itself. 'RMA-related Adjustment of the ADIB' offers a synthesis and gauges likely future trends.

From RMA to NCW: Australia's Journey

In the wake of the 1990-1 Gulf War, RMA protagonists in the United States began characterising war as

> a deadly contest in which the side that best understands the battlespace and can best transfer that knowledge among its own elements to apply force faster, more precisely and over a greater distance wins.[1]

The appeal of such RMA-thinking to Australian defence planners had much to do with the nation's geography and demographics.

The country covers 12 percent of the earth's surface, has the world's longest coastline but is populated by a mere twenty-one million people. While this population cannot sustain a large defence force, it is well educated and a ready adopter, absorber and adapter of new technology. Hence the RMA appeared to offer capabilities with a potentially valuable 'force multiplier' effect that could extend and deepen the capability of the Australian Defence Force (ADF), and perhaps more potently than it could for potential adversaries in the region.[2]

It is convenient to begin tracing the evolution of Australia's approach to NCW from the publication of *Australia's Strategic Policy, 1997* (*ASP 97).* Earlier notions of 'knowledge dominance' were here superseded by the idea of achieving a Knowledge Edge, defined as the "effective exploitation of information technologies to allow us to use our relatively small force to maximum effectiveness". In November 1999 Defence established the Office of the Revolution in Military Affairs (ORMA) to work out a transformation strategy to adapt components of RMA technology for the Australian environment and to see what organisational and doctrinal changes would be required to incorporate future warfare concepts into the ADF.[3]

---

[1] Owens (2002), cited in T. Benbow, *The Magic Bullet? Understanding the Revolution in Military Affairs (*London: Brasseys, 2004), pp. 80-1.
[2] Paul Dibb, 'The Revolution in Military Affairs and Asian Security', *Survival*, vol. 39, no. 4 (1997-98), p. 112.
[3] M. Evans, *Australia and the Revolution in Military Affairs*, Land Warfare Studies Working Paper No. 115 (Canberra: Land Warfare Studies Centre, 2001).

Two features of the Australian environment prompted Australian Defence planners to emphasise the Knowledge Edge. First, nations in the Asia-Pacific region were investing heavily in military modernisation. Second, Australia's maritime and air platforms were moving into the later stages of their useful lives. Australia, seeking to respond and rebuild, looked to retain strategic advantage through adopting RMA concepts and technology. As the Defence White Paper published in December 2000 (*Defence 2000: Our Future Defence Force*) put it:

> RMA technologies impart the ability to know more than one's adversary in relevant areas. This can result in a decisive military advantage when linked with appropriate weapons and concepts of operation.[4]

The ORMA lasted less than five years, however, before being subsumed by the Capability Development Group as the Network Centric Warfare Program Office.[5]

The Australian version of NCW capability, while incorporating many of the RMA technologies foreshadowed in *Defence 2000*, was firmly embedded in an ADF conceived as a dynamically evolving, but not a revolutionary, military institution.[6]

While Australian defence planners accept that improved integration and connectivity can lead to enhanced military effectiveness, they are yet to determine how best Defence can, and to what extent it should, embrace concepts and technological solutions developed elsewhere. Australian NCW policy emphasises that "while NCW can be a powerful means to an end in the ADF context, it will never be an end in itself".[7] Using NCW to enhance ADF military capability involves effectively using a network to link:

- A command and control grid capable of flexible, optimised decision making;
- A sensor grid to detect targets; and
- An engagement grid that permits precision engagement of targets.

The output of such networking is enhanced situational awareness, collaboration and offensive potential:

> Personnel within the networked force rely on secure and responsive linkages (network connectivity) that allow the right information to be

[4] *Defence 2000: Our Future Defence Force*, Defence White Paper (Canberra: Commonwealth of Australia, 2000)
[5] Department of Defence, *NCW Roadmap 2007* (Canberra: Commonwealth of Australia, 2007), p. 18.
[6] For a fuller description see Department of Defence, *Joint Operations for the 21st Century* (Canberra: Commonwealth of Australia, 2007), p. 3
[7] Department of Defence, *NCW Roadmap 2007*, p. 1.

> accessed at the right time by the right force elements. Increases in combat power from being a networked force are derived from the quality and timeliness of shared information and through the exploitation of new system and command relationships.[8]

Achieving this output is a long term project that will require the concurrent development of the network, human and networking dimensions of NCW. To date, Australian capability planners have focused on the *network* dimension of NCW in an effort to connect ADF engagement, sensor and command systems. Change in the network dimension is expected to have profound influence on the *human* dimension of NCW. The human dimension "is about the way people collaborate to share their awareness of the situation so that they can fight more effectively".[9] Realising the human dimension will require high standards of training, education, doctrine and leadership. While Australian defence planners claim significant progress with the network dimension of NCW, they acknowledge that

> only preliminary work on the requirements for the human dimension of NCW has commenced to date. The cumulative effort required to realise the human dimensions of NCW could well outstrip the more readily understood network dimension aspects of NCW.[10]

The *networking* dimension of NCW is about how Defence's current and future networks—both human and technical—interface or collaborate to build a self-synchronising, self-informing system of systems. In developing the network, human and networking dimensions of NCW Defence planners have embraced the concept of learning by doing.[11] Currently, NCW-related experimentation is focused on determining the optimum balance of sensors to engagement systems required to generate the right effects at the correct time and place in the battlespace.

Clearly, while Australian defence planners do not rule out what, in retrospect, might be considered revolutionary change in Australian military affairs, to date their NCW planning has followed an evolutionary path. In tracing this evolution we would expect to see very substantial legacies of past investments in elements of what would now be termed NCW capability, particularly in:

- command and control systems;
- sensor systems;
- engagement systems; and

---

[8] Ibid., p. 5.
[9] Ibid., p. 7.
[10] Ibid., p. 12.
[11] Ibid., p. 20.

