Networking & powering the underwater domain

After years of neglect following the end of the Soviet era, two recent Australian Defence think tank reports have placed the regeneration of the Australian Defence Force's future underwater warfare capability fair and squarely back on the public agenda, in anticipation of substantial funding for a broader capability 'silent service' emerging in the 2008-2018 Defence Capability Plan.

Abraham S Gubler/CANBERRA

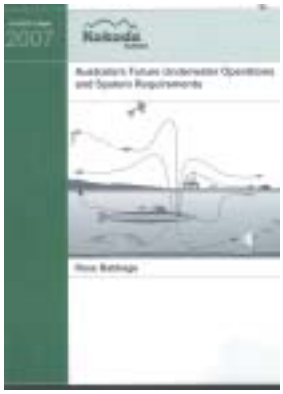
Key Points

- **Prime Minister Howard has raised the prospect** of Australia entering the global nuclear fuel cycle with proposals to ramp-up scientific and technical expertise to support a nuclear future.
- **Debate over the viability of nuclear energy**-driven electricity generation suggests 20-25 power stations would need to be built around Australia to muster sufficient industrial critical mass.
- **The Royal Australian Navy will shortly need** to consider replacing its 'Collins'-class submarines, including the prospect of such boats adopting nuclear propulsion and energy-based weapons.
- **Papers from two Australian think tanks** - whilst happily canvassing development options for future ADF underwater warfare capabilities, have shied away from discussing nuclear submarines.

The first paper, issued by the Australian Strategic Policy Institute (ASPI), provides a public-level description of the basic concepts of anti-submarine warfare (ASW) - albeit heavily slanted towards the higher profile (ie: 'Hunt for Red October'), but almost obsolescent, practice of deep sea ASW central to the former Cold War game of East versus West - and less on the emerging and regional requirement for littoral ASW operations in shallow and complex-environment water that is more relevant to contemporary Australian strategic guidance.

Further, and for an organisation that is predominantly publicly funded to raise the level of Australian strategic debate, the ASPI report's eight recommendations, as similarly noted by Defence Minister Nelson on 1 March, have mostly already been incorporated into the current (2006-2016) Defence Capability Plan (DCP), and/or reflected in other Australian Defence Force (ADF) practice and planning documents, such as the Network Centric Warfare (NCW) Roadmap.

The second paper, published via the Kokoda Foundation, reads in a manner more aligned to the needs of the professional defence community, and includes a significant contribution to better understanding the likely future underwater warfare environment that will face Australia over 2025-2050, when a 'Collins'-class submarine replacement will be required to have entered service.



Kokoda recommends that any new ADF underwater warfare capability should consist of a broader range of assets, and including: new underwater surveillance systems, new manned submarines/unmanned underwater vehicles, new sea mines, and new mine countermeasures. With a 'Collins' replacement due in-service by 2025, Government 'first pass' approval would be required by 2011, meaning first initiatives would have to be included in the 2008 DCP.

Still, two key areas needing to be thrashed out to properly round out the future definition of ADF underwater warfare capability - advanced underwater communications, and feasibility of applying nuclear power to future Australian submarines (or other underwater warfare assets) - have not been addressed sufficiently in either think tank paper.

UNDERWATER COMMUNICATIONS REVOLUTION: One of the most transforming aspects of underwater warfare capability to emerge since the end of the Cold War, is the Australian-developed Acoustic Digital Spread Spectrum (ADS2) technology. Developed by Nautronix Ltd (now L-3 Communications Nautronix), ADS2 technology enables the transfer of data discreetly, and reliably, over long distances in adverse underwater communication channels.

To date, extending the benefits of even low-level communications to military forces, not to mention the high-bandwidth required for the generation of Common Operating Pictures (COP) promised by NCW operations, has been extremely elusive for submariners. The survivability and utility of a submarine arises from its ability to operate discretely within the maritime environment without being detected, and historically drove complete communications silence, and thus, independent operations. While legacy technology does support underwater communications, this has been highly indiscrete, involving active sonar of both short range and low bandwidth.

Fremantle (WA)-based Nautronix developed ADS2 as part of an acoustic ranging measuring system developed to monitor the 'Collins'-class submarine's acoustic signature in range tests off Fremantle and Adelaide. In order to allow separate elements of the acoustic range system to communicate with each other without interfering with the water acoustics, Nautronix developed ADS2 to transfer information underwater discretely, thus inadvertently revolutionising future underwater operations.

