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KEEPING AUSTRALIA'S OPTIONS OPEN IN CONSTRAINED STRATEGIC CIRCUMSTANCES: THE FUTURE UNDERWATER WARFARE CAPACITY

"AUSTRALIA'S STRATEGIC STING"

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Executive Summary

By 2030 Australia's region will be dominated by the political, economic and strategic power of China and India, constraining Australia's strategic options. In order to maintain options under all circumstances determined choices on force development need to be made now – this is not a 'business as usual' outlook.

This strategic environment will demand a range of ADF capabilities including a high-end underwater warfare capability, centred on a long-range, sophisticated submarine. Noting the proliferation of submarines in our region of interest, it will be important that the NGS maintains an underwater warfare technological edge throughout its service life

There is a rising risk from deploying Collins, without Air Independent Propulsion, into high threat, sensitive areas as regional ASW capabilities rise. Given the lead time required to overcome this shortcoming, urgent resolution is required to assess when this risk becomes unacceptable and to determine the best option for avoiding the resultant capability gap.

Based on Collins hull life and system obsolescence, the future submarine must commence sea trials no later than 2022, to retain an effective undersea warfare capability, possibly earlier dependent on the outcome of these considerations.

To achieve a strategic sting – i.e. sufficient mass of capability to deter any use of force against Australia will require a force of at least 12 fully capable conventional submarines with the manpower and maintenance support to maintain 75% of the force available as operational submarines.

The rate of build up to this capability is a matter for judgement, made against the force projection and sea denial capacity of the emerging regional powers of India and China.

Opportunities exist to reduce the cost of ownership by moving to a rolling build programme to sustain or increase this capability.

Planning and initiation of long lead activities such as R&D are now on the critical path to inform decisions to be taken at First Pass (2011) on technologies likely to be available when the build contract is let no later than 2016.

To mitigate development risk, the high risk, software intensive systems should be based on Collins systems. The Collins' combat, C3I and ship control systems should be maintained at the leading edge, evolved and migrated into the future SM.

The design, development and construction of the future underwater warfare capability will be a uniquely Australian enterprise, a developmental project based on the Collins pedigree by 'Team Australia', with strong support from the USN and European submarine designers.

Australia's submarine design capability is a critical strategic attribute in achieving a capability edge and essential for through life safety – as for Collins, Australia will be the parent navy for the future submarine.

An extension of the Australia/US agreement on submarine cooperation to cover future underwater warfare capability is urgently required noting that the extent of access to USN submarine technology and associated USN sensitivities will be a critical factor in the acquisition strategy.

Establishment of *'Team Australia'* supported by bilateral government to government agreements with selected Western European conventional submarine design partners should also be an early priority.

Australia should undertake concept design and cost/capability trade off studies to define the requirement, identify gaps in our capability to achieve it **prior** to seeking support from US and European designers to fill the gaps.

Supporting studies and R&D projects within the *'Team Australia'* model with DSTO, industry and capability partners should be initiated as an early priority.

The Defence White Paper process must provide agreement on the Top Level Capability, acquisition strategy, numbers of submarines and timescales for the future underwater warfare capability.

Australia's submarine design capability should not be sold until the conditions necessary to access the critical submarine technologies are known and factored into the pre conditions for sale.

A paradigm shift is required in the way Australia crews its submarines; with multiple crews operating submarines selected from a 'flight line' sustained by a contractor under a regime designed to achieve 75% operational availability from the submarine force. Achieving this availability will be a critical design factor.

Introduction

1. For the past 5 years, Project SM 2020 of the Submarine Institute of Australia Inc (the Institute) has been considering the requirements for a future underwater warfare capability for Australia. Deliberations have included two international conferences, the most recent in November 2006 and a number of workshops (a third conference is to be held 6-7 November 2008).

2. In December 2006, the Institute's SM 2020 team[1] completed a study for the Chief of Capability Development, Department of Defence, into the strategic setting; capability and roles required of a future underwater warfare capability; lessons learnt from the Collins project; and the industrial and political aspects arising from the project to acquire this capability.

3. This paper is intended to provide an input to the Defence White paper. It summarises the major findings and conclusions from these earlier considerations. Writing this paper remains a team effort.

4. At the centre of this capability is a future (manned) submarine, supported by:

   a. An indigenous submarine design and R&D capability;

   b. A variety of other systems, including unmanned underwater and unmanned aerial vehicles; and

   c. A dynamic command, control and intelligence system for the direction and control of submarine operations.

5. We will use the terms 'next generation submarine' and 'future underwater warfare capability' to distinguish between the submarine component and the overall capability.

6. We will approach it in a top-down fashion and consider it in two parts:

Part 1 - The Requirement
- The strategic setting facing Australia in the period to 2050;
- Capability and Roles: What is it that ONLY submarines can do?
- Force Structure considerations.

Part 2 - How To Acquire It
- Design issues;
- Collins lessons learnt in the context of the future submarine capability;
- Personnel issues;
- Acquisition strategy; and
- Industry issues.

[1] Oscar Hughes, Terry Roach, Paul Greenfield, Allan Behm, Frank Owen, David Wyllie, Andy Keough, Marcos Alfonso, David Nicholls and Peter Briggs

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Part 1: The Requirement

1 The Strategic Setting

1.1 *Forces Shaping the Future*

1.1.1. Without attempting to predict the precise shape of Australia's strategic environment in the period 2020-2050, it is already clear that there are powerful forces at work that will determine both the strategic settings within which Australia will need to make its strategic choices and the boundaries within which Australia will seek to exercise its policy freedoms.

> *The rise of both India and China, the re-emergence of Japan as a strategic actor, and the uncertain future role of the United States, are all shifting the ground beneath our feet.*[2]

1.1.2. Overall, the prospects for global peace and stability are gloomy: the convergence of ideological extremism driven by fundamentalist Islam and significant changes in global power balances indicate major strategic discontinuities. In the Asia-Pacific region, continuing adjustments in the great power balance, together with continuing political, social and economic dislocations in the Pacific island countries indicate ongoing instability.

2 The Key Strategic Drivers

2.1 *Radicalised Islam*

2.1.1. Radicalised Islam will continue to mount a fundamental and violent challenge to the value system of liberal democratic societies, and the threat of the use of asymmetric force – particularly terrorism – will continue, sponsored by both radical non-state groups such as al-Qaida and by fundamentalist states such as Iran and Syria. Australia and western interests in South East Asia will continue to be targets for such acts of violence as is evidenced in the Philippines and Indonesia.

2.1.2. From the perspective of Australia's defence strategy, it is important to recognise that terrorism operates at the interface between the clash of values (that is, the clash between the absolutist values of radicalised Islam and the values of democratic liberalism) and the antagonism that traditionally defines relations between states pursuing opposing political and strategic objectives).

2.1.3. States, particularly those that subscribe to political principles opposed to democracy and individual rights, will continue to exploit opportunistically the potential that always exists for destabilising the security of their opponents by supporting instability on their opponents' borders. This may extend to support for groups that espouse terrorism.

2.1.4. For Australia, the political, economic and institutional fragility that characterises most of the states in its immediate neighbourhood raises the double-headed spectre of large-scale domestic violence fomented by external interference.

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[2] Defence Challenges for The Next Government, Dr Mark Thomson, ASPI 12 November 2007

2.2 *China and India*

2.2.1. China and India will emerge as major global and regional strategic players, exercising political, economic and strategic power in pursuit of their national objectives while at the same time constraining others in the pursuit of theirs. The centre of gravity of global economic power will continue in an easterly direction in the period of the strategic outlook so that, by 2050, it sits largely on the Indo-Chinese border. Their force projection capacities will create new avenues for them to assert strategic power.

2.3 *Competition for Scarce Resources*

2.3.1. A fierce global competition for resources will become an increasingly important strategic factor, particularly energy (both hydrocarbon and nuclear), key strategic minerals and water. China and India will compete in this domain with the industrialised nations – the USA, Japan and the members of the European Union – as well as the emerging industrialised nations such as the members of ASEAN, key South American nations such as Argentina, Brazil and Mexico, the emerging powers of the Middle East (particularly Iran) and Russia.

2.4 *Australia's Developing Energy Vulnerability*

2.4.1. Whilst Australia is well endowed with energy sources, the trend is heading from a *sensitivity to energy interruption* to one of *vulnerability*:[3]

a. 97% of our transport sector relies on petroleum products of which 76% is imported, most from the Asia Pacific region;

b. This trend is increasing;

c. Geosciences Australia predicts that Australia's net self-sufficiency in oil will decrease from 84% to 20% over the next 20 years;

d. Indigenous refining capacity is declining and being replaced by offshore refineries; and

e. The developing countries in our region are experiencing huge increases in their own energy requirements.

2.4.2. Australia therefore has a growing dependence on imported oil and petroleum, refined in countries that are themselves increasingly vulnerable to an interruption in supplies.

2.4.3. Water will be an emerging issue for many in the region:

> *"The consequences for humanity are grave. Water scarcity threatens economic and social gains and is a potent fuel for wars and conflict."*[4]

2.4.4. This will also translate into increased demand for energy, to provide water by desalination.

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[3] Power Plays – Energy and Australia's Security, Michael Wesley, ASPI October 2007

[4] UN Secretary-General Ban Ki-moon, The Australian, 5 December 2007

2.5 *USA Minus*

2.5.1. The political, economic and strategic reach of the USA will, in relative terms, reduce. While it will remain the wealthiest nation in *per capita* GDP terms, the balance of power between the USA and its competitors will shift, and the USA will no longer enjoy the freedom of action that accompanied its status as the sole superpower.

2.5.2. The message is clear: based on current trends, by the middle of this century, the world will see a Chinese economy that is significantly bigger than that of the USA in purchasing power parity terms, and an Indian economy that is approximately the same size as that of the USA. There are significant assumptions underpinning these predictions. One significant proviso is China's ability to maintain social cohesion and stability. Ross Terrill is optimistic in this regard:

> *".. the future is always more open than we prognosticators of China's future judge. China repeatedly eludes the limits set … transcends the categories offered by past and present foreign mythmakers."*[5]

2.5.3. This means that, with China, India, and Indonesia having economies approximately 30, 20 and 3 times bigger respectively than that of Australia, our global strategic environment will be fundamentally different from that of 2007.[6]

2.6 *Climate Change*

2.6.1. Climate change is likely to impose major stresses on the region: a number of small Pacific states may disappear, the impact of changing sea levels is likely to be felt throughout the Indonesian and Philippine archipelagos, and the inundation of large low-lying areas such as the Ganges delta is likely to initiate major population pressures on the Indian subcontinent. The impact of this on our security environment is by no means clear, but the possibility a significant impact on the global economy and strategic discontinuities cannot be ignored. We note that Professor Paul Dibb is more optimistic in this regard.[7]

3 Increased Importance of the Maritime Environment

3.1 *Sea Lanes - The Critical Sinews*

3.1.1. Against this uncertain future strategic outlook, the maritime environment will become more significant in both economic and strategic terms. Sea Lines of Communication, increasingly more critical for the economic and energy sinews of the global economy will become more heavily populated and hence, the vulnerability to commercial shipping will increase.

> *The value of international trade flowing through this region will more than double by 2020, and possibly triple by 2030 ….. the number of ships sailings in this region will more than double.*[8]

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[5] The New Chinese Empire, Ross Terrill, UNSW Press,

[6] Strategic Tides – Positioning Australia's Security Policy to 2050, Allan Behm, Kokoda Foundation

[7] Defence Policy Can't Be Left to The Doomsayers, The Australian, Paul Dibb, 21 December 2007

[8] Australia's Future Underwater Operations and Systems Requirements, p 9, Ross Babbage, Kokoda Papers April 2007

3.2 *A More Demanding Maritime Environment*

3.2.1. The maritime security environment will also become more demanding. The investment being made in maritime capability throughout the region will give nations the capability to assert their maritime sovereignty rights, including in the undersea environment. The growing dependence on the sea for resources derived from it or carried on it will provide the stimulus to use this capability. Surface and sub-surface passage will be subject to legal and quasi-legal interference and constraint. In short, more countries will seek to practise undersea denial. There is also an increased probability that non-state actors will use various forms of sea denial, such as mine laying.