- the information network.

In order to analyse the role of local industry in supplying and supporting such investments in NCW capability, we turn now to an analysis of the Australian defence industry base overall.

Australian Defence Industry Base: 1996-2006

Definitions of 'defence industry' are always contentious.[12] In this paper we have adapted a definition by Allen Consulting (1992) that, to be deemed part of the Australian defence industry base, suppliers require either a 'close' commercial relationship or 'direct support' relationship with Defence. Within this framework, the following analysis of the Australian defence industry base uses the standard Australian defence sub-division of the defence industry base as follows:

- Aerospace;
- Maritime;
- Vehicles and land systems;
- Weapons and munitions; and
- Electronics.

Defence allocation of projects to the above industry sectors is based on the proportion of estimated expenditure attributed to that sector. This methodology is particularly significant in the case of the electronics sector because Defence separates out the major electronic systems from the platform element of major projects. It attributes those electronic systems to the electronic sector rather than to, for example, the maritime or aerospace sector responsible for producing the host platform.

To analyse change in the ADIB on this basis we draw on firm-level information published in *ADM* to identify the largest forty firms supplying Defence in Australia in 1996 and 2006. We judge that the value of production for Defence by these firms accounts for a sufficiently large share of the ADIB effort to support more general observations about the evolution of the sector over the ten-year period.

[12] Todd Sandler and Keith Hartley *The Economics of Defense* (Cambridge: Cambridge University Press, 1995), Chapter 7.

Table 1: Total Defence-Related Turnover ($A2006 million)

	Top Forty	Top Ten	Top Two
1996	3 011	2 258	ADI (691) Transfield Defence Systems (542)
2006	6 171.4	4 124	Thales Australia (705) Tenix (680)

Source: Australian Defence Magazine (December 1995-January 1996), pp. 22-34; price conversions by authors.

In Table 1 we summarise the *total defence-related turnover* (2006 prices) of the top forty firms in 1996 and 2006. The largest two players in 1996, ADI Ltd and Transfield Defence Systems were well ahead of the next two players, Australian Submarine Corporation ($A343 million)[13] and British Aerospace Australia ($A335 million). These four firms are *clustered at the top* of the list, well ahead of the next largest, Boeing Australia Limited ($A206 million). Estimated total defence sales for the top two firms ($A1233m) account for two thirds of such sales by the top five.

In terms of *specialisation*, about 90 percent of players are single-sector suppliers but the largest, ADI, spans five sectors and is easily the most diversified—the correlation between sectoral diversity and relative firm size reflecting observations in international rankings.[14] The next most diversified, British Aerospace, operates in three sectors and Transfield and Boeing both produce in two. In terms of the *number of players per sector*, there tends to be polarisation, three sectors having eleven or twelve each, two having only two or three.

By 2006, and in real terms, total defence-related turnover for the top forty was over twice the turnover of the top forty in 1996, while the turnover of the top ten was up 62 percent up on a decade earlier in real terms. During the decade, Thales Australia bought ADI and Transfield changed its name to Tenix Defence Pty to reflect changed ownership arrangements. Otherwise the two largest players remained the same. Clustering at the top is, however, less marked. Estimated sales for the fourth- to tenth-ranked firms, at $A2.4bn, is now 25 percent *larger* than the total revenue of the top three. Specialisation by sector remains a feature: over 85 percent of all firms operate in only one sector. On the other hand, firms that already spanned multiple sectors in 1996 continue to do so, some of them having, in fact, diversified further. For BAE Systems (previously British Aerospace

[13] SIPRI (Stockholm International Peace Research Institute), *SIPRI Yearbook 2007* (Stockholm: SIPRI, 2007). Estimate based on 1995-96 defence expenditure on the new submarine project for which ASC was prime contractor.
[14] ADI resulted from decisions to corporatise and subsequently sell into private hands munitions and clothing factories and naval dockyards formerly owned and operated by government. ADI was thus a diversified business as a consequence of its history.

Australia), such diversification has been associated with impressive, five-fold sales growth. The number of players is larger in four out of six sectors in 2006 than 1996—much larger, at twenty rather than seven, in communications and information technology. It was steady in maritime and fell in electronics. Growth in the number of players in other sectors (especially Communications and information technology) partly reflects a trend to outsourcing 'non-core' defence-related activities that began with the Commercial Support Program (CSP) in 1990.

The pattern of ADIB ownership changed significantly over the decade. In 1996, of the three largest contractors (ADI, Transfield Defence, and the Australian Submarine Corporation (ASC)) two were wholly Australian owned with the Australian government having a 49 percent interest in the Australian Submarine Corporation. In 1996, therefore, the core of Australia's defence industry was locally owned and controlled. By 2006, Thales had taken over ADI and the firms now ranked third, fourth and fifth (BAE Systems, Raytheon and Boeing) were also local subsidiaries of overseas firms. ASC had become a much smaller player (now ninth in the rankings), having delivered all six Collins Class submarines it had contracted to build. This major shift towards direct or indirect overseas ownership in the ADIB would be heavily reinforced when BAE Systems bought Tenix (previously Transfield) in 2008, leaving ASC as the only major company with a significant Australian ownership.

This trend appears to reflect a pragmatic distinction by Defence between foreign ownership of the companies concerned and the nationality of the individuals involved in particular contracts for the supply and support of specific items of defence equipment. Defence has placed even sensitive electronic warfare-related contracts with foreign-owned companies provided the individual managers and workers involved are subject to Australian national security laws, regulations and procedures and the facilities comply with Australian industrial security requirements.