ADS2 spreads a transmitted message over a comparatively large segment of the acoustic spectrum, typically more than ten times greater than would be required for conventional narrowband communications, such as Under Water Telephones (UWT). This spreading is conducted by an optimised but complex mathematical function in real time. In order to decode the signal, the receiver must know the exact spreading code employed.

However, underwater wide-band acoustic transmissions are severely effected by Doppler (where the frequency of a wave changes with the relative velocity between the source and the observer), which is 200,000 times stronger through water than when compared to the Doppler effect of radio frequency through air. Nautronix's ADS2 technology accordingly overcomes the Doppler effect through a proprietary method, enabling high-bandwidth yet discreet acoustic based communications through water.

ADS2 is the centrepiece of Nautronix's NAS-HAIL communications system developed via a Royal Australian Navy (RAN)-funded Capability Technology Demonstrator (CTD) project, and is currently in-service within submarines in the RAN, Royal Navy and US Navy, along with several underwater acoustic ranges. The system has also recently entered service with RAN Clearance Diving Teams (CDT) via the new Mine-countermeasure Underwater Computer System (MUCS).

How ADS2 will ultimately redefine underwater warfare operations – particularly those employing unmanned/unihabited underwater vehicles (UUVs) - remains to be developed, but it could severely curtail or spell an end to the traditional 'silent service' of independent submarine operations. Combined with 'interface buoys' fitted with both ADS2 and line of sight radio and/or satellite communications, the new technology could also integrate above and below water systems. Also, ADS2 has great potential to discretely link formations of surface ships enabling data sharing without resort to radio emissions that can yield targeting information for Anti-Ship Missile (ASM) launching platforms.

TIME BEING CALLED FOR THE 'COLLINS'?: Potentially, ADS2 and UUV technology could make manned submarines redundant, as the vital human in the command and decision making loop will no longer be required to serve onboard the underwater platform. Thus, the same advantages seen from the increased operation of Unmanned Combat Aerial Systems (UCAS) can now be extended to UUVs, such as removing crews from danger and regarding personnel retention issues fuelled by repeated 'out-of-office conditions' deployments.

Such transformation will also flow through to cost savings/increased capability options (ie: having extracted humans from the operating platform), and represented by reduced platform size and cost, increased platform physical performance, endurance not limited by human frailties, massed expertise for complex problem solving, computer-speed decision making, absolute courage and expendability. Challenges include ensuring UUVs remain tied to network communications channels when needed, and grappling with the political/moral issues associated with robotic killing.

The benefits of UUVs taking up substantive elements of traditional submarine roles could also include extremely long endurance, including powered-down pre-positioning - where a UUV is deployed into an area of interest, parked on the sea floor, and powered down until needing to be reactivated for an operation (ie: much like a sea mine).

Capabilities for very deep diving by the UUV can be developed by removing the need for a pressure hull and/or significantly reducing the size of underwater warfare assets. Deep diving potentially allows the UUV to operate below the maximum depth of most current ASW weapons, whilst also taking advantage of higher water pressure for improved sonar sensing and high speed running - without generating undue noise, as it does in shallower depths.

The 240kg Hydroid 'Remus' 6000' autonomous underwater vehicle - Defence confirmed 20 April the ADF would shortly acquire the 'Remus 600' verion, its first sale outside of the United States - can dive to a depth of 6000 metres, compared to the usual maximum of 500m safe diving depth for steel hulled manned submarines. At the same time, the Government confirmed the smaller (37kg) 'Remus 100' autonomous underwater vehicle would be acquired for the Defence Science and Technology Organisation (DSTO), and applied to its underwater warfare research program.

The DSTO is currently in the process of acquiring a range of 'man-portable' UUVs and gliders to further its research into concepts of operation for littoral warfare, particularly mine/counter-mine warfare, environmental assessment, hydrography, undersea warfare and force protection. Hydroid 'Remus' UUVs (which have also been purchased by the Royal New Zealand Navy) can be fitted with a number of different types of sensors and cameras, and have been used to aid in hydrographic surveys, harbour security operations, debris field mapping, and scientific sampling & mapping.

In a further indication of the RAN's renewed interest in upgrading its underwater warfare capabilities, L3-Communications Nautronix also confirmed 30 April it had signed a $43 million contract with Defence to upgrade the Hydrographic Survey System aboard the RAN's four 'Paluma'-class Survey Motor Launches. The project will incorporate advanced modern sensors and sonars, such as the Thales Australia-manufactured 'Petrel' sonar, as well as sophisticated data handling technologies.