3.3 *Access Denied*

3.3.1. Access for surface warships or military aircraft may become constrained in many circumstances. It is not difficult to imagine a scenario in which a regional country finds the overt presence of an Australian ship or military aircraft an embarrassment in its relations with one of the regions recently emerged economic giants. Submarines, on the other hand, are able to exploit their stealth and will continue to provide Governments with an option in this scenario.

4 Regional Investment in Submarine Capability

4.1 *The Race Is On*

4.1.1. Significant investment is underway by regional nations to acquire or improve their submarine capability. Modern Western European technologies are being fielded in many of these capabilities. India and China are also acquiring European and Russian submarine technology of considerable sophistication. Indonesia's program to acquire 10 Russian Kilo class submarines is the most recent example.[9] By our reckoning, publicly available figures indicate that by 2025, there will be in excess of 130 modern submarines in our region (in addition to those of Australia and the USA).

4.1.2. China's investment in hardened submarine facilities is a significant indicator of their perspective on the future criticality of this capability and their desire to be able to sustain it in a high threat environment. [10]

4.2 *Nuclear Powered Submarines*

4.2.1. China is upgrading its nuclear powered submarines and India is also likely to acquire nuclear powered submarines; both will also field submarines with a nuclear strike capability.

4.3 *The Value of Submarines*

4.3.1. These developments illustrate a near universal acknowledgement of the force multiplier effects of modern submarine forces and their ability to

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9 Jitters As Indonesia Buys Russian Subs, SMH, 5 September 2007

10 China Builds Secret Nuclear Submarine Base in South China Sea
Friday, May 02, 2008, Fox News, http://www.foxnews.com/story/0,2933,353961,00.html

present a real threat to a potential aggressor that requires a disproportionate effort to neutralise.

5 Australia's Need for a ***"Strategic Sting"***

5.1 *Decisive Lethality Defined*

5.1.1. Allan Behm has coined the term, ***Decisive Lethality*** to describe Australia's need for the ability to deliver a decisive blow in its defence:

> *'Australia's strategic problem is unique: how to manage the defence of 20% of the earth's surface (including the EEZ) with 0.3% of the world's population? The answer lies in good policies that reduce the prospects of war – strategic diplomacy – working in tandem with defence capabilities that are decisively lethal should they be employed. Such capabilities are not premised on weapons of mass destruction. But neither can they be premised on massive conventional capabilities, because Australia has neither the resources nor the people to develop and maintain them. Rather, decisive lethality is premised on tailor-made capabilities that Australia is uniquely able to develop and deploy, for which effective counter-measures exceed the capacity of possible adversaries.'* [11]

5.2 *Australia's Bounty?*

5.2.1. This attribute becomes all the more important given the struggle to access the increasingly scarce and critical resources outlined above, ***a significant portion of which reside under Australia's control.*** For example:

5.2.2. Australia has the world's largest uranium reserves - 28 per cent of the planet's known supply. [12]

5.2.3. Australia's economically demonstrated resources of zinc, lead, nickel, mineral sands (rutile and zircon), tantalum, uranium and brown coal remain the world's largest, while bauxite, black coal, copper, gold, iron ore, ilmenite, lithium, manganese ore, niobium, silver and industrial diamond rank in the top six worldwide. [13]

5.2.4. A ***"Strategic Sting"*** is designed to make an aggressor avoid a military confrontation with Australia. There are two critical parts to this strategy. Firstly, as for all forms of deterrence, the perception of the capability in the eyes of the adversary is critical. Secondly, if put to the test the sting must be able to deliver the promised outcome - unbearable pain – this is not an occasion to 'fit for but not with'! Why do we believe Australia's future underwater warfare capability constitutes this critical ***"Strategic Sting"?***

[11] Strategic Tides – Positioning Australia's Security Policy to 2050, Allan Behm, Kokoda Foundation
[12] Australian Uranium Association, www.australianuranium.com.au
[13] Geoscience Australia, www.ga.gov.au

6 Why Submarines – What is it that ONLY Submarines Can Do?

6.1 *Australia's Underwater Special Forces*

6.1.1. Turning to Australia's requirements of its submarine force; the submarine's unique capabilities of stealth, long range and endurance that allow it access in key areas denied to other platforms will be critical in the scenario ahead of us. Other platforms can do parts of these missions; none offers the covert combination of capabilities of the submarine. Australian Defence Association Director, Neil James has likened submarines to the special forces of the navy. The analogy is a good one; operating far behind the traditional front lines, independently observing and reporting and where appropriate, striking at key points when least expected.

6.2 *Difficult and Disproportionate Cost to Counter*

6.2.1. The correct investment strategy in a next generation submarine force will confer a significant strategic deterrent capability for Australia, not only measured in Defence terms but also contributing to the security of energy supply. A significant factor in the deterrent value is the exorbitant and disproportionate cost involved in trying to counter a capable submarine force and the degree of doubt that exists that, regardless of the investment, the ASW effort can succeed. Some commentators cite an investment ratio of greater than 100:1: every $ spent on a submarine capability requires at least $100 to counter and the desired outcome can by no means be guaranteed. This is a significant strategic return on investment.

7 Strategy for Employment of Australia's Submarines

7.1 *Operate In The Deep Field.*

7.1.1. One option to achieve this impact is a submarine capability that has the range, endurance and stealth to gain access to sensitive areas and critical maritime infrastructure and carry a flexible mix of payloads to offer a range of missions.

7.1.2. Such a force of 'fully capable' submarines ensures that Australia retains the initiative even in the most severe circumstances. It provides a level of uncertainty that must be factored into an opponent's calculations, he must counter the capability or accept the risks; avoiding it is not an option.

7.1.3. To be able to execute this strategy the submarine force must have the range and endurance to be able to reach and operate in these areas covertly, with sufficient quantity and mix of payloads to complete the range of missions and remain there for significant periods of time.

7.1.4. This will require a long range submarine, say with a combined Air Independent Propulsion and diesel range of 15,000 nautical miles, an overall endurance of 10 weeks with the capacity to operate covertly in the approaches to, from and whilst in the patrol area, i.e. covert capability of 6-7 weeks. There are significant technical challenges to achieving this level of performance in a conventional submarine. The options, costs and benefits to achieve it need to be carefully evaluated in a design development/trade off phase.

7.2 *Guard The Moat*

7.2.1. An alternate strategy could entail using submarines to guard the egress points through the Indonesian archipelago. This requirement could be performed by smaller, shorter-range submarines. However this would deny Australia the early warning on intentions available from surveillance operations in the opponents training areas and forsakes the most profitable area for ASW and the capacity to stop opposing units deploying from their home base.

7.2.2. Most critically, it leaves the initiative and control of the seas beyond the area of the archipelago to others.

7.2.3. It is a reactive strategy that provides fewer options, provides no deterrent against threats to our infrastructure and offers an illusory prospect of being able to oppose submarine egress through the Indonesian archipelago. The reality is that there are too many egress options; many straits would require numerous submarines to cover, overall it would require a huge force of submarines to effectively execute this strategy.

7.2.4. Historical precedents indicate that this is not an effective use of submarines, without accurate intelligence to position themselves they are more likely to be in the wrong place and lack the mobility to reposition once the opposition's intentions become clear.

7.3 *Forward Basing*

7.3.1. **Access To Regional Ports.** Forward basing could allow smaller submarines to replenish fuel and stores to extend their range and endurance. To be effective such bases must be at a significant distance from Australia, say Singapore or the Philippines, however none of these bases are under Australian control and access cannot be assured under every circumstance.

7.3.2. Use of such bases would be a useful clue as to timing and intentions of current or future operations, eg the visual appearance of the submarine is an immediate indication of whether the submarine is going to or has just come back from 10 weeks underwater. These indicators offer a reduction in the opponents' uncertainty.

7.4 *Depot Ship*

7.4.1. An alternative option could be to provide a specially designed and equipped depot ship, positioned well forward to provide support in lieu of a regional port. Such a vessel is able to provide key elements of the support available from a submarine base albeit confined to a much smaller footprint.

7.4.2. To be effective, a depot ship requires a sheltered anchorage or berth and access to logistics support from Australia. This can only be achieved with the cooperation of a regional country and hence suffers from the same drawbacks as a regional port in terms of guaranteed access and acting as a clue to current or future operations.

7.4.3. During hostilities the depot ship would become a prime target, significantly more vulnerable than an Australian base port because of its geographic situation and inability to absorb damage. Its loss would have a significant impact on the effectiveness of any submarine force that was dependent on it to reach their key operating areas.

7.5 *Selecting the Best Deployment Strategy*

7.5.1. The desired military effects cannot be achieved by a submarine that lacks the capacity to covertly reach the critical areas and remain on station with a mixed and flexible payload for significant periods. A submarine capability that is confined to lingering on the perimeter of the areas under our control does not achieve these returns. There is a significant possibility that submarines deployed under such a strategy will be in the wrong place at the wrong time and lack the ability to quickly reposition – it surrenders the initiative to the opponent that may well calculate that he should be able to avoid the defending submarines.

7.5.2. It is concluded that in order to be able to provide deterrent effect and range of initiatives the side in the strategic setting ahead Australia requires submarines that have the range endurance and payload to accomplish the range of missions without having to depend on forward basing.

7.5.3. The strategic setting and selected strategy for employing submarines outlined above will result in a reinforcement of existing roles and an expanded range of strategic effects to be achieved by Australia's submarine force. These new or modified strategic effects expand the roles required of the future underwater warfare capability, beyond those currently expected of the Collins force, turning to discuss briefly the most critical.

8 ***Military Effects to Be Achieved by The Submarine Force***

8.1 *The Criticality of C3I*

8.1.1. We should preface these points by emphasising the importance of good operational command, control and real time intelligence support to maximise the effect of submarine operations.

8.1.2. The Falklands War provides an example. The Argentinean Navy and Air Force demonstrated how not to do it – the one modern submarine available, the *San Luis*, was deployed independently, without the benefit of coordination with the aircraft assets employed. Even with this limitation and a defective fire control system, *San Luis* conducted three attacks, all unsuccessful, possibly due to the failure to prepare the torpedoes correctly. Regardless of these realities, *San Luis* tied up a huge amount of the Royal Navy Task Force time and effort in defending against the threat and was never successfully attacked.[14]

8.2 *Surveillance and Intelligence Gathering*

8.2.1. The ability to gain access to areas denied to other units, combined with its ability to concurrently observe activities underwater, on the surface, in the air and over the electromagnetic spectrum, are particular strengths of a

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[14] Submarine Operations During The Falklands War, Lieutenant Commander Steven R Harper, USN, Naval War College, 17 June 1994, p 18 (http://stinet.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA279554)

capable submarine. Combined with the ability to fuse and interpret the observations and react immediately to maximise the opportunities for further collection and understanding the activities makes a submarine a unique platform for this role.

Only the submarine offers this capability.

8.2.2. One of the more important and challenging areas for intelligence gathering are the maritime training areas of a country of interest. The types of training being undertaken, levels of competency displayed and changes to the tempo or activities being practised are a critical indicator of future intentions and invaluable long lead indicators. These areas are highly sensitive and can only be accessed by submarine. It goes without saying that a highly capable submarine with a stealth advantage over the forces it is observing is critical if embarrassment is to be avoided.

8.2.3. The information provided will contribute to Allied and Australian knowledge, enabling us to gauge intentions, deploy diplomatic and military preparations and, in the event of a contingency, position our limited military capability for maximum effect.

8.2.4. Another example of the force multiplier effect of submarine's ability to gain access to the most sensitive areas; during the Falklands War, Royal Navy nuclear powered submarines, positioned off the major Argentinean airfields, were able to alert the task force offshore to the departure and often, the composition of the departing waves of strike aircraft – critical information to enable the limited endurance Sea Harrier aircraft defending the ships to be positioned.[15]

8.3 *Land Strike*

8.3.1. A submarine fitted with land attack cruise missiles is able to position within launch range without alerting the adversary, withdraw quietly if not required, or launch on instruction and withdraw without provoking or offering an opportunity for a further engagement.

Only the submarine offers this capability.

8.3.2. While suitable land strike cruise missiles can be carried in combination with other weapons such as torpedoes, mines and anti ship missiles, this role requires a profile from the submarine that is incompatible with roles requiring a more proactive stance. To clarify this point:

a. A submarine deployed on a land strike mission needs to find a quiet spot, at a suitable range from potential targets, keep well away from the adversaries ASW forces, avoid counter detection and await instructions;

b. Compare this profile with a submarine required to gather intelligence or conduct more offensive operations – this submarine must go to where the action is and be much more proactive to be successful; and

c. Whilst a mix of weapons can be carried – provided the submarine has the payload capacity, and the submarine can switch from one

[15] Ibid, p6

role to the other, the two roles cannot be conducted concurrently; a factor when force structure is being considered.