As we explain in greater detail below, the total number and value of NCW-related projects noticeably increased over the decade to 2006. Related to that trend, we note first that most or all of the *largest* players in the ADIB had at least some involvement in NCW-related projects. One major player, Tenix, was engaged in NCW-related projects partly in its own right and principally via RLM, a Tenix—Lockheed Martin consortium.[15] Tenix and BAE Systems were regarded as Australia's leading electronic warfare specialists and partly for that reason it made sense that they should ultimately form a single corporate entity. On the other hand, large size is not a necessary condition for participation in NCW-related projects. For example, CEA Technologies (the twenty-sixth largest company in the 2006 list) appeared as

[15] Lockheed Martin bought out Tenix's share of RLM in 2007, leaving RLM as a Lockheed Martin subsidiary.

a relatively small (though growing) player in the ADIB throughout the period.[16] Similarly, Defence contracted Codarra Advanced Systems (a smaller firm than CEA Technologies) to provide project management and systems engineering services for the command, control, communications, computing and intelligence elements of the new Headquarters for the ADF's Joint Operations Command being built near Canberra. As a second observation, NCW-related projects attract both NCW-related *specialists* like CEA Technologies, Rockwell Collins and Sun Microsystems and firms that are *sectorally diversified* (e.g. Thales, BAE Systems, Boeing and Saab Systems). Specialisation in NCW-related business sustains relatively numerous small and medium enterprises like L-3 Nautronix which specialises in through-water communications for submarines and the supply and support of facilities for managing submarine acoustic signatures.

Comparing 1996 with 2006, the NCW-related sector of the ADIB experienced significant *structural turbulence*. On the one hand, NCW-related business attracted new entrants such as Raytheon, Rockwell Collins and Sun Microsystems. But, uniquely among the six sectors, there was nonetheless a net decline (from twelve to nine) in the number of top forty defence contractors operating in electronics, communications and information technology sectors. This reflected the disappearance of firms like Telstar Systems, Telstra Applied Technologies and Vision Systems and the absorption of GEC Marconi and Siemens Plessey into BAE Systems. Previous experience with the contracting out of non-core areas of defence activity may help explain Defence's increasing readiness to outsource NCW-related business to private contractors in sensitive areas such as strategic communications. But outsourcing NCW-related business was accompanied by a fall in the number of players, implying an increase in the average value of work per contractor. In 1996, local defence industry activity was dominated by naval ship building, and NCW-related work was, with perhaps the exception of Jindalee Operational Radar Network, small in scale and value. By 2006, NCW-related projects were much more strategically and commercially significant and carried heavier price tags.

As a first step towards understanding the forces reshaping the ADIB, we turn in 'Demand for NCW-Related Capability' to showing how the pursuit of knowledge-based military advantage was reflected in the growth of demand for NCW-related capability.

Demand for NCW-Related Capability

By 1996 the quest for a knowledge edge had already caused Defence to initiate many projects that would later feature prominently in the network,

[16] CEA Technologies reportedly sold 49 percent of its equity to Northrop Grumman in March 2006 with a view to enhancing CEA's access to international markets and continuing its growth trajectory.

command/control, sensor and engagement elements of the NCW-related capability discussed in 'From RMA to NCW: Australia's Journey' above. For example, the foundations of the sensor element of Australian NCW capability were laid by the Jindalee Operational Radar Network (JORN), a $1.1 million contract let in 1991 to a consortium comprising the then Telstra, GEC Marconi and other companies. Early antecedents of the command/control element of NCW capability included the $616 million High Frequency Modernisation project (HFMOD); the Military Satellite Communications (MILSATCOM) project to provide long-range satellite communications capability for mobile Australian Defence Force (ADF) assets, the ADF Joint Command Support Environment, the earliest phases of which were approved in 1994-5 and the Australian Tactical Automated Command and Control System (AUSTACCS dating from 1992) and its successor, the Battlefield Command and Support System. An important precursor of the information network component of NCW-related capability approved in 1996 included the ADF Distributed Intelligence System. NULKA (an active missile decoy for use by naval surface combatants) was an early antecedent of the engagement element of NCW-related capability.

Over the decade new forms of NCW-related demand emerged. For example, electronic warfare self-protection (EWSP) was installed on the Royal Australian Air Force's (RAAF) twelve C-130J transport aircraft, the Army's 38 S-70A-9 Black Hawk helicopters, the Army's four CH-47D Chinook helicopters and the Royal Australian Navy's (RAN) seven SK-50A Sea King helicopters, and the EWSP on the RAAF's twenty-one F-111 aircraft was replaced. The EWSP included radar warning, missile warning, and active electronic counter measures. At its hub was the ALR 2002 radar warning receiver developed by the Defence Science and Technology Organisation (DSTO),[17] subsequently sidelined for use on the RAAF F/A-18 once access was gained to relevant US technology. Nevertheless, by 2005-06 Defence was scheduled to spend a cumulative total of $89 million on EWSP for other fixed and rotary wing aircraft, and in 2006-07 alone it was scheduled to spend some $62 million.

In 2004, Defence signed a contract with Boeing Australia for acquisition of new air defence command and control systems at an estimated cost of $253 million. These systems, when combined with Boeing airborne early warning and control aircraft, constitute a major step toward a capability for network enabled operations by the ADF. By 30 June 2006 Defence was scheduled to spend a cumulative total of $91 million on these air defence command and control units.

[17] This system was licensed to BAE Systems Australia (for installation/integration on rotary wing aircraft at a cost of $135.5 million) and to Tenix (for installation/integration on C130J at a cost of $25 million).

There is strong continuity between these projects and future plans to develop NCW-related capability as outlined in public versions of Defence Capability Plans (DCP) and the NCW Roadmap.[18]

Defence plans to deploy a networked maritime task force by 2010 and to network the entire fleet by 2014. To deploy a networked maritime task force Defence is investing in further phases of the MILSATCOM project, additional phases of the maritime tactical wide area network and upgrading data links on the Orion AP-3C long range maritime patrol aircraft. Networking the entire fleet by 2014 will depend on the introduction into service of air-warfare destroyers and amphibious support ships.