Nine portable hydrographic survey systems (three of which will be a more advanced tactical survey system) will also be used on small craft in support of survey operations. The adoption of more portable systems allows for hydrographic survey operations in very shallow waters that cannot be reached by larger survey ships. Advancement of the project will also witness the first occasion in Australia where a suite of hydrographic sensors will be integrated into a single data logging and processing system. The first system will be delivered by April 2009.

FAST-TRACK TO NUCLEAR POWERED NAVY: While from time to time regularly emerging as a point for debate within the naval community, the idea of utilising nuclear fission to power RAN underwater assets has now re-entered the realms of probability with Prime Minister Howard's push for the progressive establishment of a comprehensive Australian nuclear industry tied firmly into the global nuclear fuel cycle.

Perhaps unwilling to end up embroiled in the current 'greenhouse gases' debate, the Kokoda Foundation paper more timidly resolved that nuclear power should remain outside consideration for powering the 'Collins'-class submarine replacements, principally because the capability generation timeframe - 2012-2025 – was "too soon" for a nascent Australian nuclear industry to be in a position to support a nuclear boat fleet, "despite its many operational advantages".

However, several other factors not explored by Kokoda are pertinent in seeking to assess the viability of incorporating nuclear power as an option for the project Sea 1439 'Collins'-class submarine replacement, in particular, the prospect of achieving air-independent operations with sustained high power output.

While much focus has been given to the benefits of air-independent propulsion (AIP) for submarines compared to the Collins' diesel-electric propulsion (which requires periodic 'snorting' of air through a raiseable mast to operate the diesel engines to restore charge to the boat's batteries), such benefits seem more apparent in traditional deep sea submarine

FUTURE RAN SUBMARINE CONCEPT - ASC IMAGE

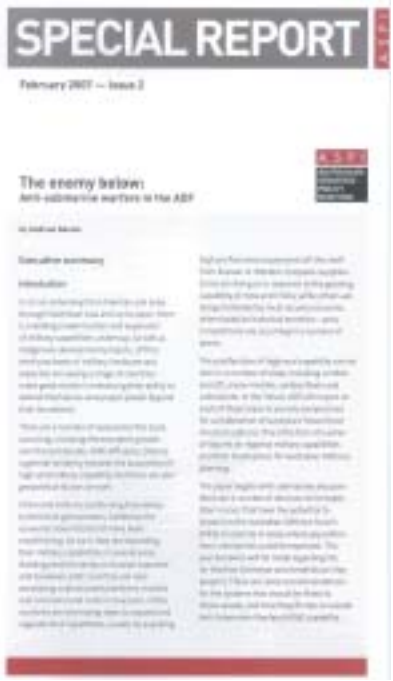
versus submarine ASW battles, or in operations against mass ASW aircraft fleets.

In the current and emerging dynamic of littoral operations - as now being addressed by DSTO researchers - the submarine is envisaged as being regularly required to be 'indiscrete' so as to interact with the above-water environment in order to effectively carry out its mission. Australian submariners are reportedly said to have had 'little trouble' in snorting within the complex surface environment embodied within littoral operations.

This is not to say that AIP is without value, but the additional weight and space required for a dedicated system to supplement a diesel-electric system (as is required by non-nuclear alternatives) is judged by many in the Australian submarine community as not worth the effort. Resort to nuclear power, however, completely replaces both a submarine's diesel engines, and its bulky chemical batteries, with the addition of a reactor being considered far more space and weight efficient than non-nuclear AIP alternatives.

Significantly, the nuclear option can also provide power at peak levels at a constant rate, thus allowing the subject underwater platform to cruise at far higher speeds than conventional submarines, which have to be parsimonious with limited fuel (and air) supplies, whether air-dependent or AIP.

Nuclear generated energy, therefore, enables higher transit speeds, increased endurance in the subject operational area, and better recourse to high-speed dashes to avoid threats. It also provides a ready power source for application to underwater vehicles or energy-based weapons.



ROADMAP TO NEW RAN CAPABILITIES: Realistically, in order to equip the next generation of RAN underwater platforms with the benefits of nuclear power, the ADF would need to draw upon an Australian Industry Capability (AIC) to sustain it. Some insight into the pathway needing to be walked to achieve such an AIC was revealed in the Prime Minister's 28 April policy announcement – '*Uranium Mining and Nuclear Energy: A Way Forward for Australia*'. This document enunciated immediate policy changes, including: removing regulatory blocks to uranium mining; and committing Australian scientific community participation in 'Generation IV' nuclear reactor research.

If successful in the currently expected late-2007 Federal Election, a fifth-term Howard Government has signalled its seriousness about measures to kick-start an Australian nuclear energy industry: through establishing a nuclear energy regulatory regime; boosting skills and technical training to address any identified gaps; and follow-on measures to support a possible expanded nuclear energy industry and enhanced nuclear technology research and development capability.

