Submission to The Economics Reference Committee: Naval Shipbuilding Inquiry – Future Submarine Project

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Introduction

1. This Submission is based on our collective experience in Oberon class submarines, the COLLINS project and developing concepts for Future Submarine (FSM).

- Peter Briggs assisted Deep Blue Tech's (DBT) developments of the A1, A2 and A3 FSM concepts.
- Neither author has a current commercial relationship with any potential FSM designers or builders.

2. The 'Greybeards' salute the recent passing of one of its members; Oscar Hughes whose wise counsel will be sorely missed – his words live on in this submission.

3. Our intervention now comes because of the criticality of timely decisions required if a capability gap is to be avoided.

4. This Submission is consistent with the advice the Greybeards have provided to successive Governments since delivering the Future Underwater Warfare Capability, Industry and Political (FUCIP) Study to the Department of Defence in December 2006.

5. The starting point for any analysis is Australia's requirement for a submarine capability.

WHY Submarines for Australia?

The Top Level Capability & Its implications

6. The 2009 and 2012 Defence White Papers both provided an adequate strategic setting, we will not reiterate it here.

7. We need to focus on the stand out attributes of submarines:

- **Able to operate in areas without air or sea control.**
- **Able to watch, listen, evaluate and act where necessary.**
- **These attributes result in a unique intelligence, surveillance and reconnaissance platform, providing an early warning of intentions.**

- **Defending against a capable submarine force is expensive and the outcome uncertain – hence submarines deter an escalation to conflict.**
- **Submarines offer unique options to Government in all scenarios.**
- **Australian Submarines are a valued contribution to Allied efforts.**

8. This capacity is based on the submarine's key attribute - **STEALTH** giving access to sensitive/critical areas denied to other vehicles and surveillance systems.

9. The high pay off areas for submarines are close to an opponent's operating bases and associated training areas. A large submarine is therefore required because of our geography; further discussion is at Attachment 1.

10. Given the right **ENDURANCE** [1] and **PAYLOAD** [2] capacity, submarines offer strategic options in Australia's future, constrained circumstances + huge uncertainty for an opponent -> **DETERRENCE.**

11. To achieve this effect they must:

- Have the endurance, stealth and payload to reach and operate effectively in sensitive areas throughout region.
- Maintain a capability edge over opposing ASW capabilities.
- Be operated proactively, exploiting the initiative gained and where appropriate, acting offensively.

12. Points of note:

- Submarines are the only ADF force element with these characteristics.
- A smaller submarine, or even a large submarine lacking the necessary range, endurance and payload, operating in a sea denial role in our maritime approaches reduces these options to defending against an opponent who has the initiative and offers the Australian Government significantly fewer choices.
- A capability edge over regional submarine and ASW forces requires an enduring/long term defence industry capability for SM R&D, design, construction and support – this national capability is also essential for a parent navy.

Key Issues

Capability Gap

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[1] Endurance is a combination of mobility (fuel and energy), habitability (food and crew support systems) and availability of sensor/platform systems (equipments, power, cooling, redundancy and onboard repair capability).

[2] Payload is the capacity/flexibility to carry/deploy specialist personnel teams, a range of weapons, remotely operated vehicles/off-board sensors – the latter are the next capability frontier/force multiplier for submarines.

13. We must avoid a capability gap between COLLINS and an operational FSM capability – two aspects are of particular note:

- The need to avoid a repeat of the Oberon/COLLINS transition drop in the number of operational submarines that decimated the RAN SM Arm manpower in the late 1990s and from which we have only recently recovered.
- A capability gap in the 2030s would leave Australia without an operational edge against growing regional submarine and ASW capabilities.