Networking in the land domain has focused on, initially, networking the Special Forces at the unit and sub-unit level. Defence plans to deploy a networked special operations task force by 2012 and to deploy two networked brigades by 2014. This will entail investment across the full spectrum of command/control, sensor, engagement and network components of NCW capability.

Realisation of a networked aerospace domain will be similarly phased. The initial networking of the aerospace domain—now largely complete—involved deployment of a networked air combat capability via the provision of tactical data links between ANZAC frigates and F/A-18 aircraft and via the introduction into service of airborne early warning and control (AEW&C) aircraft. This was complemented by the award of a contract to Boeing Australia for the supply and support of an integrated air defence system (Project Vigilaire). The next stage involves investment in a rapid mobility force based on Boeing C17 Globemaster aircraft and Airbus A330-200 multi-role tanker aircraft. Defence plans to support these assets by enhanced deployable command/control systems and a transportable tactical air defence radar system. The sustainability of networked air combat and rapid mobility forces is to be enhanced by investment in further phases of the Joint Command Support System and of the improved logistics information systems.

By 2014 network enabled operations in the aerospace domain will be enhanced through deployment of highly capable, long range intelligence, surveillance and reconnaissance sensors via AEW&C aircraft, a multi-mission unmanned aerial system and the upgraded AP-3C long range maritime patrol aircraft already mentioned. By then Defence plans to augment the network element of the system with an integrated broadcast system that will manage and disseminate (via the MILSATCOM and tactical data links already mentioned) tactically significant information from

[18] This section draws heavily on the public versions of Department of Defence, *Defence Capability Plan 2006-2016* (Canberra: Commonwealth of Australia, 2006); Department of Defence, *NCW Roadmap 2007*.

Australian and allied intelligence, surveillance and reconnaissance assets. The sensor element of this NCW capability will be also augmented by mature phases of the space-based surveillance capability (scheduled for decision round 2014) and upgrade of the Jindalee operational radar network.

Taken together, these investments in NCW capabilities will drive annual expenditure on electronics from some $A500 million in 2007-08 to over $A2000 million by 2011-12. Total expenditure on the Defence Capability Plan 2006-2016 is expected to average $A5 billion a year, of which expenditure in the electronics sector of defence industry (both local and overseas) is expected to account for some 46 percent, compared to expenditure in the aerospace sector of 26 percent, in the maritime sector of 11 percent, vehicles and land 10 percent and weapons and munitions 7 percent. At issue is how much of that expenditure will be incurred locally in ways that affect the ADIB. In the next section we briefly examine the policy context in which that question has been considered since the mid-1990s.

Policy: Defence Industry, Procurement, and Broader Policy Constraints

To understand how and why capability demand has been translated into the award of contracts to be carried out *in Australia rather than elsewhere*, it is necessary to appreciate the policy environment in which demand was being exercised. We look in turn at defence industry policy, procurement policy and broader policy constraints.

DEFENCE INDUSTRY POLICY

The *Defence 2000* White Paper provides a useful summary of the plethora of defence industry policy statements promulgated over the decade of our study. *Defence 2000* called for a sustainable and competitive defence industry base, able to support a technologically advanced defence force. This implies in-country support for repair, maintenance, modification and provisioning and, possibly working with DSTO and other research and development (R&D) agencies, "a capacity to develop new solutions for the ADF's capability needs", particularly in niche areas where there are needs unique to the Australian environment and it is cost-effective for Australia to innovate.[19] Within this framework, highest priority was accorded Australian defence industry capacity to supply and support NCW capability, including: combat and systems software and support; data management and signal processing, including for information gathering and surveillance; and command, control and communications systems.[20]

We do not seek to suggest, however, that Defence has pursued local industry involvement in NCW-related business regardless of the cost,

[19] *Defence 2000: Our Future Defence Force*, p. 99.
[20] Ibid., pp. 99-100.

schedule and technical risk involved. In fact, we would argue that the government's enthusiasm for expansive Australian industry involvement policies was probably tempered during the period by growing awareness in the media and the Parliament of the technical and managerial difficulties encountered by, for example, the JORN project (see below) and COLLINS Class submarine.

The latest iteration of defence industry policy was promulgated in 2007. The new policy focused on a series of initiatives aimed at identifying and sustaining priority local industry capabilities.[21] Such capabilities have yet to be promulgated and, following a change of government in November 2007, are on hold pending publication of the new government's defence white paper. In the meantime, the latest defence industry policy iteration represents little advance on previous versions.[22]

PROCUREMENT POLICY

In 1996, the then Minister of Defence Industry, Science and Personnel, Bronwyn Bishop required foreign firms seeking to do defence business in Australia to show long term commitment to the country by participating in major defence contracts, undertaking significant investment in facilities, plant and R&D in Australia, and creating substantial employment opportunities for Australian citizens. By 1998, however, the Minister was acknowledging that Defence would have to do business with multinationals to obtain access to NCW-related IP and technology but wished to signal its intention of dealing on preferred terms with overseas suppliers that would undertake to transfer that technology to the ADIB actively.[23]

Five years later, in his review of the Defence procurement processes Malcolm Kinnaird laid out an integrated approach to the management of defence business that facilitated the subsequent procurement of NCW capabilities.[24] As one consequence of the Kinnaird review, the Government established the Capability Development Group. The NCW Program Office was established within that Group to ensure that the ADF evolves into the comprehensively networked force described in the previous section. To this end the NCW Program Office works with capability development staff and

---

[21] Australian Government, *Defence and Industry Policy Statement 2007* (Canberra: Commonwealth of Australia, 2007), pp. 13-4.