8.4 *Battle Space Preparation*

8.4.1. The submarine's ability covertly to gain access to the denied areas, assess the environment and deployment of opposing forces, without alerting the opponent and relay this back in order to allow future task force operations in the area, make it a preferred option for effective battle space preparation.

Only a submarine offers this capability.

8.4.2. With suitable capabilities embarked, the submarine is able to identify and if permitted, neutralise threats prior to a coalition task force or shipping convoy moving into in the area. Once the task force operation is underway, the submarine is able to provide direct support, (noting that a conventional submarine lacks the mobility to support a rapidly moving task force - but is able to do so for short periods or in key geographical areas) – one option in this situation is to deploy more than one submarine along the line of advance.

8.4.3. Another example from the Falklands War: HMS SPARTAN, a Royal Navy nuclear powered submarine was able to observe the mining of the approaches to Port Stanley and fix the position of the mines as they were laid - the Rules of Engagement did not allow the submarine to do a little offensive mine sweeping! [16]

8.5 *Anti Submarine Warfare*

8.5.1. The mirror image of this capability is the challenge posed by the growth in regional submarine capability.

> *'In a contingency, submarines will be able to seriously threaten the operation of surface fleets and commercial trade.'*[17]

8.5.2. Australian submarines are arguably Australia's most potent anti-submarine weapon: this is their most demanding role. This capability is enhanced by the optimised sensor suite possessed by a submarine compared with all other ASW platforms. Maintaining an edge across the spectrum of stealth, sensors, weapons, countermeasures and training is critical to success – an ongoing investment in R&D and programs to continually upgrade capabilities in **all** these areas is the price of a viable capability. It is important that the gains made by our R&D do not find there way back into the region, highlighting the need for an indigenous submarine R&D, design and construction capability.

8.5.3. Where practicable, our submarines should operate as part of an ASW network. However, there are many scenarios, where we will lack sufficient sea and air control to permit the deployment of surface and air ASW assets.

Only a submarine offers this capability.

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[16] Ibid, p4

[17] The Enemy Below: Anti-Submarine Warfare and the ADF, Andrew Davies, ASPI Special Report February 2007

8.5.4. This is a very challenging role, it must be supported by the R&D effort to achieve a technology edge, highly trained and proficient crews, good weapons, state of the art countermeasures, current and accurate intelligence and executed by the most capable command and control support – these factors will be the difference between success or failure and all aspects of the underwater capability must be sustained and focussed to achieve this. Despite all these efforts to ensure a winning edge, the margin between success and failure is small and attrition of own forces must be anticipated. This reality and the relatively low mobility of conventional submarines are key issues for the force structure considerations.

8.6 *A Network Contributor with Unique Abilities*

8.6.1. The submarine's ability to gain access to critical, denied areas allows it to make a unique contribution to the network. The technical challenge is to do so without compromising the submarine's covert stance, off-board vehicles and low probability of interception communications channels are some of the tools to achieve this.

Only a submarine offers this capability.

8.7 *An Expanded Range of Special Forces Operations*

8.7.1. Given the strategic setting and trend for asymmetrical conflict, this is likely to be a growth area for the future underwater warfare capability, exploiting the submarine's ability to covertly transport, launch and recover the Special Forces and their equipments, provide command and control and if necessary, a level of tactical fire support.

Only a submarine offers this capability.

8.7.2. This is a particularly demanding mission, with significant impact on the design. It will require a large and flexible payload capacity and is also likely to require the fitting of additional weapons capabilities, such as short range, tactical land strike and AAW missiles.

8.8 *Offensive Mining*

8.8.1. Mining using sophisticated, discriminating, static or mobile mines will enable Australia to gain the initiative against a larger opponent and to deny access to selected areas or ports in areas not under our sea or air control. Depending on the situation, these can be declared, leaving the choice to the adversary whether or not he wishes to challenge the mine!

8.8.2. These can be laid in areas inaccessible to other units and activated on command, if necessary, by the submarine.

Only a submarine offers this capability.

8.8.3. Possession of this capability has two major strategic impacts; it acts as a deterrent for the use of such weapons against our maritime infrastructure, whilst providing an option for the government to gain the initiative and break a cycle of escalation that may be underway.

8.9 *The Role of Unmanned Vehicles In The Next Generation Submarine*

8.9.1. Remotely Operated Vehicles (ROVs) such as Unmanned Underwater Vehicles (UUV) and Unmanned Aerial Vehicles (UAV) are a force multiplier that will extend the manned submarines' reach, effectiveness and survivability. Remote sensors deployed or carried by a remotely operated vehicle could offer a winning advantage to the larger submarine in an ASW encounter with the smaller submarines proliferating in the region.

8.9.2. These vehicles are a key component of the future underwater warfare capability and should be acquired in the overall project. It is a major area for R&D and will be a design driver for the next generation submarine, impacting on payload capacity, interfaces with the sea and onboard systems to support the ROVs. The capacity to carry and deploy a range of fully capable ROVs, without offloading weapons, offers a strong advantage to a larger submarine.

9 Key Strategic Effects Required

9.1 *Introduction*

9.1.1. The foregoing analysis supports a demanding and, in many respects, unique set of strategic effects that must be deliverable by Australia's submarine force. Let us consider these in more detail.

9.2 *Visibility of Intentions*

9.2.1. Australia must have visibility and understanding of the developing maritime capabilities in the North, South, South East and Western Asian regions, with a view to ascertaining future intentions and designing appropriate response capabilities. Critically, submarines exercise a key Indications and Warning role arising from their capacity to observe changes from normal behaviour or the initiation of deployments, particularly of other submarines, where they maybe well positioned to give one of the few warnings that an opponent's submarine has departed its home waters. Similarly, submarines exercise a key intelligence, surveillance and reconnaissance role.

9.3 *Deterrence*

9.3.1. Australia must be able to deter, and if necessary retaliate against, any nation seeking to interfere with our maritime trade, critical infrastructure and resources. As discussed earlier, deterrence is a matter of perception in the eyes of the opponent; it cannot be achieved by a less than fully capable submarine force.

9.4 *Strike*

9.4.1. Australia must have the capability to be able to threaten and if necessary launch precise attacks on selected maritime and land targets using a covert and stealthy platform, thereby retaining the initiative whilst avoiding exposure of Australia's possible intentions and minimising the chances of leaving the launch platform open to immediate retaliation.

9.5 *Assured Access*

9.5.1. Australia must be able to maintain access to and a presence in the maritime areas of our region, especially the archipelagos to the north, in circumstances where Australia may not control the air or sea surface, or where an overt presence may be unwelcome, inflammatory or unacceptable to the regional countries involved.

9.6 *Undersea Warfare*

9.6.1. Australia must develop a comprehensive understanding of the underwater warfare environment and be able to conduct undersea warfare across a range of strategic and operational settings, in particular ASW.

9.7 *Key Military Strategies*

9.7.1. Australia must be able to exploit the following key military strategies:

a. Create uncertainty in the mind of an adversary about our force disposition and intentions (Submarines offer an offensive Force-In-Being and, coupled with the stealth package they bring, their capability multiplies this "force" significantly).

b. Increase the risks to an adversary of moving against us to unacceptable levels.

c. Constrain the freedom of action of a potential adversary.

d. Require disproportionate investment in a response capability by an adversary.

e. Cause force structure distortion on the part of the adversary.

f. Prevent an adversary from predicting where our forces might be.

g. Covertly mount and conduct Special Forces operations from the sea.

h. Deny access to specified areas or ports by the use of declared minefields or Naval Blockade. (In this case the submarine is less subject to land-based air attack and can effect a blockade with lower risk).

i. Contribute specialised, unique capabilities (niche capabilities) to allied maritime operations; this will continue to be a fundamental expectation of the USA.

10 Force Structure Considerations

10.1 *Top Level Capability – What Will Australia Require of Its Submarine Force?*

10.1.1. In considering the strategic setting and our geographical area of interest, it is likely that Australia will wish to concurrently maintain submarines at very long ranges (~ 3,500 nm) in the critical roles of surveillance, intelligence gathering, indications and warning and in the event of a contingency, land and maritime strike. Concurrently Australia will also wish to provide submarines in support of Task Force operations or for special force missions closer to home (2-2,500 nm).

10.1.2. The issue of concurrent roles and allowance for attrition of own submarines employed on offensive operations are additional factors to the calculation of the force structure required to achieve the strategic effects.

10.2 *Sustainability*

10.2.1. Accordingly, Australia must be able to deploy a covert maritime platform, to operate it at long range and maintain it on task for long periods of time. To be effective Australia must be able to manage the sustainment and resilience of the capability:

a. It must provide for attrition (submarine operations are dangerous and attendant risks are high).

b. Consideration must be given to manning levels – multiple crewing offers considerable operational and conditions of service advantages. This is discussed further in the personnel section of this paper.

c. In-service support levels and the cost of capabilities such as the design authority (section 17 below) arising from being a 'parent navy' for a submarine force must be addressed as part of the total package.

10.3 *Concurrency*

10.3.1. Critically, issues of concurrency must be addressed. From the discussion above it is postulated that Australia should be able to conduct surveillance/deterrence operations at long range, whilst simultaneously supporting Task Force of Special Forces operations somewhat closer to home. This requirement is a fundamental driving force structure:

10.4 *How Many?*

10.4.1. Two on The Deterrence/Surveillance Task. Force levels should enable Australia to offset the risk that counter detection, the mobility restrictions of a conventional submarine, combined with ROE restrictions limiting the submarine's ability to break contact by attacking its pursuers, could allow one submarine to be neutralised as a deterrent response. Accordingly, maximum strategic effect at lowest risk is generated by maintaining two submarines on task for deterrence.

10.4.2. Task Force Support - Concurrently, submarines must be available to support Task Force or other warfare operations.

10.5 *The Mathematics*

10.5.1. A simple mathematical model based on proposed performance figures for the next generation submarine (attachment 2) indicates that a force of 10 submarines are required to maintain 2 continuously on task at 3,500 nautical miles and a further 5 submarines are required to maintain one on task at 2,500 nautical miles leading to a total force of 15 submarines.

10.5.2. The model is particularly sensitive on the availability of submarines (assumed as 75%) and the time on task (35 days are used). Allowing for attrition and mishaps, a total force of 15 - 18 submarines would accomplish this top level capability.

10.5.3. The assumptions underpinning these calculations are judgements on possible performance targets for NGS, some will be difficult or expensive to achieve. These will require adjustment during concept development and design trade off considerations with an appropriately R&D team such as that proposed under '*Team Australia*' model.

10.5.4. Mathematics aside we are dealing with perceptions, there is another way of looking at the issue of how many - what is a sufficient force to deter?

11 Achieving Sufficient Mass To Represent A Strategic Sting

11.1 *The Objective*

11.1.1. The objective of this strategy is to deter an opponent from undertaking military action against our vital interests, on the basis that Australia is able to inflict an unacceptable price in return. Deterrence is about perception; a submarine force's ability to achieve this outcome rests principally on the uncertainty about their position and intentions, combined with recognition of their ability to inflict an unacceptable penalty.

11.2 *How Many Is Enough?*

11.2.1. Given an appropriate design philosophy, sufficient investment in maintenance support and crews it should be possible to achieve an overall availability of '***operational submarines***'[18] from the next generation submarine force of 75%. This is a far higher figure than has been achieved in practice with the Collins force, where the investment in support and crews has been inadequate.

11.2.2. Typically ⅔ of *operational submarines* will be deployed; coming, going or on patrol - out of sight – whereabouts and intentions unknown. This is the deterrent force. So, from a force of six submarines up to three will be unaccounted for; we suggest this is unlikely to constitute a strategic sting. We suggest a force of six or more submarines unaccounted for at any time constitutes a strategic consequence that cannot be ignored. This requires a force of at least 12 fully capable submarines, a judgement endorsed by ASPI's Dr Andrew Davies.[19]

11.3 *Conclusions On Numbers*

11.3.1. A force of 12-18 submarines is considered sufficient to achieve the minimum necessary *Strategic Sting*, and provide an increasing level of capacity to achieve the top level capability.