Life Extension Program for Collins

14. Prevarication by successive Governments has made a Life Extension Program (LEP) for Collins difficult to avoid.

15. We should recognize that a COLLINS LEP would be:

- Expensive and demanding technically.
- Risky - difficult to guarantee the operational outcome/cost/availability.
- N**ot provide the operational edge needed in the 2030s** – 80/90s technology will always struggle against a more modern design.
- Consume scarce resources - time, submarine technical expertise in Industry/Defence and $s – all better spent on FSM.
- Constrain choices for the future – these resources are finite.

16. Whilst a Collins LEP should be considered as a contingency plan, Government would be prudent to keep its options open and:

- **Australia should avoid the risks and unknowns of an LEP if possible.**

SM Design 101 - NO MOTS

17. In simple terms a SM has to have sufficient buoyancy or volume to support its payload when it is underwater, i.e. it is neutrally buoyant.

18. If you add more fuel (or any other payload) then you have to take out an equivalent weight or increase the volume. These adjustments must be positioned so as to maintain the fore and aft balance of the submarine.

19. Simply lengthening it by adding hull sections to add volume only works so far, once you get to a length:beam ratio of 11:1 the shape becomes less efficient, requiring more energy to propel it; it is also less agile and noisier.

20. At this point increasing the volume requires an increased hull diameter – it is no longer the same design!

21. It is safer to let the designer get all your parameters on the table and

design a SM with the volume to carry the payloads required by the capability.

22. Some may see this as a huge risk, but trying to stretch/adapt an existing submarine design with the restrictions this places on the designer is actually often a more difficult and a higher risk in our opinion. The level of risk associated with reach design will vary and must be carefully assessed in selecting the final solution.

23. Anything/everything you touch in a SM design interacts with other features of the design. A simple and partial example arising from increasing the volume, eg by adding a hull section for an AIP capability to an existing design:

- More generating capacity is required for the long transits, either larger diesels or more of them.
- These need more fuel.
- If larger diesels are required a larger diameter pressure hull may also be required to accommodate them with the necessary quieting measures.
- Supporting systems such as cooling and switchboards may need to be enhanced, etc.

24. The result is a substantially new design.

25. All the roads lead to this decision point for FSM;

- A MOTS is not feasible, a new design is required (though the DMO has spent several years and $M re-validating the same analysis that preceded the development of the COLLINS design).

26. The next key questions are:

- What baseline do you wish to start from?
- In our case we have two principal choices - COLLINS with 20 years experience (good and bad) in our operating environment, or another existing design:
    - e.g. Soryu.
- Leading to the second question:
    - Who do you wish to partner with to develop and build FSM?

<u>A Developmental Project</u>

27. Germany, UK, France, Sweden and the USA all use sole source design/builders for their contemporary submarine programs.

- New designs are undertaken as a developmental project, evolving from the current in service experience, often with substantial changes to the platform and systems to accommodate requirement growth or lessons learnt.
- The USN technique is the best described of the project management techniques used. It is termed an Integrated Production, Process

Development (IPPD) design/build process.

- IPPD uses a seamless process and avoids the traditional step by step design process with a period between each phase whilst decisions on proceeding were taken; often leading to delays, design changes and cost escalation. [3]
    - Life cycle costs are considered at every stage of development.
    - IPPD has resulted in designs being completed much more rapidly than the traditional process.
    - Individuals with knowledge of the construction process are involved throughout, minimizing the requirement/costs for re-work.

28. Australia has yet to settle on a design/build process for FSM; precious time and $s have been expended without a clear focus on the steps to deliver a new submarine.

- The DMO's process driven approach developed for 'off the shelf' acquisitions is poorly suited to undertake a developmental project using an IPPD process.

<u>A Japanese Solution?</u>

29. The recent discussion in the press on the possible acquisition of Japanese submarines for Australia to replace the COLLINS Class raises a number of issues:

- There is no publicly available information on the performance, roles and missions of Japanese Submarines.
- Apart from the Air Independent Propulsion system, the platform and combat system components are Japanese, developed in an environment isolated from competition with Western/NATO suppliers amplifying concerns about the level of their performance.
- Hence it is difficult to come to any judgment on how well these submarines could meet Australian capability requirements in our unique operating environment.
- Australia must be absolutely confident that FSM will possess a capability edge throughout their operational lives; their primary purpose, to fight and win, must be paramount.