[22] R. Wylie, 'A Defence Policy for Australian Industry: Are we there yet?', *Security Challenges*, vol. 3, no. 2 (2007), pp. 70-1.

[23] B. Bishop, 'Doing Business in Australia', Press release of speech made at the official opening of Rockwell Collins Australia Pty Ltd, 19 January 1998, at <www.minister.defence.gov.au/1998/s980119.html> [Accessed 21 October 2007].

[24] Department of Defence, *Defence Procurement Review* (Kinnaird Report) (Canberra: Department of Defence, 2003), pp. 11-20.

defence procurement staff to ensure that ADF capability development complies with the requirements of NCW integration and architecture.[25]

Within this framework the NCW Program Office sponsors the Rapid Prototyping, Development and Evaluation Program (RPDE) to facilitate local industry involvement in supply and support of Australian Defence Force capabilities for NCW. As a collaborative venture between Defence and local industry, RPDE complements the high level Defence Capability Planning process by addressing the more immediate 'bite-sized' problems that the ADF encounters in fielding NCW capabilities.[26]

BROADER POLICY CONCERNS

Local industry involvement in supply and support of ADF capability for NCW reflects the tension between two divergent national interests. On one hand, and in order to obtain best value within the perennial constraints of the defence procurement budget, Defence relies heavily on privileged access to NCW-related innovation by, in particular, the United States. (Australia's choices here are also influenced by Australian commitments to join UN-sanctioned international operations to help manage security in the region and supporting 'wider interests' through contributing to coalition operations, i.e. operations involving the United States and its allies).[27] On the other hand, and in order to husband the fruits of its massive investments in NCW-related innovation, the US Government exerts close control over the release of such innovation to its friends and allies, including Australia. Specifically, Australian access to US-origin NCW-related technology is subject to case by case licensing by the US State Department under the US International Traffic in Arms Regulations.[28] Official interest in fostering Australian industry capacity to supply and support the ADF's NCW-related capabilities may thus be viewed as a modest attempt to manage the sovereign risk inherent in these arrangements.

Information Capability-Related Contract Awards

Above, we noted a governmental desire for having defence-related production work undertaken locally, within the ADIB, and a preference for developing industry capability as part of the process. This section briefly examines selected NCW-related contracts and, recognising that such work was in important instances awarded to firms headquartered overseas, seeks to link growth in NCW-related business to observed changes in the ADIB

[25] Department of Defence, Defence Capability Development Manual 2006, pp. 95-8, available at <http://www.defence.gov.au/Capability/_home/_publications> [Accessed 4 October 2008].
[26] Rapid Prototyping, Development and Evaluation Program (RPDE), home page at <http://www.rpde.org.au> [Accessed 4 October 2008].
[27] *Defence 2000*, pp. 48-52.
[28] R. Wylie, 'Facilitating Defence Trade Between Australia and the United States: A Vital Work in Progress', *Security Challenges*, vol. 4, no. 3 (2008), pp. 123-6.

itself.[29] The commercial dynamics of interactions between the ADIB and defence procurement of information capability are outlined in greater detail in Table 2 below.

Table 2: Defence Information Capability (Firms & Projects)—1996 (Turnover and Cost figures in 2006 A$ million)

Firms	Turn-over	Employees	Selected Defence Information Projects	Remarks
ADI Ltd	691	3 700	ADF Joint Command Support	ADI acquired Stanilite July 1996
			Communication systems for RAN surface ships	
British Aerospace Australia	206	1 840	NULKA	BAE acquired AWADI Jan 1996
			Parakeet secure tactical communication system	
			Orion P3C-ESM	
Boeing Australia	206	1 800	Combat system for COLLINS Class submarine	Boeing acquired Rockwell Aerospace & Defence August 1996
			Operation, maintenance & support of ADF fixed strategic communications	Outsourced (to Rockwell) via Defence Commercial Support Program (CSP)
			HF Modernisation	This multi-phase project was originally awarded to Rockwell 1996

[29] Not all RMA-related projects that receive approval have a direct impact on the ADTIB. During the 1996-2006 period, for example, the Australian Government approved the acquisition of six Boeing airborne early warning and control (AEW&C) aircraft for $3 530 million (2006 prices and exchange rates). While the ADTIB will be involved in support of the AEW&C aircraft and associated systems, most expenditure is being incurred in the US. Similarly, the AEGIS combat system is at the core of the air warfare destroyers' very considerable RMA-related capabilities. That system is being procured from the US Navy on a government-to-government basis at a total estimated cost of $1329 million (2006 prices and exchange rates).

Seimens Plessey	139	486	Raven single channel radio system	Acquired by BAE 1997
GEC Marconi	116	450	JORN software, hardware sub-contractor,	Acquired by BAE November 1999
Telstra Applied Technologies	n/a	360	Jindalee operational radar network (prime contractor)	RLM managed JORN contract from November 1997
Telstar Systems	26	168	JORN software subcontractor	Telstra subsidiary taken over by RLM in 1997
CelsiusTech Australia	65	90	ANZAC ship command & control system	The ANZAC ship project started in 1989 and concluded in 2006
Vision Abell	39	450	Signal processing, 'Starlight' information security system	Tenix bought Vision Abell for $74 m in 2000.
CEA Technologies	13	85	RAN tactical communication systems, scaleable active phased array radars	invested private resources in development of active phased array radar for naval applications

Notes: All company data from Judy Hinze, 'ADM Top 40 Defence Contractors 1996', Australian Defence Magazine (December 1996/January 1997). Source of turnover figures: Australian Defence Magazine (December 1996/January 1997), converted to 2006 prices.

