Defining Australia's future submarine fleet

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> The greatest risk Australia will confront in defining and acquiring its future submarine fleet will be that of ideology rather than rigorous techno-strategic thinking being used to define the submarine requirement.

Virginia class SSN USS Washington displaying its propulsor system. Prof Ross Babbage recently proposed that Australia acquire this state of the art boat.

THE matter of the replacement submarine class for Australia's Collins SSKs has elicited more media attention than any other single force structure planning problem in Australia over recent years. Curiously, much of this public debate has been centred on what manufacturer's off-the-shelf 'shrinkwrapped' submarine should be procured, with almost no discussion of what roles should the future submarine perform, and what might be the best long term choices in basic technology to ensure the longevity of the design in a highly competitive and rapidly evolving 'threat environment'.

Survivability Considerations for the Future Submarine

Submarines exist because submerged operation affords a measure of stealthiness that surface vessels can never achieve. The result of this is that ASW sensors have evolved continuously over the last century.

At this time the single biggest long term risk to submarines, in terms of basic technology, are neither advancing supercavitating 200 knot torpedoes or persistent Remotely Piloted Vehicles. The greatest risk arises from exponential growth in commodity digital computers, as these permit the use of sophisticated software algorithms for sifting faint submarine noises from acoustic clutter, finding submarine wakes in radar sea surface clutter, and networking/fusing data from multiple sensors to find correlations between extremely faint signatures, be they acoustic, radar, chemical or thermal.

Two decades ago submarines were primarily hunted by their acoustic signatures, using passive and active sonar, and by the radar signatures of their masts when snorkelling or using a periscope to target an attack. Emerging sensor technologies such as synthetic aperture radar optimised for detecting the surface wakes of submerged submarines will over time significantly increase the risk of detection at shallow depths. The popularity of Air Independent Propulsion (AIP) reflects this reality – future submarines will have to spend more time at greater depths and slower speeds to survive. Under hostile airborne or satellite radar coverage, snorkelling will be only marginally better than surfaced operation.

The increasing use of batteries of vertical cruise missile launch tubes in attack submarines and missile submarines, in preference to firing and reloading from torpedo tubes is no differently a reflection on the reality, that missile launches are 'indiscretions' which betray the position of the submarine to hostile sonar and once the missiles are airborne, radar. The faster all of the missiles can be launched, the better, as it gives the submarine commander more time to put distance between the launch point and the submarine, when the opponent does react.

The mathematics of submarine survivability follow the same pattern as with stealth aircraft. Even if the vehicle can survive most encounters with hostile defences, the more frequent the encounters, the lower the cumulative probability of surviving a sortie.

This will be a critical issue in the definition of the new submarine class, as key choices such as the role of the submarine, and its propulsion package, will have to be made against projected ASW sensor capabilities of two or more decades hence, rather than contemporary ASW capabilities. Short term choices will prove fatal in the long term, where rapid evolution of ASW sensors can be expected. In many respects, survivability against future ASW sensors, rather than political ideology, should be the determinant of whether the future submarine employs nuclear or non-nuclear propulsion.

The Roles of the New Submarine

As noted, the future role of the Collins replacement has not been explored well in the ongoing submarine debate.

Decades ago the role of submarines could be easily defined, as they were built to be attack submarines, with a hunter-killer role against hostile submarines and surface ships, or they were built as launch platforms for ballistic missiles.

The results were four basic classes of submarine – diesel-electric powered attack submarines or SSKs armed with torpedos, nuclear powered attack submarines or SSNs armed with torpedos, diesel-electric powered ballistic missile submarines or SSBs armed with ballistic missiles and torpedos for self defence, and nuclear powered ballistic missile submarines or SSBNs armed with ballistic missiles and torpedos for self defence. The imperative in attack submarines was low signature, but also speed in nuclear powered boats, while the imperative in SSB/SSBN classes was extremely low signatures. Stealth remains the central imperative in all submarines, regardless of category.

These four classes of submarine remain numerically dominant in the current world. The largest SSBNs are in the 18,000 – 24,000 tonne range, while SSNs typically span the 2,600 – 14,000 tonne range. SSKs remain one of the most numerous categories, ranging in displacement up to 3,300 tonnes.

Other categories have evolved in parallel. The most important of these, built in respectable numbers by the Soviets, were cruise missile armed diesel-electric SSGs and nuclear powered SSGNs. The intent of these designs was to stalk or ambush CVBGs, SAGs and convoys, and unleash a saturation attack using subsonic and later supersonic sea-skimming cruise missiles. The largest of these is the Soviet Oscar class at 19,400 tonnes, armed with 24 P-700 Granit long range supersonic cruise missiles.

The US Navy more recently converted four Ohio class SSBNs into SSGNs, arming them with up to 154 Tomahawk subsonic land attack cruise missiles.