30. Table 1 below provides a comparison of the Soryu and COLLINS class submarines using publicly available information.

[3] Sustaining US Nuclear Submarine Design Capabilities, *John F Schank, Mark V Arena, Paul DeLuca, Jesse Riposa, Kimberly Curry Hall, Kimberly Curry,* Rand Corporation

Characteristic	Soryu	Collins	FSM Requirement	Remarks
Surface Displacement (tonnes)	2950*	3100	Not less than Collins	Regularly quoted displacement in media for Soryu (4200 tonnes) is submerged displacement, which means that Soryu carries 1300 tonnes of ballast water. Useable space on-board is determined by the surfaced displacement. Without the AIP section, Soryu has less useable volume than Collins. Note: since Soyru is a double hulled design some of the ballast tanks may be convertible to fuel tanks, improving the useable volume calculation.
Range (NM)	6000 @ 6.5 knots	9000 @ 10 knots	Not less than Collins	Australian operations require long distance transit to reach patrol area within a reasonable timeframe. Soryu is not designed for long transits.
Top Speed	Similar	Similar	Similar	
Diesel Generators	2 x 1400 kW	3 x 1400 kW	Not less than Collins	Similar diesel design on Soryu and Collins. Less installed power results in longer snorting time and reduced stealth.
Propulsion	5900 kW	5400 kW	Not less than Collins	The higher installed power on Soryu is required due to the extra ballast water carried when submerged.
Combat System	C2 (Japanese)	AN/BGY-1 (US/Aus)	Updated version of AN/BGY-1 (US/Aus)	US based combat system fully integrated on Collins. Integration of US combat system into Soryu required.
Torpedoes	Type 89 – (Japanese)	MK 48 (US/Aus)	MK 48 (US/Aus)	MK 48 torpedoes fully integrated on Collins. Integration of US combat system into Soryu required.
Missiles	Harpoon	Harpoon	Harpoon	
Crew	65	58		
Legislation and Naval Requirements	Japanese	Australian	Australian	Modification of Soryu is required to meet Australian safety and technical regulatory standards.
Operational Life	16 years	28 years	Not less than Collins	Changes in design and support philosophy required for Soryu. New maintenance program required.

Table 1 – A Comparison of some characteristics of the Soryu and COLLINS Class submarines

32. It is apparent therefore that SORYU would need to be heavily modified to meet the Australian requirements, particularly for long ocean transits and patrols. This would carry cost, performance and schedule risks and will amount to a new design; it will not be a Military Off The Shelf (MOTS) acquisition.

33. The design philosophy is also an important factor to be considered in modifying and owning a submarine:

- The Japanese submarines are reportedly retired at a much earlier age (about 16 or so years) than normally expected in the Western world, which will require Australia to invest heavily in special maintenance and upgrade programs unless we do the same.
- This policy is important; through-life support is the most expensive component of the cost of ownership.

34. The Coles Review highlighted the vital importance of establishing through life logistic support arrangements in Australia during the submarine construction phase. For this to be done successfully it is critical that Australia has full access to those technologies that underpin Australia's Submarine Force strategic interests – otherwise the effectiveness of the new submarines will always be reliant on the relationship with the overseas parent navy and its industry base.

35. COLLINS experience demonstrated that the required transfer of technology can only be gained through the construction of the first submarine in an Australian shipyard and that the associated risks could be successfully managed.

36. The cultural differences between European ship and submarine builders have been sufficient to cause significant problems for the COLLINS Class Submarine Project and the Air Warfare Destroyer, as set out in the McIntosh/Prescott Report [4] on COLLINS and the recent Winter/White report on AWD:

- The prospects for difficulties arising from cultural differences with Japan are all too apparent and very real.
- To expect to access all relevant technologies during the course of an overseas build of such a complex vessel as a submarine for the initial collaboration with a country, which has no experience in such matters, is extraordinarily ambitious and inherently risky.