Table 3: Defence Information Capability (Firms & Projects)—2006 Turnover and Cost figures in 2006 A$ million)

Firms[30]	Turn-over	Employees	Selected Defence Information Projects	Remarks
Tenix	680	2 700	EWSP for C130 aircraft	EWSP technology licensed from DSTO
			Upgrade of forward looking infra-red, electronic support measures, and electronic counter measures for RAN SeaHawk helicopters	Original contract with Hawker de Havilland in March 1998, now taken over by Tenix
Raytheon	512	1 119	Replacement combat system for the COLLINS class	The initial combat system supplied by Rockwell (Boeing) discarded
			Aegis combat system for air warfare destroyers	Embedded in $6 billion air warfare destroyer project
BAE Systems Australia	535	2 800	NULKA	taken over with acquisition of AWADI
			Echidna EW self protection for ADF aircraft	EWSP technology licensed from DSTO
			MILSATCOM ground infrastructure	current phase only
Boeing Australia	400	3 500	Defence fixed strategic communications networks	outsourced by Defence in the Commercial Support Program

30 All company data from Hinze, 'ADM Top 40 Defence Contractors 2006'.

			Airborne early warning & control aircraft and associated systems	System component embedded
SAAB Systems	177	300	Management/upgrade of ANZAC ship combat system	local adaptation of Swedish parent's combat system technology
			Repair/maintenance of army battlefield command support, combat net radios	
General Dynamics Australia	106	100	Battlespace Communications Land (JP 2072)	Initial system design for a multiphase project
RLM Group	67	270	Jindalee operational radar network	JORN accepted into service in 2003, future upgrades to be approved
CEA Technologie s	40	228	FFG sensor fusion	Embedded in $A1464m FFG Upgrade Project (SEA 1390)
			ANZAC anti-ship missile defence upgrade	Active phased array radars developed by CEA, program managed by ANZAC Alliance
Codarra Advanced Systems	14	70	Project management for command, control, communication, computing and intelligence aspects of HQ Joint Operations Command	
L3-Nautronix	14	95	Through water communication systems, acoustic measurement ranges	technology developed in-house with defence funding

JINDALEE OPERATIONAL RADAR NETWORK (JORN)

The Australian government approved the acquisition of JORN in 1986. In order to ensure sovereign control over this strategically sensitive network, and in order to maximise the local commercial benefit of indigenous innovation, the Government required the prime contractors to be Australian-owned and Australian-controlled. At the same time, however, it expected the local companies to team with experienced overseas suppliers in order to reduce the technical risk involved. Accordingly, in 1989 Defence invited the following Australian companies to tender for the JORN contract:

- Amalgamated Wireless Australia (AWA) who teamed with General Electric (who had prior experience developing over-the-horizon radar for the US Air Force);
- Broken Hill Pty Ltd (BHP) who teamed with Raytheon (who had prior experience in developing over-the-horizon radar for the US Navy);
- Telecom Australia (Telecom) teamed with GEC Marconi (who had no prior OTHR experience but who was involved in developing related digital signal processing technology in the UK).

In 1991 Defence awarded the prime construction contract to Telecom (later Telstra), the government owned and operated national communications provider, and its principal sub-contractor, the British firm GEC Marconi. Five years later the Australian National Audit Office[31] and the Australian Parliament's Joint Committee of Public Accounts and Audit[32] documented the technical, commercial and managerial difficulties encountered by the Telstra/GEC Marconi team and Defence in progressing the JORN project. Telstra announced a major loss on the project in 1997, at the same time as GEC Marconi was encountering major commercial difficulties that culminated in its sale to British Aerospace. Both Telstra and Defence were thus receptive to an unsolicited proposal by what is now Lockheed Martin to take over the contract. In the course of post Cold War rationalisation of US defence industry, Lockheed Martin had acquired what were originally the above General Electric OTHR assets employed on the US Air Force OTHR program. The mothballing of the US Air Force program in 1991 released scientists, engineers and managers with proven OTHR expertise which Lockheed Martin was able to assign to the JORN task. The transaction also established Lockheed Martin as a systems house in Australia. (Hitherto Lockheed's involvement in Australia was confined to support for the venerable C130 Hercules and P3–Orion aircraft operated by the RAAF.)

To retain local industry capacity to support JORN Defence required that Lockheed Martin team with an Australian owned and controlled company.[33] Lockheed Martin chose Tenix, a successful local shipbuilder keen to diversify into NCW-related business. The new consortium, named RLM,

[31] Ray McNally, *Jindalee Operational Radar Network* (Audit Report No 28 1995-96) (Australian National Audit Office, June 1996).
[32] Joint Committee of Public Accounts and Audit, *Report No 357: The Jindalee Operational Radar Network* (Australian Government Publishing Service, March 1998).
[33] Paul Johnson, interview with Robert Wylie, 25 July 2005.

took over management of the JORN contract in November 1997, assumed full responsibility for it in 1999 and delivered a fully compliant JORN system to the RAAF four years later. The upshot of Lockheed Martin's acquisition strategy and Defence's insistence on substantive local industry involvement in JORN is that local industry is capable of supporting JORN hardware and software and of collaborating with DSTO and RAAF in on-going development of the system.

Telstra, initially the Australian champion, left the defence market and the ADIB after relinquishing JORN to RLM. On the other hand, membership of RLM enabled Lockheed Martin to enter the Australian defence market, bringing a new—and giant—overseas player into the ADIB. Tenix, meanwhile, diversified its ADIB footprint—see Tables 2 and 3.