Inevitably the size and cost of submarines is closely linked to their role and weapons payload. By far the largest submarines are SSBNs and SSGNs, as their missile payloads are reflected in large internal volume and displacement. In SSNs, weapon payload is also reflected in displacement and cost – the recent trend to arm traditional SSNs with vertically launched cruise missiles typically impacts displacement and/or torpedo reload capacity.

In diesel-electric boats, the range and persistence of the boat becomes a major factor impacting displacement and cost, as range/persistence performance is gained by carrying more fuel. The advent of AIP is again reflected in displacement and cost, as an additional hull section is typically required to carry oxidiser and/or fuel for the AIP system, and reactors to use the oxidiser and/or fuel. At some point nuclear propulsion becomes the better choice, as the size/displacement/cost penalty of a non-nuclear propulsion package for a given weapon payload and range/persistence becomes prohibitive.

The central question for the ADF will be that of what role the future submarines are to perform, whether the intended 12 boats or a smaller number are to be procured.

The Collins SSKs are traditional attack submarines by design, armed with a fairly standard payload of 22 torpedoes or Harpoon ASCMs, all launched from six 21 inch bow tubes, but built for range and persistence, with a nominal endurance of 70 days or operating radius in excess of 4,500 nautical miles, the latter reflecting their strategic role. The Collins like all SSKs is primarily an ambush hunter, as it lacks the submerged speed and endurance to escort a SAG or stalk a hostile SAG or CVBG travelling at dash speeds.

The primary role of the Collins class is strategic denial of key regional shipping lanes and chokepoints, by ambushing hostile surface shipping and submarines, and mining sea lanes, chokepoints and port entrances, with secondary roles of ISR and deploying and recovering special forces. The Collins is not equipped with land attack cruise missiles, despite a persistent decades-long advocacy campaign by the Navy League and other submarine force advocates.

The issues of whether the future submarine should be equipped to launch land attack cruise missiles is one which should be carefully studied, as it has major cost and survivability implications. An argument commonly raised by submarine advocates is that Australia should deploy a land attack cruise missile on its submarine force, as a substitute for the use of air power as a cruise missile delivery system.

The difficulties any experienced missile warfare strategist or operations analyst will observe immediately are the dual problems of 'weight of fire' and 'magazine depth'. Cruise missiles have limited killing power, and at best compare to a 1,000 lb air delivered bomb. The United States has performed numerous cruise missile bombardments since 1991. Typically targets such as airfields require dozens of cruise missile hits to effect significant damage, no differently than in air raids where packages of aircraft drop dozens of guided bombs. A single submarine armed with a dozen cruise missiles provides at best a harassment or 'pinprick' capability – the same as a raid by one cruise missile armed B-52H, three F-111s, or six F/A-18s with tanker support. To cripple a military or large civil / dual use airfield would require two SSG/SSGNs each with 24 cruise missiles. A large fixed Surface to Air Missile site would require at least one submarine armed with 24 cruise missiles, or two armed with 12 each.

The difficulty is that once the missiles are expended, the boats have to transit to a safe area at tens of knots, evading defences, to reload from a tender or a safe harbour. As a result, reattacks may be days or weeks apart, compared to air power which can reattack in a matter of hours.

The US Navy addressed this limitation by rebuilding four Ohio SSBNs into SSGNs each carrying up to 154 Tomahawks. Even so, these vessels are used primarily for 'first day of the war' attacks, to surprise the opponent and cause disruption and damage to critical assets – they are not intended

HMAS Waller and a US Navy Ohio class SSGN.

The exceptionally fast Soviet Akula class SSN was a benchmark in attack submarines.

The primary role of the Collins class SSKs is ASW/ASuW.

to compete with air power.

An important factor is the proliferation of 'Counter-PGM' weapon systems, like the Russian 96K6 Pantsir S1 or Chinese LD-2000, intended to kill incoming cruise missiles as they approach their targets. Such systems will drive up the number of cruise missile rounds required for effect, in turn driving up the number of cruise missiles to be launched. A launch of six cruise missiles against a 'Counter-PGM' battery defended target could see no effect, with all rounds shot down. The game then becomes how to saturate the defending battery with more rounds than it can handle, exacerbating the 'weight of fire' and 'magazine depth' problems.

Another key issue for land attack is the problem of ISR capability for targeting and damage assessment, and responsiveness in dealing with mobile or relocatable targets, both of which have been major issues in bombardment campaigns since 1991. Submarines are wholly reliant on aircraft for time critical ISR – while a submarine launched expendable autonomous UAV is feasible, its launch increases risk of exposure, and would require satellite relay for datalinking beyond 400 nautical miles.

No amount of vocal advocacy or wishful thinking by submarine supporters can fix the 'weight of fire', 'magazine depth and time critical ISR problems – submarine launched cruise missiles are highly valuable supplements to air power for bombardment of fixed targets, but are simply not viable in any sustained campaign where persistent bombardment of targets for weeks or months is required to produce effect, or mobile targets are involved. Claims otherwise cannot be substantiated by operational analysis or historical precedent.