37. A change in design intent, including system design, build strategy and operating and maintenance philosophies (and the associated logistics chains) from the COLLINS to SORYU will introduce extra risk and cost and disruption

[4] Report to the Minister for Defence on the Collins Class Submarine and Related Matters, *Malcolm Kenneth McIntosh and John B Prescott,* CW of Australia 1999.

to the program and ultimately to the Navy's submarine capability.

- It will also require two submarine programs for very different platforms to be run in parallel, at a much greater cost, until all the Collins submarines are withdrawn from service.

38. Careful, measured consideration of risks must be undertaken - a Japanese solution for the Future Submarine must address these issues. Based on the assessment possible from the limited amount of information available this does not seem to have been done.

39. The practicalities of establishing a transparent dialogue with Japan, a country that has no established protocols with Australia for the exchange of classified, sensitive technical data and which must develop regimes to regulate this dialogue seem to have been ignored. It is certain that this will be a very protracted process.

40. Despite the apparent political attraction to this solution if media statements can be believed, [the 'best conventional submarines in the world' etc.] it seems most unlikely that they are as capable as COLLINS and almost certainly cannot offer the sort of improvements required in Australia's FSM Considerable development would be required before a SORYU or its successor could achieve this.

41. Nor can continuing political support in Japan be assumed, the current positive atmosphere is highly dependent on the personal commitment of the Japanese PM; a position that has changed 14 times in the last 15 years:

- This represents a large and unquantifiable sovereign risk for a FSM program based on a Soryu class submarine.

42. The $20B program cost being used in the media softeners lacks any details or credibility; for example, does it include the 25-30% contingency appropriate for a developmental project with the risks and issues identified above?

43. Finally, all this will take time; time we do not have if a capability gap is to be avoided.

44. We do have time to do it properly - using Collins as an indicator, the contract was signed in 1987 and the first submarine was delivered in 1996. While there were issues to resolve, this was a nine-year design and build program for the first of class from a greenfield site.

- There is still time to deliver the first of class FSM in 2027, providing we stop wasting time and money on fruitless studies and GET ON WITH IT.

Australian Design Environment

45. An Australian design environment would aim to achieve and sustain ownership of the design for future development. It does not mean we undertake the design; rather we should engage a selected major conventional submarine designer to undertake this whilst developing Australian expertise and specialist manpower and transfer the skills and IP necessary to undertake the in service design authority role.

46. Advantages of an Australian design environment include:

- Optimum access to US and European technology:
    - We will require assistance from both sources.
- Allows total cost of ownership to be minimised.
- Strong demonstration of long term investment in Australian engineering and shipbuilding skills.
- Enables cost/capability trade offs + cost and capability caps.
- Essential to obtain real cost as opposed to academic extrapolations.
- Maximises opportunities for DSTO & Australian Industry involvement.
- Best use of our limited resources to manage!

Australian Construction

47. As a starting point for this consideration we will briefly review the results achieved by the COLLINS project:

- The Collins program was completed with an average schedule delay of about 26 months and within 3-4% of the original contract price after allowing for inflation.
    - If all the extra expenditure on improvements is included the project came within 20% of the original budget. [5]
    - This is a commendable result for a development project of this complexity; a contingency of 20-25% would have been reasonable, in which case it would have been within budget.
    - In approving the Project the Government imposed an arbitrarily cost cap, resulting in an effective contingency of <5%, compounding the challenge of rectification of shortcomings.
- The Project's aim to expend at least 70% of expenditure in Australia was comfortably exceeded. [6]

    - "*This money was paid to many sub-contractors large and small throughout Australia, and with the money came new technology and training, and an emphasis on quality control previously foreign to Australian industry.*"

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[5] The Collins Submarine Story, *Peter Yule & Derek Woolner,* Cambridge University press, 2008, p325.
[6] Ibid, p327.