HIGH FREQUENCY MODIFICATION PROJECT (HFMOD)

Rockwell Australia was short-listed for the HFMOD project in the early 1990s. By this time it had won other contracts for supply and support of defence information capability. These contracts included that for the initial combat system for the Collins Class submarine, a contract that was later novated to Boeing Australia and eventually terminated amid much controversy. In 1996, Boeing in the United States acquired Rockwell's aerospace and defence business and the local subsidiary, Boeing Australia, acquired its defence systems capability as a consequence.

In December 1997 Boeing Australia was awarded the HFMOD contract, enabling it to consolidate its position as a defence systems supplier within the ADIB. The HFMOD program involved supply and support of a nation-wide network of distributed HF radio stations managed centrally from Canberra. In NCW terms, local industry involvement fostered indigenous capacity for the design, development, applied research and engineering required to provide the ADF with a secure, cost-effective information exchange capability for the command and control of deployed forces. As such, it complements ADF satellite communications. Winning the HFMOD contract and successful roll out of the fixed and mobile elements of the system over the 1998-2010 period thus cemented Boeing's position as key supplier and supporter of the communications element of Australian NCW-related business—see Table 3.

MILITARY SATELLITE COMMUNICATIONS SYSTEM (MILSATCOM)

The system comprises a netted, broadcast and full duplex satellite communication service to high priority ADF platforms and units *via* a Defence payload on the Optus C1 satellite. BAE Systems, well established in Australia since the 1990s, secured the prime contract for the terrestrial infrastructure component of the system in 2003 and is responsible for delivering some twenty-six land-based terminals. Australian Defence demand for this element of NCW-related capability thus provided an opportunity for BAE Systems to build on its technological and production strengths in this area and expand its local footprint. By 2008, BAE Systems had become the largest corporate player in the ADIB

RMA-Related Adjustment of the ADIB

For new technologies to diffuse and be adopted remote from their initial source, the environments to which they travel must be sufficiently absorptive. Absorptiveness calls on one hand for willingness and commitment to adopt innovations and on the other for the technological and organisational capability to do so. Australian defence planners were not only predisposed to accept NCW-related thinking, they were also confronting the ageing and obsolescence of much ADF capability. The contemporary trajectory of technological advance meant that acquisitions to fill the gap would inevitably have embodied aspects of RMA technology. But the emerging security and economic challenges confronting Australia post-Cold War gave focus to this demand by creating a specific desire to exploit the new technological opportunities offered by NCW-related developments.

At issue is the extent to which Defence looked to the ADIB to meet this demand for NCW-related inputs. We would argue that two factors probably played an important role in shaping the answer. First, knowledge edge-related developments and upgrades for ADF capabilities had to be technologically compatible with existing, legacy systems. Such adaptive work would inevitably draw on domestically located know-how about the operational characteristics of the legacy systems. To benefit from close proximity to such systems and the ADF members who had worked with them, it would have been thought desirable to perform elements of adaptive work locally. In some cases, the ADF would possibly have been unwilling to impart operating knowledge to overseas contractors. In others, foreign suppliers might have been unwilling to make the highly specific, relatively small scale and—to them—costly investments required to undertake contracts.

Second, technological innovations had to be developed domestically, often with major initial inputs from DSTO, in instances where overseas suppliers were prevented by their own governments from making strategically sensitive capability inputs available to Australia. An example of this is the stealth technology embodied in anechoic tiles developed for use on the hulls of Collins Class submarines.

But, as is true for the whole domain of innovation, the large majority of new knowledge for military applications is generated and put to work outside Australia. As the ADIB responded to requirements specifically generated by innovative RMA thinking, it was perhaps inevitable that the influence of overseas firms would be increasingly felt. In the case of JORN, one overseas company replaced another as the project proceeded and the corporate restructuring during the project helps explain the structural turbulence we noted in 'Australian Defence Industry Base: 1996-2006'.[34] Challenges on the supply-side were, we would argue, exacerbated by the then (Labor) government's desire to boost local industry participation. But government ministers and their advisers may have underestimated the technological and managerial challenges inherent in the task. And that JORN's ultimate delivery required key technological and managerial inputs from a US company (Lockheed Martin) suggests that Australia may have lacked the depth of indigenous industrial capability required to harvest the fruits of fundamental scientific advances in fielded, operational systems, even when substantial in-country scientific research capability was available through DSTO[35]. In other cases, overseas players already endowed with the capabilities to produce NCW-related systems won major Australian contracts calling for similar expertise and experience and thereby consolidated and/or strengthened their positions in the ADIB. (See 'Information Capability-Related Contract Awards'.) Given the absolute and relative growth in demand for defence capabilities of this kind, we perhaps should not be surprised at the current preponderance of foreign subsidiaries within the ADIB.

This has major implications for the role of the ADIB in supplying and supporting future investment in NCW-related capabilities outlined in 'Demand for NCW-Related Capability'. Commercial forces will ensure that much of the information technology underlying NCW capability will continue to diffuse rapidly. But national governments will continue to control the diffusion of those NCW-related technologies that will determine the outcome of the perennial competition for military advantage among states and between states and non-state actors, including terrorists. In what follows we assess the incentives for the main military innovators (in the present context the United States, the United Kingdom and to a lesser extent the West Europeans) to release to Australia the technologies the nation requires to realise its ambitious plans for fielding, over the next decade or so, a seamless joint force based on the command/control/network, sensor and engagement elements of NCW capability.

With respect to the command/control/network elements of NCW capability, the main military innovators would have a significant incentive to release to

[34] R. Wylie, S. Markowski and P. Hall, 'Big Science, Small Country and the Challenges of Defence System Development: An Australian Case Study', *Defence and Peace Economics*, vol. 17, no. 3 (2006), pp. 257-72.