11.3.2. The proposed force structure strategy would be an initial build of 12, with the capacity to continue or accelerate the build rate to achieve a larger force should strategic circumstances at the time warrant this investment

11.4 *Impact on ADF Force Structure*

11.4.1. It is recognised that the acquisition of 12 fully capable submarines (albeit over a number of years) would entail a significant investment that can probably only be made at the expense of some other ADF capabilities. It

[18] *'operational submarines'* are defined as those not in depot level maintenance, such submarines are plainly not available for operations.

[19] Keeping Our Heads Below Water, Dr Andrew Davies, ASPI Policy Analysis, 30 January 2008

is suggested that a reassessment of the current ADF force structure is warranted, noting the unique capabilities and range of initiatives offered by submarines under all circumstances, including extreme circumstances. In this situation the strategic effects generated by a capable submarine force would provide critical options for Australia in a high threat environment.

11.5 *Growing The Force*

11.5.1. A programme to grow the current capability to at least this level, with the capacity to later increase the force should circumstances demand the capacity to maintain 2+1 on task discussed above is suggested. This will be neither quick nor easy – the strategy to achieve it needs be carefully crafted. A force of this size has significant implications for personnel, acquisition strategy and through life cost these are discussed further in subsequent sections of this paper.

11.6 *Rolling Construction Programme*

11.6.1. A force of 12 submarines may be sufficient to enable a rolling construction programme, producing a replacement submarine at say, 2 years intervals once the build up has been achieved. This would have the advantage of achieving a steady state loading for the design, construction and supporting industries, a reduced cost of ownership for achieving and sustaining the capability and the ability to more quickly expand the force structure. [20] The transition and industrial arrangements would require further development once a better understanding of the capability required is available.

11.7 *What Will Our Alliance Partner Expect of Australia's Submarine Force?*

11.7.1. In view of the democratic and liberal values that both Australia and the USA share, the Australia-USA alliance will remain a core feature of our strategy. Arguably, the USA will place an increasingly high priority on Australia's capacity to provide a capable conventional submarine force as a contribution to that alliance. This is precisely the point that the then-Rear Admiral Al Konetzni made to the then-Minister for Defence John Moore in 2000, when, prior to its systems upgrade and noise reduction, a Collins had already impressed at the annual RIMPAC exercise (news, by the way, that the then-Minister was not altogether too pleased to hear!). "Mr Minister, the USN needs those boats!" It is reflected in the Agreement on Submarine Cooperation, signed by the Australian Prime Minister at the Pentagon on 8 September 2001 – three days before the terrorist attack.

11.7.2. Properly managed it is a critical factor in gaining access to the USN's sensitive submarine Intellectual Property.

[20] Japan has such an arrangement to sustain a force of 15 submarines.

12 Why Not Nuclear Power?

12.1 *Practical Considerations*

12.1.1. Whilst the requirement could well justify the use of nuclear powered submarines there are a number of practical considerations against this proposal:

a. Australia has no engineering, academic or commercial nuclear infrastructure or the regulatory regimes necessary to support such a capability.

b. Significant public and political obstacles would exist to the introduction of a nuclear powered submarine capability.

c. A strategically significant force of nuclear powered submarines would be considerably more expensive to acquire and operate than a conventional equivalent.

d. Even if these obstacles could be overcome there is insufficient time to achieve a capability before Collins becomes obsolete.

13 Conclusions On Part 1 – The Requirement

13.1.1. The following conclusions are drawn from Part 1 of this paper*:*

a. The likelihood of significant strategic discontinuities and major shifts in global power balance over the next four decades create a compelling case for the acquisition of a new and expanded undersea warfare capability to ensure there is no capability gap as the Collins class reach end of its capability, possibly from 2018 onward and hull life from 2025.

b. The strategic environment of 2020–2050 demands an advanced underwater warfare capability, centred on a long-range, sophisticated submarine backed by a through life R&D based improvement program to achieve and maintain a qualitative edge.

c. Compared with COLLINS, the future underwater warfare capability will be required to operate in a more demanding environment, at greater range and to achieve an expanded number of strategic effects.

d. The underwater warfare capability will be a critical and unique asset in the nation's Defence capability; providing the Government with options and choices to retain the initiative in the constrained circumstances Australia is likely to face.

e. As the ***"Strategic Sting"*** it will deter 'would be' aggressors and if necessary deliver a painful response, causing them to desist from an aggressive solution.

f. It will provide an increasing important contribution to the US alliance obligations.

g. The strategic effects, consequent roles, the need for concurrency and an allowance for attrition should be factored into force structure considerations, through life support and crewing arrangements.

h. A force of at least 12 submarines, with levels of support and crewing able to sustain 9 operational of which 6 could be deployed for operations at any time is required to achieve a strategic sting.

i. The acquisition strategy should allow the option to continue the build up to 15-18 submarines, sufficient to achieve the top level capability should circumstances warrant.

j. This should be accomplished by a large, fully capable, conventionally powered submarine force: it is not feasible to acquire nuclear powered submarines at this time. This will only be feasible once Australia has established the necessary nuclear industry infrastructure.

k. A fleet of 12 fully capable submarines would entail significant investment that could probably only be made at the expense of some other ADF capabilities. However, noting the unique capabilities and range of initiatives offered by submarines under all strategic circumstances, including extreme circumstances and the benefit for Australia in a high threat environment, it is suggested that a reassessment of the current ADF force structure is warranted.

Part 2: Acquiring The Capability

14 Design Issues

14.1 *A Unique Requirement*

14.1.1. Selection of a ‘deep field’ deployment strategy, discussed in section 7.1, combined with Australia’s geography and strategic circumstances require the design and operational characteristics of the submarine to accommodate a unique combination of factors:

a. Long transits from home bases in Australia to a distant patrol area, combined with the likelihood of short-notice contingencies will demand high levels of mobility and long endurance.

b. The capacity and flexibility to carry a mix of payloads will be critical; returning to base to change mission and reconfigure could take weeks. The limitations imposed by the use of torpedo tubes and weapon reload stowages for non weapon payloads will become increasingly restrictive.

c. New payloads and missions, such as UUVs, off board sensors and the requirements of special force’s missions will require new interfaces with the ocean and much greater flexibility in the capacity to safely carry, sustain, launch and where necessary, recover these payloads.

d. The nature of the littoral operating areas, stretching from the Arabian Gulf to the North Pacific will demand both high agility and prolonged covert operations in littoral operating areas and the approaches.

14.1.2. As a result of the changes to the maritime operating environment noted above, Australia’s submarine force will require a very low signature in all spectrums and at high speed, thereby imposing new demands on conventional submarine design.

14.2 *Some of the More Significant Criteria*

14.2.1. Range

a. As illustrated in the deployment model at Attachment 2, the transit to a patrol area at 3,500 nautical miles and five weeks on station at an average speed 4 knots, with appropriate safety margins would require a combined diesel and AIP fuel endurance of 15,000 nautical miles. This is a 50% increase on Collins diesel endurance and more than double the typical range of existing European designed submarines in the 1,700 to 2,000 tonne range.

14.2.2. Endurance

a. The deployment model also illustrates the endurance required to reach these operating areas and achieve an effective time on task; the larger submarine is able to achieve a total endurance of 10 weeks with a good level of habitability for its crew and embarked specialist personnel. This is not possible in the smaller European designs where habitability is more spartan. This is a limitation of the smaller submarine, typically these have a maximum total endurance of 5-6 weeks and will impact on effectiveness and the capacity to sustain its crew and embarked specialist personnel.

14.2.3. Payload

a. In addition to the typical submarine weapon load of torpedoes, anti-ship missiles and possibly mines, the new strategic effects and missions outlined in Part 1 will require additional weapons. A precision, land strike missile such as Tomahawk, and a shorter range missile for the combined purposes of AAW/tactical land strike/tactical maritime strike. To exploit its inherent mission flexibility, the next generation submarine should be able to carry a mix of these weapons as its standard weapon load.

b. UUVs will be routinely carried and form a critical force multiplier for the next generation submarine. Restricting these to the physical dimensions required for a torpedo tube would be a significant design and performance limitation. A suitable stowage, with access to the ocean to allow their launch and recovery is required to achieve maximum effectiveness.

c. The requirements to provide submerged exit and re-entry and vehicles for the transport of Special Forces will be a demanding design driver. Restricting these forces to use a standard torpedo tube would be a significant operational limitation.

d. The combined requirement of capacity, flexibility in accommodating various sizes and forms of payload and their particular requirements for access to the ocean will require the capacity of a larger, custom-designed submarine. Incorporation of modifications into an existing, smaller design to achieve these visions would involve significant compromise and impose limitations on their mission effectiveness.

14.2.4. Habitability

a. The crew in a modern, minimum manned submarine typically work in 2 watch shifts and complete a working day of 18 - 22 hours. To sustain their effectiveness over the long missions requires a good standard of habitability. In addition to its crew the submarine must also be capable of carrying upwards of 20-25 additional personnel, eg trainees plus a mission specific specialist teams, or a Special Forces team.

b. Apart from domestic services such as bunks, food, rest and recreation space, the necessary life support systems and emergency systems such as escape arrangements must be provided. Whilst the smaller submarine may require fewer crew, the size of the embarked teams are mission dependent and will not vary significantly. The capacity to accommodate these numbers and provide the essential support necessary is unlikely to be effectively achieved in the smaller submarine.

14.2.5. The Size of The Sting

a. The practical limitations imposed by the smaller submarines range, endurance, payload and habitability combined to achieve much reduced and in some cases, no access to denied and sensitive areas, creating less uncertainty and strategic vulnerability for an opponent and hence significantly less impact as a Strategic Sting. The overall deterrent effect of such a force is much reduced.

14.3 *Timescales – Extend or Replace Collins?*

14.3.1. By 2025 HMAS COLLINS will be 30 years old and obsolete.[21] If we are to avoid a critical capability gap, the future underwater warfare capability must be operational at this time.

14.3.2. Similar to the Oberon experience at this time of life, it will not be cost-effective to sustain or replace ageing/obsolescent systems, nor is it an option to extend Collins, since:

a. The capability gap between the 1987 specification and contemporary needs is increasing;

b. The Collins class currently lacks any design margins (space, ship stability, power, cooling etc) to sustain significant capability enhancements to meet the increasingly demanding environment and new requirements;

c. It is possible to achieve additional capacity by cutting the submarine and installing an additional length or 'plug', for example to provide air independent propulsion. Ship systems providing support such as power and cooling would also require upgrading. Such measures would still not achieve the full range of capabilities necessary to achieve the outcomes set out in the first part of this paper.

d. The ageing platform and its fundamental systems will become a demanding and expensive vehicle to continue to operate.

e. There is an increasing risk of major failures that would be costly and or time consuming to rectify; major defects will occur without warning, with compounding effects on availability, long term planning, bad press and recruitment and retention.

f. The application of new and up to date safety requirements will be difficult in an asset designed in the 1980s.

g. A life extension program is therefore likely to be a poor return on investment.

h. The attraction of this option to the bureaucrat, as a means of delaying a difficult decision should be resisted: it is a distraction and will result in a serious capability gap.

14.3.3. We must therefore field a new underwater warfare capability no later than 2025. Assuming our recommendations on the acquisition strategy are followed, the timescale (counting back) could be:

a. First of Class Pre Acceptance Trials – No Later Than 2022 – 2024

Three years of pre acceptance trials; this is a critical part of the risk mitigation strategy and must not be regarded as a 'just in case buffer' or project float. During this period the submarine and its

[21] Australia's Future Underwater Operations and Systems Requirement, Ross Babbage, Kokoda Paper, April 2007 page ii.

systems such as UUVs and weapons will undergo extensive trials to identify the inevitable, unexpected problems, resolve them and provide a submarine ready to commission, work up and send in harm's way.

b. Detailed Design and Construction – No Later Than 2016 – 2021

Six years will be required to finalise the design and construct the first submarine. The contract must be let in 2016, i.e. 'Second Pass' 2016.

c. Design/Technology Trade Offs – No Later Than 2011 – 2015

Four years to complete the design studies/trade-offs, develop the technologies to the point that they can safely be incorporated into the design and prepare the contract documentation for the design and build and supplier contracts, i.e. First Pass 2011.

d. Concept development and Project Mobilisation - 2008 – 2011

Three years to establish the project teams, finalise the requirements and acquisition strategy, initiate the R&D teams, design teams, industry partnerships and Government to Government relationships whilst completing the initial studies to inform the design and trade off processes. By 2011 we must have identified those technologies likely to lead to the capability edge we seek.