- Construction standards, demonstrated by weld rejection rates and hull circularity were excellent, exceeding international norms.
- There were a significant number of design and system defects requiring rectification in the newly built submarines, this was undertaken by ASC, supported by DSTO, the USN and industry.
    - Kockums played a limited role.
    - I believe this was due to its limited R&D capacity, compounded by exhaustion of its contingency for the project and commercial distractions in Sweden; the company was sold shortly afterwards to TKMS.
    - ASC designed the 'fixes' and Kockums, the Designer, subsequently certified these.

    - *"It is often forgotten, in the rush to apportion blame for the things that went wrong, that the vast majority of things went right and that Kockums as the designer and ASC as the contractor – with the guidance of the project team – were responsible for these."* [7]

    - ASC subsequently took over the role of in service Designer and continues to discharge this role.
- The majority of the detailed design work for COLLINS was undertaken at ASC, by 40 Australian and 20 Swedes as part of an overall design team of approximately 300. Kockums oversaw the production of the drawings necessary to construct the submarines. [8]
- The spinoffs from COLLINS construction were significant and widespread.
- The availability problems that have caused such poor ongoing public perception of the submarines arose from poor support arrangements.
    - These started when the RAN rejected the Project's logistics support plan in the mid 1990s as too expensive.
    - What followed has proved to be far more expensive – as you would expect!
    - The RAN (and DMO as their agent) struggled to come to grips with their role as a parent Navy.
    - It has taken many years and several reviews [9] to rectify this situation.
- In its final report the Coles Review found a major improvement in COLLINS availability as its recommendations were implemented:

    - *"Submarine availability has improved significantly with the submarine force currently achieving usually two and frequently three submarines materially available on any one day. This steady and measured improvement has provided the opportunity for three submarines to be*

[7] Ibid, p326.
[8] Ibid, p136.
[9] Study Into the Business of Sustaining Australia's Strategic Collins Class Capability, Phase III November 2012, Phase IV March 2014

deployed simultaneously at great distances from their home port during 2013, thus stress testing the robustness of the improving logistical support arrangements.

Progress towards achieving benchmark performance is equally impressive." [10]

48. We would argue that viewed against other contemporary submarine projects such as the USN's SEAWOLF or RN's ASTUTE:

- COLLINS was better than average, ie the reality is far better than the public perception.
- COLLINS is a sound starting point for FSM.
- The RAN now has 19 years of experience operating the submarine in our environment to feed into the FSM design development process.

49. There are substantial benefits of construction in Australia, these include:

- Establish the engineering and technical knowledge to support the through life evolution of what will be a uniquely Australian design.
- If the Project is appropriately structured, the Designer function can become a national capability, offering the benefits of an Australian Design Environment cited above.

50. The Senate has previously produced a Report [11] into the costs and benefits of Australian naval construction, these will not be reiterated here, however local construction will be particularly important for FSM given its unique design and strategic importance.

Nuclear Power

51. Australia's requirement for long range transits provides a strong argument for the mobility of a nuclear powered submarine. Adopting nuclear power for FSM is not practical for a number of reasons:

- The manning required for the larger western SSNs (VIRGINIA and ASTUTE), each of which has crew of ~ 100+ (VIRGINIA crew is more than double that of a COLLINS) is not available and may never be sustainably achievable.

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[10] Ibid, Progress review – March 2014, page i.