[35] We are grateful to a referee for pointing out that DSTO collaborated successfully with AWADI to develop the JFAS radar system, suggesting the existence at the time of the indigenous capability required to develop operational systems built on recent scientific advances. We would argue, however, that the performance specifications of the radar that Telecom was contracted to supply went well beyond DSTO-AWADI's very creditable achievements with the JFAS. In the event, Lockheed Martin/RLM engaged DSTO to assist in developing the technology required to meet the specification and it might be argued in hindsight that the technical risks inherent in JORN could been better managed had DSTO been involved at an earlier stage.

Australia, for example, the command and battlespace management technologies that Australia needs for, say, its joint command support environment.[36] Hence, for example, in 2007 the United States agreed to Australia participating in the US Wideband Global satellite Communications System, with Australia funding one of the system's six satellites and associated infrastructure and the US funding the balance. Innovators' incentives to release technologies to Australia on a government-to-government basis (or to permit their companies to sell to Australia) stem from their interest in enhancing Australia's capacity to make a militarily significant contribution to coalition operations. Conversely, however, innovators are only likely to release the sensor and data fusion technology Australia requires in deploying a space–based surveillance system on a tightly restricted, government-to-government basis: Defence planning expressly recognises that the security classification of this system will preclude engagement of Australian industry to supply or upgrade the equipment involved.[37]

For the foreseeable future, developments in radar technology will continue to dominate the sensor element of NCW capability. The importance of radar-related innovation to military advantage means that the main military innovators are likely to continue heavy unilateral investment in national capacity for radar-related research, design, manufacture and integration. While Australia will be able to buy older generations of such technology, the main innovators will only release the later, more competitive versions if it is in their national interest and if Australia can reciprocate. Hence, for example, Australia's ability to adapt its evolving JORN technology for ballistic missile defence will enable it to sustain substantive engagement of the United States in the latter.[38]

On the other hand, the electro-optic technology that determines the capability of, for example, precision guided munitions are now widely available and relatively cheap, although diffusion of these technologies is controlled via, for example, the US International Traffic in Arms Regulations. Subject to protecting, and being seen to protect, electro-optic technology from unauthorised third party access, the Australian Defence Organisation and Australian companies supplying it seem likely to retain access to those electro-optic technologies required to achieve Australian NCW objectives.

[36] Joint Project 2030: the later phases of which are intended to integrate several new and existing ADF command and support systems at a cost of $A350-500 million (see Department of Defence, *Defence Capability Plan 2006-2016*, pp. 62-3)
[37] Joint Project 2044: early risk reduction phases of development of a space-based surveillance capability have been completed and, subject to government agreement, the capability is indicatively scheduled for delivery 2012-2014 at a total cost of $A100-150 million (see Department of Defence, *Defence Capability Plan 2006-2016*, p. 64).
[38] US and Australian representatives announced their intention to cooperate in this area on 7 July 2004, see <http://www.defenselink.mil/news/newsarticle.aspx?id=25750> [Accessed 25 June 2007].

That said, Australia is likely to encounter greater difficulty obtaining electro-optic countermeasures developed by the main innovators in this area.

Developments in electronic warfare will exert a profound influence on the outcome of the competition for military advantage at tactical and operational levels of combat. Hence access to related technologies is of commensurate importance to Australia in realising the engagement element of its plans for NCW capability. The main military innovators are investing heavily in national capabilities across the full spectrum of electronic surveillance, electronic defence and electronic attack but, because of the importance of innovation in this area to military competitiveness, will only release leading developments to Australia on a government –to-government basis and then only when the innovator has a compelling national interest in doing so. Defence, for its part, envisages a minimal role for Australian industry in the supply and support for high grade cryptographic equipment it plans to procure to protect nationally classified information during electronic transmission while also maintaining interoperability with allies.[39]

In principle, Australia would get highest return from *successful* investment in indigenous technological innovation in those NCW-related technologies that the main military innovators are least likely to share. Such technologies include those related to, for example:

- Electronic warfare and the assurance of information transmitted over the network/command/control elements of NCW capability;

- Enhancement of the sensor element of NCW capability through, for example, novel use of electro-optic technology to identify targets at longer range and to improve discrimination by better exploiting target signatures;

- Improving the engagement element of NCW capability through, for example, fostering low-observable technologies for fixed wing aviation, developing the automatic target recognition and data fusion technologies required to exploit unmanned aerial vehicles and submarine signature management.

At issue here is Australian Governments' appetite for risk. In the case of indigenous development of NCW-related technologies, Australia's appetite for *downside* risk relates to how much cost and schedule overrun the Government—and the Parliament—are prepared to tolerate in order to maintain sovereign control over decisions about how to use the ADF in network enabled operations and when to do so. The above analysis

[39] Joint Project 2069, the later phases of which are indicatively scheduled to be in-service round 2019-2021 at a cost of some $A75-105 million (Department of Defence, *Defence Capability Plan 2006-2016*, pp. 78-9).

suggests that Australian governments and their advisers have relatively little appetite for such risk and place relatively greater emphasis on managing relations to foster access to the fruits of the main innovators' investments.

Conversely, Australia's appetite for *upside* risk relates to how much it is prepared to invest in high risk development aimed at gaining the benefits of sovereign control over NCW-related technology. In the NCW context it entails Australian Governments and their advisers comparing the value (financial or otherwise) of potential benefits with potential losses that might be incurred either with or without realising those benefits. The above analysis suggests that Australia will continue to accord high value to, for example, indigenous cryptographic capacity required to assure the integrity of sovereign communications and indigenous capacity to manage the signature of key assets like COLLINS Class submarines. But the record suggests that the diversion of limited resources from other priorities to these ventures will be vigorously contested.

Peter Hall is Professor (Emeritus) in the School of Business, University of New South Wales at the Australian Defence Force Academy, Canberra. p.hall@adfa.edu.au.

Robert Wylie lectures at the School of Business, University of New South Wales, Canberra. r.wylie@adfa.edu.au.