14.4 *Acquisition Options*

14.4.1. The above timescales assumes an acquisition strategy of developing from the COLLINS pedigree using the 'Team Australia' model set out in this paper. There are other models but none, we submit, that can achieve the end point with a lower risk profile **and** in this time scale.

14.5 *How Does This Timescale Fit The Strategic Background?*

14.5.1. The growing sophistication of the maritime surveillance and ASW capability in the region will pose increasing challenges to a conventional submarine required to regularly snort in a sensitive patrol area in order to recharge his batteries. It is a matter for judgment, informed by accurate intelligence assessments, as to when this risk becomes unacceptable for Collins. It is suggested that within 10 years, i.e. 2018, this is likely to be the case.

a. The critical deficiency is an air independent propulsion capability, able to remove the need for snorting in high threat areas.

b. The lead time to correct this is at least 3 years, the quickest option would to be retrofit Collins by inserting a plug containing the AIP system; typically a 10 m plug could achieve 10 days covert endurance. This is a significant design and engineering task (and a very useful developmental task for the submarine design authority). It is probably best accomplished in the second full cycle docking if a worthwhile return is to be achieved on the significant investment involved. This may not prove feasible in the time remaining until these dockings are due to be conducted.

14.6 *Advance The Timescales for NGS*

14.6.1. Alternatively, it may prove more cost-effective to advance the build of an early batch of next generation submarines incorporating this capability, accepting that the time scales may not permit achievement of full capability in this first batch.

15 Collins Lessons Learnt in the Context of The Next Generation Submarine Capability

15.1 *Outcome*

15.1.1. The principal aim of the Collins program was to acquire a new class of submarines suitable for operations in the mid-1990s and beyond. Compared to a 'build to print' program (e.g. construction of, say, Upholder class submarines based on 1970s technology), the Collins program involved a number of innovations and acceptance of risk to ensure the capability sought was appropriate to the future strategic environment. It is now clear that, despite its complexity and controversy, the aim was achieved and Australia acquired a world-class conventional submarine capability augmented by a strong industrial support base. In so doing, the foundation necessary for the next generation submarine capability program has also been established.

15.2 *Australia's Capability to Manage a Complex Developmental Project*

15.2.1. The Collins program demonstrated that Australia has the capacity to manage a complex submarine construction program as well or better than a European or US supplier. Deficiencies in the build phase related more to design and contractual problems, including with overseas suppliers, than to shortcomings on the part of Australian industry. While a future program will also involve a number of innovations and acceptance of risk, there will also be initiatives based on Collins experience that will mitigate risk. These include migration of some of the high risk software based systems, evolved in the Collins class, access to USN and European submarine technology, adoption of more appropriate contract terms and conditions and improved transition planning.

16 Personnel Issues

16.1 *Manpower Levels*

16.1.1. With assistance from the USN by way of sonar operators, the RAN has just sufficient trained submariners to sustain 3 operational crews. The annual loss rate of ~ 50 personnel is being matched by newly qualified personnel, leading to a nett loss of experienced personnel. The personnel remaining are stretched to cover the gaps.

16.1.2. The manpower review currently underway is the first key step to recovery. Building back to the required number of personnel to operate a force of 6 submarines, i.e. 4 operational at any one time, will be a long and difficult process. For example, it will take in the order of 3 years of dedicated effort with 3 seagoing submarines to generate and train a fourth crew.

16.1.3. This will be more difficult because of the situation with the maintenance of the submarines.

16.2 *Maintenance Levels*

16.2.1. To understand the maintenance regime required to safely operate submarines they are best regarded as underwater aeroplanes; defects have to be promptly rectified, in some cases operations must be curtailed or cut short until this is done. A demanding regime of routine maintenance must be followed, with mandatory checks at specified intervals requiring a docking and access to a similar level of facility as was used to construct them. All work must be subject to rigorous quality control of men and materials – exactly the same arrangements we hope our airline is following.

16.2.2. The submarine design authority's role to resolve emerging technical issues and oversee their rectification is a critical component of the systemic approach required for safe operations – similar to an airworthiness authority for aircraft.

16.2.3. The aircraft analogy holds good in terms of operational availability, i.e. the RAN has a 'flight line' of 6 submarines, the number available for operations is directly related to the amount of support from the maintenance authority (ASC), until the limit of time required for defects and mandatory checks is reached, i.e. 4 out of 6 operationally available.

16.2.4. Three submarines are currently in depot level maintenance in Adelaide. It is understood that a fourth submarine is likely to join later this year.

16.2.5. The principal factor in this situation is the availability of funds to complete the maintenance by ASC. Annual maintenance funds should be compared with the heavy industry benchmark of between 2 and 10 percent of asset net replacement value to be spent on maintenance per year – 2 percent for a building in a benign environment, 10 percent for a plant producing hot, highly corrosive chemicals.

16.3 *Double Jeopardy*

16.3.1. Manning levels are at survival levels with 3 crews only just managing to match the exit rate. The crews we have are being overworked as a consequence of manning shortfalls in support areas. The few personnel ashore, numbers of personnel ashore, in theory for rest and respite from sea service, are frequently posted at short notice as operational reliefs in seagoing submarines. And so the vicious cycle of a submarine arm manpower crisis plays out. To recover, improvements will be needed in retention and training throughput.

16.3.2. We will not dwell on the retention issue, but have to observe that this will be made more difficult by the additional demands being placed on an increasingly smaller cadre of experienced personnel!

16.3.3. Given a sufficient flow of suitable initial trainees – (one of the key steps to avoid a manpower crisis in the first place) and capacity in the submarine school, the throttle on the training pipeline is the number of sea going bunks for trainees in an operational submarine. The impending reduction to 2 operational submarines will make the recovery programme extraordinarily difficult.

16.3.4. The situation is best described as precarious. It will have developing significance for the transition to NGS.

16.4 *Implications of This Situation For the Next Generation Submarine Project*

16.4.1. The review into the sustainability of submarine arm manpower currently underway is the critical first step in a recovery programme; the outcomes should not be second-guessed here. However, some observations on the significance of the situation for the next generation submarine programme appropriate.

16.5 *Crew Workloads*

16.5.1. One reaction to this situation is to suggest that we should be looking for a smaller crew size in next generation submarine to ease this problem; this suggestion is misdirected. Firstly, an analogy to place the crew workload into perspective:

a. The Collins crew (46) is slightly larger than that of a Huon Class Minehunter (40);

b. Whilst at sea crew members operate in two watches, working 18-22 hours per day;

c. Operating a vessel the same size and arguably, greater complexity than an Anzac class frigate with a quarter of the crew (185);

d. In a very hostile, demanding and dangerous environment, often with significant national tasks at risk.

16.6 *Breaking the Cycle*

16.6.1. Some brief suggestions on steps to break the ongoing cycle of RAN submarine manpower crisis:

a. First and foremost a paradigm shift in the way the RAN regards and handles its submarine force, allocating a priority to ensure the necessary quality and quantity of trainees are provided, if necessary, at the expense of other areas within Navy.

b. The entity should be the crew, not the platform. As has been done for the Armadale class patrol boats, multiple crews should be made available to man the operational submarines, thus a force of six submarines of which 4 should be operational would require 8 crews.

c. A third watch, managed by the Commanding Officer should be provided for each crew to provide the immediate source of operational reliefs and allow rotation of individuals for career training, personal reasons, etc and to support the submarine in its self conducted maintenance. This would entail increasing the crew size. For the sake of planning, let's say NGS has a seagoing crew of 50 and a 3rd watch of 25, i.e. a total crew of 75.

d. A flight line regime should be instituted with crews manning a platform for say six months to complete a series of missions before the handover to a relief crew for assisted maintenance. Operational crews should be supported by the 3rd watch and contractor maintenance personnel for periods alongside.

e. The off going crew would cycle ashore at the end of a 6 months operational period for leave, respite, professional, individual and team training and to prepare for the maintenance period to be undertaken prior to commencing another 6 months at sea.

f. Under the new regime the sea:shore roster concept would be abandoned, it has never worked satisfactorily for these minimum manned vessels.

g. The non-operational submarines would not be manned; they would be handed over to maintenance support contractor for maintenance.

h. It follows that adequate funding should be made available to sustain the number of operational submarines to accomplish the missions allocated to the FEG.

i. Under this regime a force of 12 submarines, of which 9 were operational, would require 18 crews, of say of 75. This would entail an at sea force of 1,350 personnel, managed and supported by a shore staff of say 150 for a total force of 1,500. An overall increase of 833 personnel over the current Collins force where 667 billets are allocated (many fewer filled of course!). This about 12% of Navy's manpower, arguably a reasonable allocation considering the importance of the capability.

16.7 *Submarine Personnel Skills Shortages*

16.7.1. The lack of submariners to support the role of Defence as an 'informed buyer' with the skills and abilities to manage the future underwater warfare capability project will be a significant issue.

16.7.2. As was predicted at the time of the decision in 2000, disbanding the submarine policy directorate in Canberra has left a significant gap in experienced submarine skills to mount and manage this project; arguably the lack of a policy advocate in Canberra has also contributed to the failure of senior management that has allowed submarine manpower to drop to survival levels and long term availability of operational submarines to drop to the levels now observed. It has also removed a career path for mid seniority submarine officers and, arguably, contributed to the significant loss rate of these personnel.

16.7.3. Currently, the RAN has a severe shortage of senior submarine qualified engineers and operators. Very few of those in the service have the experience, networks and understanding to guide a complex project through the labyrinthine processes of Canberra.

16.7.4. The transition from COLLINS to a next generation submarine capability will also pose significant personnel challenges for the operational submarine force. Manning the operational submarines and generating the surplus crews to transition to the new capability will be a demanding challenge. Against the backdrop of the current shortages this will require priority allocation of scarce RAN manpower resources to achieve.

16.8 *Non-Uniformed Expertise*

16.8.1. The civilian submarine technical capability in Canberra has also been substantially reduced from that previously available to mount and conduct the Collins project, when a civilian Naval Technical Services of over 500 personnel existed. Filling these gaps in a timely fashion will require lateral solutions to make use of the skills available from industry and within the Defence Department to best effect.

17 Acquisition Strategy

17.1 *Global Marketplace*

17.1.1. The global marketplace for submarine construction has undergone considerable consolidation in recent years particularly in the UK, Germany and US. While a number of countries construct submarines under licence, only Germany, Russia, France and most recently, Spain are active in the export market. None of the western suppliers are building a submarine that meets the capability required of Australia's next generation submarine.

17.2 *Submarine Design Capability*

17.2.1. **A Comparative Regional Advantage.** Given the importance of a submarine capability as a core defence requirement for Australia beyond 2020, Australia's regional pre-eminence as a designer, builder and operator of submarines is a comparative regional advantage; it should be maintained as a matter of strategic priority.

> *'Australia is currently one of the few countries to have mastered advanced defence operations in the underwater environment…. cannot readily be matched or countered by most potential adversaries …in many future defence contingencies, this competitive advantage would be extremely useful and in some is likely to prove decisive'.*[22]

17.2.2. The number of submarine designers available worldwide has also shrunk considerably. The current situation is summarised in Table 1 overleaf.

[22] Australia's Future Underwater Operations and Systems Requirement, Ross Babbage, Kokoda Paper, April 2007, p 3.

