Defining future submarine capabilities

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> The changing strategic environment does not favour the use of diesel-electric boats, with or without Air Independent Propulsion (AIP), in the most critical blue water operating roles, given the demand for high, sustained transit speeds and dash speeds.

Virginia-class attack submarine USS California (SSN 781).

The ongoing debate over Australia's future SEA 1000 submarine fleet could be characterised as a 'cart before the horse' argument over hardware choices rather than a techno-strategic analysis of needs, followed by a deliberate, systematic assessment of choices in definition and final systems. The hardware-first approach is at the heart of most program failures in recent decades, in Australia and overseas. It is a problem that has cost US taxpayers tens of billions of dollars in wasted development, unusable or operationally compromised hardware, and associated sustainment costs. Bad capability definition has only one outcome – lost capability at enormous cost to taxpayers, with all of the strategic impacts that flow from that.

The SEA 1000 submarine procurement effort in Australia was recently described in a Centre for Independent Studies paper by Simon Cowan thus: 'It is unfortunate that the Future Submarine selection process to date has been marred by indecision and waste, conflicts of interest, and substandard procurement practices.'

Role of the Future Submarine?

The starting point for any capability procurement should be to identify and understand the basic strategic need for the capability, and what it will be into the future, over the life of the capability. This can a difficult task in detail, but is otherwise straightforward, involving analysis of the strategic picture and associated long term trends, and the capabilities being acquired by strategically relevant players.

For the next few decades the defining strategic trend for Australia will focus on strategic competition in Asia resulting from industrialisation, and the associated demand for energy and raw materials, almost exclusively delivered by sea. This competition has led to large scale procurements by China, India and other Asian nations, particularly in maritime Anti-Access / Area Denial (A2/AD) capabilities, which include nuclear and diesel-electric submarines, modern surface warships, aircraft and helicopter carriers, subsonic and supersonic anti-shipping and land attack cruise missiles, maritime patrol aircraft, and anti-shipping strike aircraft.

The areas contested are the Western Pacific and Indian Oceans, overlapping Australia's air-sea gap and critical Sea Lines Of Communication (SLOC). To support this effort the United States declared a 'strategic pivot to Asia', with associated plans for basing enhancements and expansion, along with the 'Air Sea Battle' concept, which has yet to mature. These measures are reactions to China's 'Second Island Chain' A2/AD concept and 'String of Pearls' basing strategy, the latter leading to new port facilities in Pakistan, Myanmar (Burma) and ongoing engagement of other regional nations, including East Timor.

The strategic imperative for Australia is in many respects no different to that during the 1940s and the Cold War era, and that is to keep unwanted foreign maritime and air assets out of Australia's sea-air gap and SLOCs. Operations aimed at A2/AD in Australia's maritime areas of interest could produce devastating economic impacts, given Australia's dependency on SLOCs for primary exports, and energy and manufactured goods imports.

The most likely future threat in the maritime domain will be cruise missile armed submarines tasked with A2/AD interdiction of SLOCs, and attacks on offshore and coastal facilities, be they economic or military. Submarine attacks would be supplemented by aerial attacks, subject to basing and tanker availability.

This puts the primary strategic force structure planning imperative for Australia's maritime capabilities firmly in the domain of Anti-Submarine Warfare (ASW), with survivability of the surface and submarine fleets in so contested waters a directly related imperative.

For the RAN's surface fleet, this indicates a focus on ASW capabilities in surface combatants, and very robust capabilities to survive sea-skimming anti-ship cruise missile attacks, especially

involving supersonic weapons. The obvious planning measures to strengthen capabilities in this area include improved ASMD systems in the AWD, ANZAC and LHD classes, new ASW helicopters, over-the-horizon SAM targeting for surface vessels, and 'dual-roling' the new Canberra class LHDs as ASW helicopter carriers, following the Japanese DDH and Russian 'Aviation Cruiser' models. The value of equipping the LHDs for ASW should not be underestimated, as this provides a direct return on this significant investment in a primary strategic role, rather than dedicating them to secondary roles like disaster relief and expeditionary land campaigns in benign environments.

Given a primary force structure focus on ASW, inevitably this puts the primary role of the future submarines in the domain of ASW. Other roles such as surface target interdiction, land strike and Special Forces deployment/extraction and Combat Search and Rescue (CSAR) will be secondary to ASW.

While secondary role adaptations add considerable flexibility to submarine roles, with useful strategic impacts in many situations, they can also significantly impact the size and thus life cycle costs of the boat. This is especially true with adaptations for surface target interdiction and land attack. For an anti-ship cruise missile attack on a convoy or surface action group to be effective, a salvo attack with multiple cruise missiles will be required to overcome defensive systems. In land attack roles, US Navy experience shows that multiple cruise missiles need to be targeted at multiple aimpoints for typical critical infrastructure and air defence targets. Torpedo tube launches are not viable for this regime of operation, and vertical launch tubes for cruise missiles will incur inevitable costs.