Such new initiatives could be expected to be fast-tracked from 2008, and prospectively could be well underway within the time-frame running up to submission of any 'Collins'-class submarine replacement business case for Government 'first pass' consideration from 2011.

In the event a fast-track campaign was unable to deliver a fully functioning AIC in nuclear power technology in time for the post-2015 build phase, not all would be lost. Activities undertaken to that point could receive a boost if combined with assistance from the United States, but how? It is already widely known (as championed by Prime Minister Howard when declaring the first 'Collins'-class replacement combat system operation in Adelaide on 3 April), that the Government-to-Government Memorandum of Understanding (MoU) between Australia and the USA on submarine sustainment has been judiciously used to enhance Australia's submarine fleet - with both a US-sourced combat management technology, as well as a development of the Mk48 Mod 7 Common Broadband Advanced Sonar System (CBASS) shallow water-friendly torpedo, for both the Australian and US navies.

Any Australian Government decision to adopt nuclear power for the propulsion of its replacement submarine fleet, might therefore be realised by giving expanded coverage to the MoU, namely to give Australian scientists and authorities access to US-sourced nuclear reactors for installation on Royal Australian Navy submarines.

Even if erring on the side of conservatism in terms of the likely timetable for the development of a feasible AIC for nuclear power sustainment, it would not be unreasonable for military capability architects to envisage a design for the 'Collins' replacements that at some later time could cost-effectively incorporate a nuclear powered engine room, in place of a diesel-electric system.

It is a fact that the adoption of modular, sectionised, submarine hull design can cost effectively incorporate hull section additions (as done with the 'Collins' design) or 'tube' swaps. Such options are most viable if the overall submarine is initially designed to manage such changes as part of each boat's overall weight distribution regime to accommodate 'centre of balance' requirements and any other peripheral effects of such a swap.

Further, new submarine technology is replacing optical periscopes with digital-optics masts, thus removing the requirement to position each vessel's central control room directly under the submarine's 'fin' (ie: which encases the masts), thus freeing submarine designers to position the engine room in the most 'centre of gravity'-neutral location.

For example, the US Navy's 'Virginia'-class submarines have had their control rooms repositioned away from the 'fin' toward lower in the hull to provide the largest possible single room space to combine all critical command & control (C2) elements of the boat.

If nuclear power was ultimately considered by the Australian government to become the preferred option for powering future underwater warfare platforms, then it would be natural to also consider extending such technology to powering the surface fleet. The RAN might find the cost of sustaining 6-8 nuclear reactors (particularly in terms of skilled engineering expertise) for submarines highly difficult. However, an aggregate base of 24-32 common nuclear reactors powering all major surface combatants, amphibious ships and submarines would no doubt be more sustainable. Such an approach offers considerable mobility benefits to the surface fleet, reduces the RAN's very high usage of diesel fuel (along with the requirement for at sea re-supply, and in a fashion could be considered more environmentally emissions friendly.

ARMING & CREWING FUTURE SUBMARINES: Another consideration for shaping future underwater warfare platforms not considered in either of the cited think tank papers was the opportunity to arm 'Collins' submarine replacements with more than traditional torpedo-tube launched weapons, given the maximum diameter of the tubes is 533mm.

Such dimensions automatically rule out encapsulated launches of new missiles, such as potential land attack variants of Lockheed Martin's AGM-158 Joint Air-to-Surface Strike Missile in extended range (over 1,000km) – or JASSM-ER - and follow on anti-ship versions. Potential opportunity also exists to equip underwater platforms with ascent phase Ballistic Missile Defence (BMD) Kinetic Energy Interceptors (KEI) - as currently being explored by the US Navy - to form a stealthy

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'Bogue Field' (North Carolina). The tower systems are being acquired by the USMC as an option under an October 2005 contract. The latest order brings total Marine Corps procurement to nine 'MaxSim' simulators and associated databases.

DCN completes its corporate makeover

The Euros three billion annual turnover French-based DCN group unveiled 4 April a new corporate identity to employees to mark the group's new organisation and ambitions following the integration of Thales's naval businesses in France into the company. The familiar company acronym – DCN - has now been replaced by a new brand and logo: DCNS – drawing off the historical legacy of the company along with the addition of an 'S' (standing for systems and services), and to highlight the company's growing expertise in system prime contracting and related service provision. The launching of the new DCNS brand has also been accompanied by the adoption of a new corporate slogan – 'Strength at Sea' (as formerly used by Armaris, DCN's export JV with Thales) - and symbolising the company's market positioning at the intersection of two worlds: naval power and the sea. In addition to enhancing the company's image, company officials indicated the changes were also designed to promote the "simple yet powerful idea" of a group that is determined to win more business on international markets and play a leading role in the consolidation of Europe's naval defence industry. ADBR

Project Sea 1439/N - Ctd from page 29

and high survivable part of an Australian national BMD system similarly anticipated to find form in the 2008-2018 DCP.