Table 1 - Global Submarine Designer/Builders

Country	Main Contract	Nationality of Owner	Type of Company	Number of SM since 1980	Number of SM Designers	New classes since 1980	Builder	Notes
Australia	ASC	Australian	Govt	6	Developing	1	ASC	Swedish Design
USA	EB	US	Public	74	1	3	EB & Newport News	2 builders
France	DCNS	French	Govt/ Private	11	1	3	DCNS	
Germany	TKMS	German	Public/ Thyssen	12	1	3	TKMS	
Sweden	Kockums	German	Private/TKMS	5	1	3	Kockums	Foreign ownership
UK	BAE Systems	UK	Private	13	1	4	BEA Systems	Only nuclear since 1985
Japan	Kawasaki/ Mitsubishi	Japanese	Public	16	1	3	Kawasaki/ Mitsubishi	Two builders
Italy	Fincantieri	Italian	Govt	6	0	2	Fincantieri	German design
Spain	Navantia	Spanish	Govt	4	Developing	1	Navantia	Based on French design
Korea	Daewoo Shipbuilding & Marine Engineering (DSME) and Hyundai Heavy Industries	Korean	Public/Private	10	Developing	1	DSME, HHI	German Design support

Notes

1. *Only one case of foreign ownership.*
2. *Only Germany, France, Sweden and Japan have an ongoing development of conventional submarines.*
3. *UK and the USA design nuclear powered submarines only.*
4. *Japan does not export due to constitutional/political impediments.*
5. *Italy builds German type 212 submarines under licence.*
6. *Korea builds type 214 submarines under licence and has initiated a design project for a new submarine with TKMS support.*

17.3 *Submarine Design Authority Functions*

17.3.1. **Critical Safety Function.** The Submarine Design Authority has a crucial role every stage in the life of a submarine: from concept, detailed design, production, through life support to disposal. Having managed the production of the detailed the design it oversees the construction, much as an architect does in a large construction project. Prior to the submarine going into service and throughout its life a named individual within the design authority certifies that the vessel:

a. meets the customer's requirements

b. is fit for its intended purpose

c. is safe to operate

d. complies with relevant legislation and regulations.

17.3.2. **Critical To Meet Parent Navy Responsibility.** An effective submarine design authority is a vital component of the parent navy's, in this case, the RAN's, safety system.

17.4 *Exercising Design Authority*

17.4.1. The Design Authority seeks to provide assurance, both to the customer and the builder that adequate steps have been taken to ensure that a large and complex product has been designed and produced 'correctly'. The role has four main aspects:

a. **Design Assurance**. This provides assurance that the design phase has been adequately conducted, meets the customer's requirements, is fit for its intended purpose, is safe to operate and complies with relevant legislation and regulations. Design Assurance also includes the independent verification and validation of the functional and physical design, where there is a significant contribution to safety, functional, performance or business goals.

b. **Product Assurance.** This builds upon Design Assurance to demonstrate that the product has been built in accordance with the validated Design Intent. Product Assurance activities build upon detailed information provided by inspections and audits and provides key evidence for both customer acceptance and to support the safety case.

c. **Safety Case Development.** The Safety Case provides logical, reasoned arguments, demonstrating that the risks to people, property and the environment are as low as reasonably practicable. It also demonstrates that regulatory safety requirements have been met.

d. **Design and Product Certification**. A Design Authority issues certificates at key points in the design and production lifecycle. These certificates must be supported by documentation providing evidence that the certification statement is valid and the evidence is adequate to support certification.

17.5 *Skill-sets*

17.5.1. In order to discharge these responsibilities the submarine design authority must have access to the necessary professionals skills; naval architects, engineers of various disciplines and logisticians, supported by specialist computer facilities such as, computer aided design, process monitoring and quality control software. They must be operating in a real world submarine support environment, not a theoretical think tank.

17.5.2. Efforts to outsource submarine design authorities in the UK and USA [23] have met with mixed success, in the absence of a steady level of design work the commercial instinct has been to downsize, leading to a loss of skill-sets and capability that have created difficulties and additional expenses for both countries. A recent study into the situation in the UK observes that:

[23] Sustaining US Nuclear Submarine Design Capabilities, Schank, et al, RAND Report, 2007

> *"The perceived need to reduce the overhead cost of the MOD's technical bureaucracy was the driving factor... the resultant haemorrhaging of talent is now acknowledged as a mistake"* [24]

18 ASC's Design Capacity

18.1 *Design Background*

18.1.1. Following a design phase conducted at Kockums in Sweden, ASC produced the detailed drawings for the production of the Collins, while Kockums personnel led the design work and oversaw completion of the production drawings. The majority of the fixes required to overcome the shortcomings detected during the initial sea trials were developed and documented by ASC's design team and subsequently cleared by Kockums as the Design Authority. The role of Design Authority for Collins was officially taken over by ASC in 2001: ASC has been the Design Authority for Collins for 7 years.

18.1.2. Provided its ownership is appropriate, it is uniquely placed to be able to access the critical, sensitive technology from both US and European suppliers and combine this with its own real world experience of 21 years on the Collins class. **No other potential designer offers this opportunity**.

18.1.3. Its capacity to act as the Design Authority for a new submarine will depend on:

a. continuing efforts to build its internal capacity by judicious hiring of experienced personnel;

b. suitable design development tasks in Collins through life development;

c. a continuing relationship with Electric Boat; and

d. support of a European design house to provide the technology unique to a conventional submarine.

18.2 *Australian Shipbuilding Skills Base*

18.2.1. Commonwealth investment in the Collins class has greatly boosted the skills base of naval shipbuilding in Australia. The base was further enhanced by the selection of ASC to construct the Air Warfare Destroyer (AWD).

18.3 *Commitment To the Australian Shipbuilding Industry*

18.3.1. Recognition and commitment by government of the strategic importance of the naval shipbuilding industry and relevant industry at large has given the industry greater confidence in its future and should encourage investment in its workforce, facilities and innovation.

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[24] Beyond Artful: Government & Industry Roles In Britain's Future Submarine Design, Build and Support, Gavin Ireland, RUSI Whitehall Report 3-07, p 13.

19 'Team Australia' – The Lowest Risk Path

19.1 *The Model*

19.1.1. Given that there is currently no "off the shelf" conventional design (nor is one expected) that will meet the ADF requirements for next generation submarine capability a design development project, based on the Collins pedigree is the low risk path. This strategy builds on the experience and capability developed to resolve the issues surrounding Collins introduction into service. The key elements of the model are:

a. An R&D team led by DSTO, exploiting our access to the USN's submarine R&D establishment (the world's largest such capacity) and selected industry partners.

b. A design team centred on Australia's Collins design authority, with support and oversight from the USN's submarine design authority and access to selected European submarine design input.

c. To build on the current US based weapons and acquire the new strike capabilities required.

d. To continued development and introduction of an open systems architecture in Collins for the high risk, software based systems (combat, C3I and ship control systems). These should be maintained at the state of the art and evolved and migrated to the next generation submarine.

19.1.2. We have termed this model 'Team Australia'; it is illustrated at Figure 1.

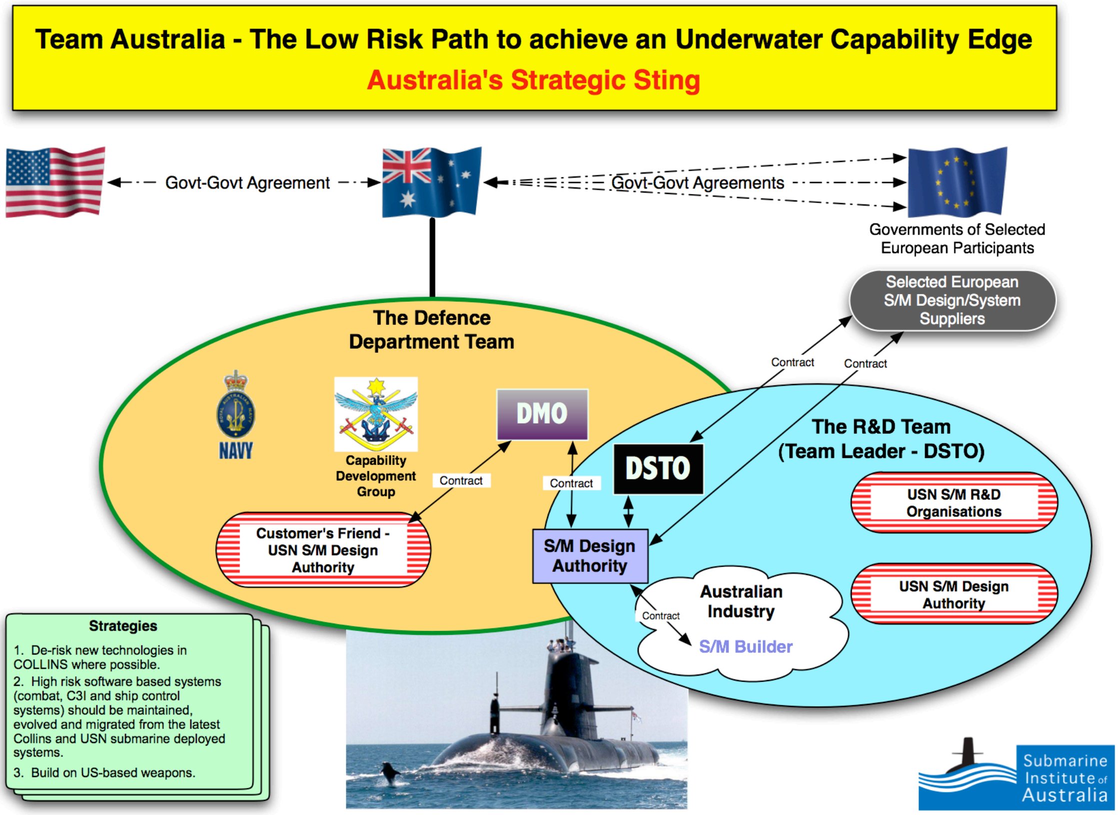

Figure 1 - Team Australia – The Low Risk Path To Achieving a Capability Edge

19.2 *R&D - The Key To A Capability Edge*

19.2.1. There is a need for high capability submarines that can undertake a diversity of roles and posses sufficient capabilities to survive and be effective in major conflict. Importantly the next generation submarines must have a technology edge (particularly stealth) and be interoperable with USN submarines.

19.2.2. The Commonwealth will need to define the top level requirements as a basis for undertaking design concept studies and further refinement of construction cost estimates. This will involve a number of iterations (capability/cost tradeoffs). The outcome should be a clear statement of the requirement, how we intend to achieve it and identification of the gaps to be filled by others.

19.2.3. The first principle in filling the gaps should be to mobilise as much of the innovation and R&D capacity required as possible from within Australia and Australian industry, particularly the Small Medium Enterprises that have proved so fruitful in the past. Many of the talents nurtured through this process will be critical for through life support and maintaining a capability edge.

19.2.4. Secondly, we will require ongoing access to US and European submarine technology and recognition that both sources will require certain safeguards to protect their technology and interests. In particular, it is anticipated that safeguards imposed by the USN could restrict the range of options including involvement of European design houses and level of competition for NGS design development and construction phases. It will be important to have these arrangements clearly set out and agreed in a high level Government to Government agreement to ensure that future access is assured.

19.2.5. Armed with this information the Commonwealth can then identify the extent and implications of involvement/reliance on US and European industry and USN support prior to any tender action, be it sole source or competitive.

19.2.6. A review of the market place including availability of a MOTS solution, an improbable option in our opinion and the prospect of a European sourced design could then follow.

19.2.7. Likely determinants of the 'way ahead' following this review include:

a. Australia's unique requirements will probably rule out a Military Off The Shelf solution.

b. The need to access USN technology would most likely rule out development of European design (other than as a 'straw man').

c. Realisation that an Australian led consortium (involving relevant stakeholders) would have the potential to develop the preliminary design (including associated performance specifications) and refined cost estimates that in turn could form the basis of the construction bid package.

d. Acknowledgement that that a single design development phase would not preclude a competitive construction phase.

e. Acknowledgement that a single design development approach would have the potential to realise significant cost savings (compared to a competitive design development program) with little, if any, increase in program risk.

f. Recognition that this is also a more practical option given the Department's limited submarine expertise to manage this process.

g. The construction bid package (including contract terms and conditions) would underpin the letting of a restricted tender to Australian shipbuilders. The viability of this competitive construction approach would be subject to the ownership structure having regard to USN and European technology suppliers' sensitivities and involvement of US industry.

h. The availability of Commonwealth resources and capacity to manage the program.

19.3 *Accessing Submarine Intellectual Property*

19.3.1. Access to and control over Intellectual Property (IP) is a key determinant of shipbuilding and repair capacity particularly in relation to vessel design and combat systems and their ongoing development and upgrades. Australia needs to be able to access the quote "best of breed" in submarine systems and design to achieve the capability. These will be drawn from Western European designers and our current submarine capability partner, the USN. All parties are particularly sensitive and wish to protect their submarine IP. Governments who fund much of the R&D are very sensitive to exposing their leading edge submarine technology to third parties. Australia must be able to demonstrate that it is able to protect this information from third parties. This has significant implications for the future ownership of ASC.