The same is not true if the target is a CVBG, SAG or convoy, and the cruise missiles are antishipping weapons. Lacking the hardness of reinforced concrete land structures, and capability for rapid repair of heavy damage, surface shipping is particularly vulnerable to saturation missile attacks, which an SSG/SSGN can autonomously target using passive sonar. A saturation attack with two dozen supersonic ASCMs will cause mayhem in any concentrated group of surface vessels, be they warships or a convoy of transports. The Soviets would not have so heavily invested in the Echo, Papa, Charlie and Oscar class SSGN fleets had this not been true.

What is abundantly clear is that injudicious choices in the intended role of the future submarine could produce large cost and survivability impacts with possibly little actual combat effect or strategic impact. Clearly a case can be made for a land attack or ASuW cruise missile capability, but extensive and rigorous operational analysis and modelling will be required to determine actual payoff versus additional expenses incurred throughout the life cycle of the fleet.

That the RAAF leadership of the last decade has chosen to unilaterally opt out of the strategic land strike and blue-water ASuW strike roles does not mean that air power should be written off as a future strategic or blue-water ASuW strike tool for the ADF. Nor does this mean that the ADF should put all of its strategic land strike or anti-shipping strike capabilities into a future submarine fleet, which would be most heavily tasked with critical ASW and ASuW strategic denial roles in time of war.

Similar arguments can be put for and against equipping the future submarines with extensive capabilities for special forces deployment and recovery, and Combat Search And Rescue (CSAR) roles. While these are valuable niche capabilities, they will impact the size and life cycle costs of the new submarines.

The greatest risk Australia will confront in defining and acquiring its future submarine fleet will be that of ideology rather than rigorous techno-strategic thinking being used to define the submarine requirement. This will be true whether the matter is the intended role of the submarines, or whether they should employ conventional or nuclear propulsion.

Managing the New Submarine Program

Australia's Collins class SSKs have been the subject of almost incessant controversy, much of it for good reason. A decade ago Australia operated two key strategic weapon systems which were unique to Australia, and thus required the complete engineering life cycle process be managed in Australia. These two systems were the Collins SSK and F-111 bomber fleet. Both systems fell victim to the changes in the Defence procurement system, as experienced technical engineers were purged a decade ago and replaced by semi-skilled or even unskilled business managers and administrators, while support was largely 'outsourced' to contractors. What followed over the last decade was a campaign of 'blaming the weapon system for shortcomings in the procurement system' rather than the proper action of 'fixing the procurement system so it was competent to maintain the weapon system'. Both weapon systems became sources of persistent public embarrassment. The Collins survived as the industry protected it, the F-111 did not.

More recent problems with the loss of experienced submariners, departing to private sector jobs, are a direct consequence of personnel losing confidence, this in turn a consequence of persistent problems in management resulting from an underskilled procurement organisation.

The decline in Australia's engineering skills base required to maintain and evolve modern weapon systems through their life cycle was well progressed during the 1990s, as the management of major weapon systems programs was progressively taken away from the military and given to the civilian procurement system in Defence.

Two decades ago this author, then a chief engineer in the computer industry, was tasked to brief the 'crack software development team', then developing the Collins SSK combat system, on some real-time software development tools, which were at the heart of the development system used for the combat system software. The 'team' as it turned out were all recent University graduates, none from the upper tier of engineering and computer science schools, and clearly none had either significant experience or university training in the real time software development area, or the architectural issues in developing a state-of-the-art combat system. What they did disclose was endemic micromanagement of engineering choices in the combat system, down to the level of hardware specifications, by non-engineers in the procurement system, placed into jobs traditionally performed by experienced engineers with systems integration backgrounds.

Suffice to say subsequent public disclosures on the failure of the combat system came as no surprise.

The important lesson from the Collins program is that key decisions in the definition and design of a major weapon system like a submarine cannot and should not be delegated to personnel who by background experience and lack of proper education and training are not qualified for the task.

Whether Australia opts to buy an off-the-shelf submarine, locally construct an off-the-shelf submarine, or evolve an existing design in the manner of the Collins, staffing of the project management team must from the outset incorporate personnel with deep engineering and operations analysis expertise in relevant areas. Otherwise the result will be another fiasco like the Collins program, only much more expensive and strategically risky given Australia's regional environment.

The Ohio class SSGN is a conversion from an SSBN, armed with up to 154 Tomahawk cruise missiles, in six round launchers which are inserted into former Trident SLBM tubes.

Launch of a Block IV Tomahawk SLCM.

USS Santa Fe displaying its twelve open vertical launch tubes for SLCMs. Later Virginia class boats use a six round launcher arrangement adapted from the Ohio SSGN design, with two large doors.