Given a primary focus on ASW, consideration must then be given to the style of ASW operations to be conducted. This in turn depends on the intended area of operations.

In brown water and littoral ASW operations the submarine will position itself in proximity to a critical choke point, and quietly wait in ambush. A hostile submarine passing through the area will be detected and attacked, opportunities permitting, a scenario well described in Tom Clancy novels. This is the historical regime of operations for most diesel-electric subs, as it minimises fuel burn and puts little demand upon sustained speed during combat operations. The main imperative is quietness, and submerged endurance in the area of operations. This regime of operations can be employed offensively by positioning submarines at distant foreign chokepoints or in proximity to foreign ports, or defensively by positioning the submarine near ports or chokepoints in friendly waters, intending to ambush hostile submarines playing the offensive dimension of this 'game'.

Blue water operations present similar dualities in offensive and defensive operations. The classical examples of offensive blue water operations are the Kriegsmarine U-Boat efforts during the Battle of the Atlantic, and the Soviet investment in SSNs and SSGNs intended to replay the Battle of the Atlantic against NATO resupply convoys in a Cold War period conflagration. The popular view of submarine operations is largely coloured by these historical examples.

The offensive dimension of blue water ASW operations today will involve the defeat of hostile submarines tasked with defending carrier battle groups, large surface action groups especially tasked with ASW and, of course, convoys. While ambush tactics are feasible where there is reasonably accurate knowledge of the future position of the targets, the imperative for submarines in such operations will be sustained speed. The Soviet investment in very fast SSNs (and SSGNs) reflected the need to intercept NATO fleet assets with incomplete prior information on target locations. Defensive operations, where the submarine is effectively acting as a subsurface 'escort' for a carrier battle group, large surface action group, or convoy, also imposes a strong need for sustained speed, as the boat must be capable of matching the transit and dash speeds of the assets it is protecting. This is also why SSNs and SSGNs are the weapon of choice in blue water operations.

The key and critical strategic force structure planning choices Australia needs to make are whether the primary focus of the Future Submarine will be for blue water or brown water / littoral operations, and whether the focus should be on distant offensive operations or close-in defensive operations. Importantly, a submarine that can perform well in distant offensive blue water operations can also be used effectively in close-in defensive brown water / littoral work. The opposite is simply not true.

The Collins class ended up becoming the largest SSK/SSG built since the 1940s, as the intent was to provide it with the capability to play in distant offensive operations, and address as many of the blue water roles as possible with a diesel-electric. These realities appear to have not been well understood by a great many participants in the current submarine debate.

The changing strategic environment raises the importance of blue water roles for submarines, especially roles in which the defeat of nuclear powered SSNs and SSGNs is necessary.

Consider a foreign nuclear powered SSN or SSGN tasked with conducting a cruise missile attack on an Australian coastal target. To launch, it needs to be within a circle with a radius of around several nautical miles of the intended aimpoints. Whether the target is in the deep North, the Kimberley, Pilbara or Perth area, or anywhere along the eastern seaboard or southern coast of the continent, the area to be patrolled is very large. This is considerably larger than the patrol area required to deny operations by a torpedo armed SSN or SSK attempting to ambush shipping in proximity to key ports, or in a major SLOC. For an SSGN tasked with convoy interdiction in Indian Ocean or Pacific SLOCs, the patrol footprint expands even further. This presupposes the SEA 1000 submarine is not working as a subsurface escort to a surface group or convoy.

Even assuming a potent acoustic and aerial detection grid in these areas of interest, to permit a defending submarine to effectively intercept a detected subsurface threat, there will be a strong demand for the submarine to dash from a patrol station to the intercept area.

SUBMARINE ROLES

In defensive roles the rising priority of blue water sea denial / ASW roles does not favour a diesel-electric solution, as high sustained speeds will be required for many scenarios.

Playing the offensive side of the game, the principal challenge will lie in advancing means for detecting submarines, especially submarines at shallow depths.

Towed sonar is now widely used by submarines and surface combatants, and the commodification of high performance computing power puts such equipment within the reach of most key players in Asia. Moore's Law favours the sonar over time.

Autonomous robotic submersibles are also advancing, a good example being the LRI Waveglider *(http://liquidr.com/technology/wave-glider.html)*. Devices such as this will present opportunities to rapidly deploy sensor grids in areas of interest, putting a premium on quiet deep submerged operations.