Instead of pressure-launch tubes, such weapons would require vertical launching tubes mounted either within or outside the pressure hull of the carriage platform, similar to those incorporated on US Navy submarines to accommodate nuclear-tipped ballistic missiles, and currently being modified on four 'Ohio'-class boats to accommodate conventionally-armed weapons, as well as a range of other underwater & surface warfighting capabilities. Benefits of such mounting options include reduced overall weight and crew requirements.

Design of the future 'Collins' replacement to operate its own fleet of UUVs, even if the vessel itself is unmanned, does not necessarily need to be tied to complex large submarine hangars, as mentioned in the Kokoda paper. Many UUVs are very small, with a number sized for torpedo tube launch. Larger UUVs can be carried by the parent platform in 'piggy back' form, either atop of the casing, or along the hull sides. Another method is to tether the UUV, a practice used to deploy WWII 'X-craft' mini-submarines beyond the limited range of their own propulsion system.

Most importantly for the challenge of sustaining Australia's future underwater warfare capability, is the issue of addressing deficiencies in recruiting and retaining submariners. This challenge is at critical levels already, with the flow-on effect of existing submarines being tied up for lack of suitable crews (or hauled up on land for 'snails-pace' refits), and leading to the sprouting argument regarding the futility of debate about replacement platforms when extant assets are unable to be fully utilised.

As such, 'work place' and manning issues need to be thoroughly addressed at the conceptualisation and design stage of any future manned underwater platform, and in short, might drive more innovative solutions. For example, scientific research into submarine habitability problems has already yielded benefits, with the DSTO's identification of a biofilter blanket to suppress the infamous 'pong' that arises from submariners working in confined spaces, compounded by tactical (and environmental) requirements to store waste onboard. The DSTO's work is reported to have resulted in an 80-90% reduction in perceived odours onboard during a 48-day trial on HMAS 'Sheean'.

Any manned 'Collins' replacement will therefore need to have significantly enhanced accommodation standards for its crew, pitched well above those currently provided. Without further reductions in crew size via resort to automation, this might require a significantly larger submarine - in the 4,000-5,000 tonne class – in order to provide the required internal volume for cabin accommodations, support facilities and recreation spaces.

Whilst seemingly lavish for a 'silent service' often regarded as constantly whingeing and paid above their grade, the provision of similar standards of accommodations on new submarines to the latest generation of surface ships, may go some way to alleviating complaints regarding submariner conditions of service, which are currently not being neutralised through large pay and allowance increases.

Lastly, the importance of ADF basing strategy for sustaining future underwater warfare capability, especially submarines, should not be understated. While the decision to concentrate the submarine fleet and training facilities at Fleet Base West would initially appear to be efficient in the course of satisfying the geographic-determinist demands of the now defunct 'Defence of Australia'-only policy, the reality is that locating the whole fleet at HMAS 'Stirling' in Western Australia effectively isolates the RAN's submarine workforce from the wider Australian community.

The Greater Perth region boasts less than 10% of the national population, yet holds the large majority of the national submarine community. In short, a post-election decision to base submarines on the Eastern seaboard, could go a long way to addressing recruitment and retention issues frequently raised by submariners.

ADDITIONAL READING:
Kokoda Papers No.4 (April 2007) – '*Australia's Future Underwater Operations and Systems Requirements*', by Ross Babbage (www.kokodafoundation.org); and Australian Strategic Policy Institute (ASPI) Special Report – '*The Enemy Below: Anti-Submarine Warfare in the ADF*', by Andrew Davies (www.aspi.org.com). ADBR

Shipbuilding crunchtime - Ctd from page 8

Alternatively, the separate establishment of Tenix Defence could be viewed as providing a ready base for assumption in the process of establishing Navantia Australia Holdings to assume prime responsibility for progression of the amphibious ships project.

Any such move would allow Tenix to sell out the value of its share in the JP 2048 undertaking, along with a number of its traditional shipbuilding assets in Australia. Yet rather than being seen as a negative for the company, the repositioning and cash raised from such an outcome could later be turned around to underpin a Tenix bid for ASC Pty Ltd, thus cleverly manoeuvring >>>34