19.3.2. An open market approach is therefore not likely to lead to the most capable solution; instead, access to this technology will require specific agreements between Governments, the conditions attached may well limit the range of participants.

19.3.3. Selecting the right partners is therefore important; a critical test in this selection process is the depth and capability of their ongoing submarine R&D programs. This capability for original work is important in optimising the design, maintaining the leading technology edge in through life capability development and solving the inevitable 'unexpected' in service problems that are the lot of a parent navy. This 'Team' capacity will also be a major factor in identifying valid design options for future underwater warfare capability.

19.3.4. Access to US submarine technology will need early resolution and probably, an extension of the current government-to-government agreement on submarine cooperation on the Collins class. Similar government-to-government level agreements will be required to cover European involvement.

19.3.5. However, noting the unique features of Australia's requirements and difficulty of accessing submarine IP there are a number of areas where Australia will have to develop its own solutions to the problems. Examples are provided in the earlier consideration of the R&D issue.

19.3.6. The Defence Science and Technology Organisation working in conjunction with the USN and industry have demonstrated this capability in resolving many of the issues associated with the Collins program. Much of this Australian capability has now dissipated; it will require time and incentives to re-establish an indigenous R&D capability in a number of key submarine technologies. Given the lead times for such activities, this is now an urgent requirement.

19.4 *Impact on the Sale of ASC*

19.4.1. Accessing state of the art submarine IP will be a critical success factor; the acquisition strategy must meet the concerns of the USN and European designers to avoid 3rd party access to their information. Until we understand exactly what we wish to build, how we intend to do so and the conditions attached to accessing the necessary IP we should not sell the Australian submarine design authority. Once sold it will be difficult and expensive to recover from an unsatisfactory situation.

19.5 *Contracting Arrangements*

19.5.1. Irrespective of the level of competition, ensuring value for money will require an innovative approach to contracting. Models for such arrangements exist with the USN, RN, French, German and Swedish Navies.

19.6 *Options For Developing The Design*

19.6.1. **A Competitive Development.** In our opinion, it is unlikely that competition between two design proposals will be practicable in the timescales now available (the Collins programme took 4 years from initiation of a competitive Project Definition Study to letting a contract). A further complication is the limited number of experienced personnel within the Department available to manage such an activity.

19.6.2. **Evolution from Collins.** The low-risk option is to evolve from the Collins pedigree. This development will result in substantial differences; the most visible will be the external hull shape, optimised for high-speed transit. This can be expected to:

a. Yield a 10% energy efficiency gain over Collins;

b. Improve sonar performance compared with Collins, particularly when moving at high speed; and

c. Reduce self-noise.

19.6.3. Internally, new technologies will be critical to achieving a capability edge; perhaps the most challenging areas are associated with acquiring, storing and using energy for both transit to a patrol area and covert patrol when on station.

19.6.4. Few if any of the equipments used in Collins will be available or appropriate for the next generation submarine; developing and integrating new equipments is a substantial design and construction task, but one that was very successfully undertaken for Collins.

19.6.5. There will be a number of new issues for the designers and operators to weigh up and consider in the trade off process. Some examples include:

a. Reconfigurability – the flexibility to adapt for the role of the day;

b. Carrying capacity – the ability to accommodate and sustain the additional personnel and equipments associated with particular missions: The unmanned underwater and aerial vehicles pose a particular challenge in this regard; and

c. Achieving sufficient design margins, e.g. space, stability to allow for future growth.

19.6.6. There are many other issues for consideration during the early phases of the design trade offs; these examples are not exhaustive, simply intended to make the point that this will be a developmental project and should be appropriately managed and resourced. The lessons from Collins in this regard include the need to:

a. Recognise and accept the developmental nature of the project – allow an appropriate contingency in time, funding and scientific support to cope with the unknowns that are bound to arise; and

b. Assign the risks so that they can be actively managed by those best able to do so. This approach points to a relationship style of contract, not a 'black letter law' performance specification contract.

19.6.7. In the high-risk software based systems, the low risk path is to evolve from current weapons, combat system and C3I systems and continue to use the US family of weapons. To be effective these systems must become 'open architecture' [25]systems and be maintained to the state of the art, for example, the ship control system is now facing obsolescence of its processors and many of its sensors. When combined with the fitting of new land strike cruise missile, this strategy reinforces the need to maintain access to US technology.

19.6.8. The experience with the Collins Replacement Combat System demonstrates the criticality of Australia retaining the capability to adapt and develop these systems itself; the USN requirement is frequently quite different and the solution developed for a nuclear powered submarine may well be inappropriate. This is a 'parent navy' cost arising from our strategic alignment with the US.

19.7 *Air Independence*

19.7.1. Given the threat environment arising from the strategic setting, it will be critical that the next generation submarine is able to operate completely covertly whilst in a patrol area and approaches without the need to snort to recharge batteries or refresh its atmosphere.

19.7.2. Current air independent propulsion technologies such as fuel cells or Stirling engines incur a substantial space and weight penalty; the solution adopted in many smaller European submarines is to remove battery and generator capacity to offer up space and weight. This is not an appropriate solution for a submarine wishing to complete long transits, quickly and with minimum indiscretion. The air independent propulsion

[25] a type of computer architecture or software architecture that allows adding, upgrading and swapping components. Wikipedia.

offers no assistance in this phase as its precious and limited quantity of fuel must be conserved for the patrol area.

19.7.3. We should be looking to second generation air independent propulsion technologies and alternatives now under development in the laboratories. There is a major developmental project entailed in achieving an operational capability – an early candidate for DSTO and industry partnered R&D.

19.8 *Next Generation Submarine Capability Prototyping in Collins*

19.8.1. Collins class technology refresh/spiral development programs could serve to reduce the risk of design development work and prototype testing associated with the next generation submarine capability.

19.8.2. To be effective, this program must not only maintain the capability of Collins, but also provide a test bed to push the technology boundaries where appropriate, e.g. emerging battery technologies, second generation Air Independent Propulsion systems and propulsion motor technology.

19.8.3. The design work involved in this programme will provide an important opportunity to grow the submarine design authority capability, skill sets and processes.

19.8.4. However, the lack of design margins in Collins will be a significant limitation on this programme.

19.9 *Research and Development Program*

19.9.1. We should be seeking a technology ‘leap’ to counter the regional growth in maritime technologies. By First Pass in 2011, we must have identified those technologies that offer this potential and then develop these to enable a contract to be placed in 2016 to incorporate these into the future underwater warfare capability.

19.9.2. A through-life R&D program involving DSTO, ASC, industry and technology partners will be essential to sustain the capability edge and is part of the parent navy obligation. The program should be used to deliberately foster and support small to medium enterprise companies in Australia, these companies have been the source of much of the leading edge innovation available in the Oberon and Collins programs.

19.9.3. Establishing the teams and relationships will take time. This work will provide a key input into the design trade offs to be considered in finalising the specifications and letting the contract in 2016.

19.9.4. The following areas are a sample of some of the areas likely to require indigenous R&D by DSTO and industry through all phases of the design, build and in service life of the capability:

a. Hull materials;

b. Hull forms;

c. Diesel generators and batteries – European designers have not pursued advances in diesels, the associated generator or batteries, since the AIP system is now viewed as the primary energy source;

d. Air Independent Propulsion systems;

e. Propulsion arrangements including motors and propellers/ propulsors;

f. Life support systems for the extended period of dived operations;

g. Unmanned vehicles, their interface with the submarine and measures to avoid compromising the covert stance of the parent submarine;

h. Signature reduction measures in all spectra, including coatings to reduce the submarines signature, eg anechoic coatings v active sonar, radar absorbent material v radar, etc;

i. Countermeasures operating in all spectra;

j. Combat system, and sensors;

k. C3I technologies, including those to support networking in a hostile environment; and

l. Ship control systems to reduce crew workload and numbers.

19.9.5. These programs also provide the essential entrée to our selected partners' R&D in these sensitive areas – part of the essential currency for a joint R&D project.

19.10 *Key Design Drivers*

19.10.1. The key design drivers for a next generation submarine capability are identified in priority order are:

a. Stealth, including at speed;

b. Mobility;

c. Range and endurance;

d. Payload including weapons, countermeasures and unmanned vehicles;

e. Sensors and connectivity;

f. Habitability and manning;

g. Handling characteristics; and

h. Through life supportability and growth potential.

20 Industry Issues

20.1 *Competitive Teaming for Efficiency*

20.1.1. In addition to the design support provided by the US and European designers, competitive teaming through commercial alliances between overseas suppliers and local industry for the supply of systems and components offers the best prospect of ensuring efficient Australian construction.

20.1.2. Early selection of industry partners may be required where substantial development of the system is required in order to meet the requirement and to encourage mutual investment and sharing of risks.

20.2 *Ownership of Australia's Submarine Design Authority*

20.2.1. The future ownership of the design authority must facilitate access to submarine IP in the complex and sensitive scenario outlined above. This is essential to maintain the new design through life, including the need for future modifications. To avoid future conflicts of interest and to demonstrate that Australia is able to protect 3rd parties sensitive technology, it is essential that the ownership be 'fully Australian' owned and controlled.

20.2.2. In our opinion we should not rush the sale process; it is important to 'get it right'. The ground rules for accessing the critical IP should be fully understood and complied with as a pre condition of the sale.

21 Conclusions On Part 2 – How To Acquire It

21.1.1. The following conclusions are drawn from Part 2:

a. The Collins project, despite its complexity and controversy, delivered an excellent strategic capability for Australia. A next generation submarine project will have a much stronger starting point as a result. The Government and Defence Department should have strong confidence in Australia's capacity to manage and deliver the capability.

b. Submarine manpower is at survival levels. The current review is a key starting point for recovery programme that will require great dedication and take a number of years to work back from the brink.

c. The shortages of skilled personnel in Defence and Navy to oversee the project are a significant limitation and must be factored into the acquisition strategy; and

d. A sustained priority allocation of the RAN's scarce manpower and funding for the Collins force will be required to recover from the current shortfall, sustain the project and transition into the next generation submarine.

e. Adequate funding to provide sufficient operational submarines to match the training programme and provide maintenance assistance to the hard pressed crews and base staff is required.

f. To achieve the necessary capability edge over the European and Russian designed submarines entering service in the region and meet Australia's geostrategic circumstances, the design, development and construction of the NGS capability will be a uniquely Australian led enterprise, with strong support from the USN and selected European submarine designer(s).

g. While a competitive design development phase is considered impractical, further studies are required to assess the viability, benefits and other implications of a competitive construction phase. The low risk strategy is a design development from the Collins pedigree with a model we have termed 'Team Australia'.

h. Irrespective of the level of competition, ensuring value for money will require an innovative approach to contracting; models for such arrangements exist with the USN, RN, French, German and Swedish Navies.

i. Achieving the capability edge will require significant and ongoing investment in submarine systems R&D, led by DSTO and involving selected industry partners, particularly Australian SMEs and the USN.

j. Accessing sensitive submarine IP will be a critical factor for success. Achieving the necessary access will drive the acquisition strategy and ownership structure of Australia's submarine design authority.

k. The global market for conventional submarine design and construction has shrunk considerably since COLLINS was designed.

l. Australia's industry base has grown significantly during the same period.

m. The submarine design authority developed in ASC over the past 21 years is a critical, strategic asset and provides an excellent starting point for the next generation submarine project, Australia should build on the capacity established by the Collins project to design and build the next generation submarine.

n. The preconditions attached to ASC's access to these technology sources should be understood and complied with in the sale of ASC.

o. COLLINS can be used as a trials platform to reduce the risk of introducing new technologies for the next generation submarine.

p. Time is tight, early agreement on the acquisition strategy and initiation of studies and R&D is now critical.

P. Briggs AO CSC
Rear Admiral RAN Rtd
President, Submarine Institute of Australia Inc.

Attachments

1. The Submarine Institute of Australia's Next Generation Submarine Team
2. Next Generation Submarine Deployment Model

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SIA NEXT GENERATION SUBMARINE TEAM MEMBERS

The study team was made up of the following members:

Mr Allan Behm

Allan spent almost thirty years in the Australian Public Service, the last eighteen as a member of the Senior Executive Service. He was a member of the Australian Diplomatic service (1972-80), and then senior advisor in the Prime Minister's Department responsible for defence issues (1980-83). In 1983 he moved to Defence, where he was head of the Asia Branch and then of the Strategic Policy and Planning Branch (1985-90).