Surface wake detection by radar carried by satellites, or manned or robotic aircraft, is another means that will profoundly impact ASW operations, as it matures and proliferates.

Interdicting hostile SLOCs or setting up for ambushes near hostile chokepoints or ports all involve transits and entries into patrol areas, which will be surveilled by the best equipment an opponent can get. The notion that industrialised nations in Asia will be unable to procure, maintain or develop such equipment over the next four decades is wildly optimistic, and any decisions based on this assumption well and truly qualify as 'courageous'.

The changing strategic environment does not favour the use of diesel-electric boats, with or without Air Independent Propulsion (AIP), in the most critical

USS North Carolina (SSN 777) being launched in 2007.

HMAS Rankin in Hawaii.

Virginia class boat USS Minnesota (SSN 783) under construction.

blue water operating roles, given the demand for high, sustained transit speeds and dash speeds. In offensive roles, penetrating into contested or defended waters, advancing sensors will present unprecedented survivability challenges for diesel-electric boats, with or without AIP capabilities.

The submarine debate has seen a great many assertions, stating that Australia will not or should not consider nuclear powered boats. This import of these ideologically and/or commercially driven statements lies in what kind of boats might be procured, and in what roles they could perform.

If Australia intends no more basic capability than the Collins boats provide, to perform exactly the same roles, then another 'Collins-like' boat will result, but even larger than the Collins, due to the need to integrate an AIP system and oxidiser tanks for the AIP system. If the intent is to add secondary surface and land attack capabilities of substance, a further size increase will be required to add vertical launch tubes for cruise missiles, and commensurate increases in fuel and oxidiser capacity to provide equal range and endurance. If submerged endurance needs to be greater, to accommodate offensive roles in contested waters, an even larger AIP oxidiser capacity will be required. There are no off-the-shelf SSKs in this class, at this time, requiring a new boat.

This is no different to the basic problem encountered in aircraft definition, as performance and useful payload demands increase, so does the weight and size of the vehicle required. A blue water role optimised diesel-electric boat intended to fight nuclear boats will need a competitive sensor suite, and weapons payload, with commensurate scaling impacts upon hull volume and powerplant size, with proportional scaling of fuel supply and AIP oxidiser supply. Such a diesel-electric boat will never match the range, endurance and sustained high speeds of a nuclear boat, and a sufficient number of tenders will be required for replenishment and refuelling in blue water operations, an additional and significant cost which appears to be invisible in the current submarine debate.

Defence state that 'SEA 1000 will provide Australia with a new and more potent defence capability with greater range, longer patrol endurance and increased capability compared with the COLLINS Class. Key capabilities will be in the areas of anti-submarine warfare; anti-surface warfare; strike; intelligence, surveillance and reconnaissance; electronic warfare; mine warfare; and support to both Special Forces and advance force operations.' This inherently dictates a boat larger than the Collins class.

It follows that the merit of any diesel-electric solution to Australia's extant and future strategic needs must be critically assessed against some achievable capability and cost baseline. A good baseline for comparison is the US Navy's nuclear powered Virginia class SSN/SSGN, which has been repeatedly proposed in the submarine debate as the solution for Australia.

The Virginia boats displace just under 8,000 tonnes submerged, carry up to 27 torpedo tube-launched weapons and twelve vertically launched cruise missiles: a state-of-the-art sensor package, with the unlimited range, endurance and sustained high speeds typical of modern nuclear boats. Displacement is just over twice that of the Collins boats, and crew complement also just over twice that of the Collins boats.

Official US DoD cost reporting to Congress in Selected Acquisition Reports puts Procurement Unit Cost in 2018 dollars at US$2,644.7 Million per boat, with an estimated annual operating and sustainment cost of ~US$85 Million in FY 2025 dollars at a three per cent annual inflation rate. In US dollars, six boats come to US$15.9B, eight to US$21.2B, and twelve to US$31.7B. Whether Australia could fully crew more than six boats is an open question.

A useful comparison is that the operating and sustainment cost of the Collins class is currently around AU$100M per boat, annually. A larger diesel-electric would be proportionally more expensive to operate, and in turn additional fleet tenders to support blue water operations would further increase annual outlays.

Clearly, there is not a compelling strategic or budgetary case for a diesel-electric solution to SEA 1000, versus the procurement of an Evolved Military Off-The-Shelf (EMOTS) Virginia class derivative boat; that is, if blue water roles are the strategic priority for Australia, which they should be.

Conversely, there is a compelling strategic and budgetary case for Australia's political leadership to put aside ideological and commercial agendas and open the submarine contest to nuclear powered boats, with a specific focus on the Virginia class. Ultimately, strategic effect per dollar invested must be the final determinant in the SEA 1000 program.

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