He was head of the Security Division (later the Federal Justice Office) in the Attorney-General's Department (1990-94), until he was appointed General Manager (Practice Development) in the Attorney-General's Legal Practice (1994-96). He returned to the Department of Defence in 1996, first as head of the International Policy Division (1996-2000), and subsequently as head of strategic policy and planning (2000-1).

He is now in private practice as a director of three companies specialising in strategy and infrastructure development.

Rear Admiral Oscar Hughes AO RAN retired

Oscar retired in late 1993 after more than forty-two years of service embracing naval aviation, general service and project management. Amongst a wide variety of appointments, he served as Aircraft Carrier Project Director (1981-83), Director General of Naval Production (1983-84) and New Submarine (Collins Class) Project Director (1984-93).

Following retirement from the RAN, Oscar was a consultant to Department of Defence and a number of companies. He also served for four years as a member of the Management Board of the University of South Australia's Centre for Test and Evaluation.

In February 1998, Oscar joined IBM's Sydney 2000 Olympics Technology Project Office as Operational Readiness Assurance manager responsible for the operational readiness of the total IT solution for the Sydney Olympic Games. He left IBM and returned to Canberra in December 2000.

Commodore Terence Roach AM RAN retired

Terence commanded two RAN O Class submarines, helped to develop the operational concepts which led to the selection of Mk 48 torpedo and the Harpoon Missile in the Submarine Weapons Update Programme [SWUP] for the O Class. As the inaugural Director he established the Submarine Warfare Systems Centre which oversaw the introduction into service of these weapons.

He was heavily involved in the selection and management of the decision process for the COLLINS Class submarines and the ANZAC frigates and was the inaugural DG for four years in what is now Maritime Capability Development. After a final tour as the NA Washington, upon retirement he conducted a number of studies for the Department on SM Commanding Officer's training and on submarine export and construction issues.

He continues to consult to Defence Industry.

Commodore Paul Greenfield AM RAN (Reserves)

In 2005, Paul transferred to the Naval Reserve after 32 years in naval engineering in operational, support and project areas in ships and submarines. He established Navy's first contract ship repairs (in Western Australia), the COLLINS in-service support strategy, and was Chief Engineer for the Fleet Commander.

Paul was Head of Secretariat for the McIntosh/Prescott Review into the Collins Submarines, and Chief of Staff to the Submarine Capability Team. At Defence senior leadership level, he was Submarine Project Director for modifications of the two "fast track" submarines. As Director General Maritime Development he developed the acquisition strategy and Government approvals for the Aegis combat system for the Air Warfare Destroyer project.

He has worked extensively with the US Navy in the submarine field and with the US and other foreign Navies in maritime missile defence.

Commander Frank Owen RAN (Reserves).

Frank is the Managing Director of InDepth Project Management Pty Ltd. Before founding the company in July 1999, Frank served in the RAN for 28 years, specialising in submarines. During that period, he served as the Follow-On Submarine Project Officer immediately prior to formation of the project team for the Submarine Project.

Following wide-ranging sea and shore service in submarines and surface ships, he returned to the Project and served as its Operational Requirements Manager for 6 years until his retirement from active service. He has spent the last twelve years specialising in project management within the Defence Materiel Organisation (and its predecessors) and in Navy Headquarters (managing the Navy's Submarine Safety Program) Including over three years supporting the management of the outcomes of the Submarine Capability Team.

Frank is presently providing 12 months' Continuous Full Time Service to the RAN.

Rear Admiral Peter Briggs AO CSC RAN retired

Peter Briggs commanded two submarines, including HMAS Oxley, the first Oberon class submarine to undergo the Submarine Weapons Update Program. As the Director of the Submarine Warfare Systems Centre, he oversaw a major upgrade to the Oberon combat system, including the introduction of the Mark 48 Mod 4 torpedo and Harpoon missile. During this period SWSC developed the initial Required Ship Characteristics, Combat System and ISCMMS operator specifications for Collins.

In an 11 year span as a Flag Officer, he oversaw the development of HMAS STIRLING, introduced new technician training and programs associated with the induction of Collins, Anzac, Minehunter and Sea Hawk capabilities into the Fleet.

His service in Defence Headquarters included a tour as the Head of Strategic Command Division and the Submarine Capability Team established to lead to the Collins recovery programme.

Dr David Wyllie

Dr David Wyllie retired from the DSTO after 45 years in various roles in undersea warfare R&D. From 1998 to 2006 he was Chief of Maritime Platforms Division, DSTO, which played a major role in the Collins get-well program, including hull and machinery improvements, propellers and acoustic quietening. Collaboration with USN NAVSEA was important element of this work. Dr Wyllie has conducted research on submarine sonar, underwater acoustics and sonar signal-processing at DSTO

Edinburgh, the RAN Research Laboratory and USN NUC, San Diego. He was the DSTO representative on the Defence Efficiency Review in 1996/97.

Dr Wyllie is the Conference Chairman for the international Undersea Defence Technology Conference and Exhibition (UDT Pacific 2008) to be held in Sydney in November. He is currently a maritime advisor with Australian Aerospace and Defence Innovations, Melbourne and consultant with Analatom, Sunnyvale, California.

Commander David Nicholls RAN Retired

David Nicholls is a former command qualified naval officer with considerable experience in defence acquisition. In addition to two submarine commands, David Nicholls spent two years in Maritime Headquarters, three years as the Director of the Submarine Warfare Systems Centre and four years in Defence Capability Development.

He spent three years developing his international maritime warfare knowledge working with the USN Pacific Fleet. Since his transition from full-time service into private business, David Nicholls has been involved in the support of maritime related Defence Industry, particularly in relation to project SEA 1439 and a number of successful Capability Technology Demonstrator projects.

Commander Andrew Keough CSC RAN (Reserves)

Andrew graduated from the Australian Defence Force Academy in 1987 with a BSc. After training and qualification in the surface fleet, Andrew transferred to submarines in 1989 and later commanded two Collins class submarines, HMAS WALLER (1999-2000) and HMAS SHEEAN (2004-05). In between commands, Andrew served on the staff of Commander US Submarine Force Pacific (COMSUBPAC), in Pearl Harbor, Hawaii where he developed tactics and provided training for the US Navy Submarine Fleet. In 2006, Andrew joined the staff of Maritime Headquarters as the Fleet Submarine Operations Officer, responsible to the Maritime Commander for the operations of the submarine force.

Andrew transferred to the RAN Active Reserve in 2007 and now runs a consulting business. He has an MBA and was awarded the Conspicuous Service Cross (CSC) in 2006 for his leadership whilst in command of HMAS SHEEAN.

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NEXT GENERATION SUBMARINE DEPLOYMENT MODEL

Assumptions/Inputs

	Next Generation Submarine
Distance to patrol Area 1 (nm)	3500
Distance to Patrol Area 2 (nm)	2500
Length of low threat transit once clear of egress area	1400
Time allowed for own ASW Forces training	0
Period for egress from operating base, a high threat area (no progress on transit) (days)	0.5
Low Threat Transit	
Indiscretion ratio low threat (time spent snorting on transit)	50%
Lost time - no progress on transit	5%
Resultant Balance of time deep and fast low threat	45%
Snort Speed contribution to SOA low threat portion of Transit (Kn)	10
Overall SOA for low threat	12
Higher Threat Transit	
Indiscretion ratio higher threat (time spent snorting on transit)	20%
Lost time - no progress on transit	5%
Resultant Balance of time deep and fast higher threat	75%
SOA contribution at periscope depth, ie Snort Speed higher threat portion of Transit (Kn)	4
Overall SOA (Kn)	10
Time lost for navigation obstacles	0.5
Maximum permissible (ie max endurance) length of deployment (days)	70
Time in patrol area - crew fatigue limit (days), (AIP endurance is the other limitation)	35
Covert Entry & exit to Patrol area	
Initiate covert posture, no snorting - distance from patrol area (nm)	500
SOA (Kn)	6
Time to enter patrol area (days)	3.5

Outputs

Patrol Area 1 (Nautical miles)	**3,500**
Low Threat Transit time (there and back) (days)	9.7
High Threat transit time (there and back)	13.3
High + low threat transit time (there and back) (days)	23.1
Low + High Threat Transit Time + egress time lost	23.6
Plus navigational obstruction time lost (There and back)	24.6
Plus time for covert entry & exit fm Patrol Area (days)	31.5
Mission length (Transit + Patrol time + Own Forces training) (days)	66.5
Low threat Transit speed deep Calculation	
Snorting time low threat there and back (days)	4.9
distance covered snorting low threat there and back (nm)	1167
Distance to be covered deep and fast in low threat section there and back (nm)	1,633
Time deep and fast low threat	4
Speed deep in low threat	**15.6**
Higher Threat Transit Speeds calculation	
Snorting time high threat there and back (days)	2.7
distance covered snorting high threat there and back (nm)	256
Distance to be covered deep and fast in low threat section there and back (nm)	2,944
Time deep and fast low threat	10
Speed deep in high threat	**12.3**
Diesel fuel capacity (nm)	
Safety margin - balance of fuel unexpended	30%
To and from Patrol area + safety margin remains (assumes AIP for time in patrol area, allows for exit from patrol area on diesels in event of AIP failure)	8,450
AIP Capacity	
Average SOA on AIP in Patrol area (Kn)	5.0
Distance covered in Patrol, Area	4,200
Entry & Exit from Patrol Area	1000.0
safety Margin	20.0%
Total AIP Endurance (nm)	6240.0
Total AIP and life support system Endurance (days)	42
Total fuel Range including safety margins (Diesel (30%)+ AIP (20%))	**14,690**

Patrol Area 2 (Nautical miles)	**2,500**
Low Threat Transit time (there and back) (days)	9.7
High Threat transit time (there and back)	5.0
High + low threat transit time (there and back) (days)	14.7
Low + High Threat Transit Time + egress time lost	15.2
Plus navigational obstruction time lost (There and back)	16.2
Plus time for covert entry & exit fm Patrol Area (days)	23.2
Mission length (Transit + Patrol time + Own Forces training) (days)	58.2
Low threat Transit speed deep Calculation	
Snorting time low threat there and back (days)	4.9
distance covered snorting low threat there and back (nm)	1167
Distance to be covered deep and fast in low threat section there and back (nm)	1,633
Time deep and fast low threat	4
Speed deep in low threat	**15.6**
Higher Threat Transit Speeds calculation	
Snorting time high threat there and back (days)	1.0
distance covered snorting high threat there and back (nm)	96
Distance to be covered deep and fast in high threat section there and back (nm)	1,104
Time deep and fast low threat	4
Speed deep in high threat	**12.3**
Diesel fuel capacity (nm)	
Safety margin - balance of fuel unexpended	30%
To and from Patrol area + safety margin remains (assumes AIP for time in patrol area, allows for exit from patrol area on diesels in event of AIP failure)	5,850
AIP Capacity	
Average SOA on AIP in Patrol area (Kn)	5.0
Distance covered in Patrol, Area	4,200
Entry & Exit from Patrol Area	1000.0
safety Margin	20.0%
Total AIP Endurance (nm)	6240.0
Total AIP and life support system Endurance (days)	42
Total fuel Range including safety margins (Diesel (30%)+ AIP (20%))	**12,090**

Availability	
At Sea Availability assumed	75%

Usage/Upkeep Cycle Patrol, Area 1	
At sea shakedown, training, workup and assessment (days)	28
Lost time defects etc (days)	5
Deployed Time Patrol Area 1 (Mission Days from Speed Time calculation	67
Assisted Maintenance (days)	28
Total days for cycle	128
% in Patrol area	27.5%
Number of available SM to sustain 1 in Patrol area	4
Total number to achieve 1 in Patrol Area (Number available to sustain * availability %)	5

Usage/Upkeep Cycle Patrol, Area 2	
At sea shakedown, training, workup and assessment (days)	28
Lost time defects etc (days)	5
Deployed Time Patrol Area 2 (Mission Days from Speed Time calculation	58
Assisted Maintenance (days)	28
Total days for cycle	119
% in Patrol area	29.4%
Number of available SM to sustain 1 in Patrol area	3
Total number to achieve 1 in Patrol Area	5

SM Force Numbers	
Number on station Patrol Area 1	2
Total force to sustain this number continuously in Patrol Area 1	9.7
Number on station Patrol Area 2	1
Total force to sustain this number continuously in Patrol Area 2	4.5
Total Force (rounded up)	15