[11] Senate Standing Committee Foreign Affairs, Defence and Trade: Blue water ships: consolidating past achievements, 7 December 2006, Ch 11 Economic Benefits

- The lead time to develop sufficient nuclear engineering knowledge and skills to oversee an acquisition program is probably in the order of 10-15 years.
    - For example, the University of NSW has just reopened Australia's only nuclear engineering faculty following a short sighted decision to close it down in 1975.
- The lead time for an SSN capability would require an LEP for COLLINS with all that would entail for Australia's submarine capability.
- The transition from conventional to nuclear propulsion would be particularly challenging, particularly during the overlap when two different classes of submarines will be operating; this will require careful preparation.
- The French Barracuda class SSN currently under construction is much smaller and with a crew of 60 would offer a more practical manning option.
    - The practicality of installing of US weapons and combat system components would be an issue for early resolution in developing this option.
    - Operating two classes from the same 'stable' would reduce some of the conversion challenges.

52. Given the lead time, it would be prudent for current planning to consider a nuclear propulsion option for follow on batches of FSM, ie following the replacement of the COLLINS class by 6 conventional submarines, with a possible decision point to then move to nuclear propulsion in subsequent batches.

Conclusions

53. Submarines are a critical strategic capability for the uncertain times ahead.

54. Australia's requirements and geography demand a larger submarine; trying to stretch an existing design is a high risk proposal with limited capability to grow to meet future changes.

55. If possible, Australia should avoid the distraction, expense, risks and capability gap arising from an extension to the life of COLLINS.

56. The current focus on a Japanese solution is misdirected and a distraction from the correct path to achieve the required FSM capability.

57. Selecting the most appropriate design partner is the next key step, this should be done by undertaking a competitive Project Definition Study (PDS) to provide costed, fixed price bids for the design and construction of FSM in Australia, including proposals from the contenders to achieve this in time to avoid an LEP for Collins if practicable:

- An Australian led PDS, utilising reputable European designers is the correct way ahead.

- This would provide Government with the information and maximum options for the key decisions necessary to avoid a capability gap

58. The possibility of a nuclear propulsion option in future acquisition post COLLINS replacement should also be included in the PDS considerations.

59. We should recognize that the standard Defence procurement processes are ill placed to manage the short fuse developmental project that is now required and move to a more efficient structure able to drive a developmental project against the tight time scales now required.

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Attachment:

1. Does Australia need to be able to operate submarines independently at long range?
2. How Many Submarines?

Does Australia need to be able to operate submarines independently at long range?

An excellent question.

Submarine Critical/Unique Characteristics

There are a number of critical and unique submarine characteristics that make submarines so effective.

The first is stealth, the ability for a well handled submarine to exploit the laws of physics and avoid detection enable it to operate in areas where we do not have air or sea control.

It is the only platform in the ADF to be able to do so.

The second is its performance as a sensor platform, particularly a passive sonar platform. In effect a submarine is a large, manned and mobile collection of arrays operating across the spectrum from sub acoustic to visual, able to position for best effect, observe, interpret and react or respond.

My final set of critical characteristics is endurance and payload capacity.

I define ***endurance*** is a combination of ***mobility*** (fuel and energy to complete a transit quickly and securely, undertake a patrol and return), ***habitability*** (food and crew support systems) and ***availability of sensor/platform systems*** (equipments, power, cooling, redundancy and onboard repair capability). This must be accomplished with a workable minimum of fuel, food and systems remaining.

I define ***payload capacity*** is the ability, ***flexibility*** and ***adaptability*** to enable the submarine to carry and deploy a range of payloads such as specialist personnel teams, a range of weapons and remotely operated vehicles/off-board sensors – the latter are the next capability frontier/force multiplier for submarines.

In summary, a capable submarine is the ultimate stealth platform, able to operate without fuss in areas where sea and air control is not assured and to gain access to areas denied to others.

Exploiting The Unique Impact Of Submarines

A submarine operated to exploit these characteristics can create great uncertainty for an opponent.

It is able observe operations in key training and trial areas otherwise denied to comprehensive observation across all spectra, providing long term intelligence of intentions and capabilities.

During a period of tension they are able to report deployments, providing an invaluable indication and warning and enable counteraction to neutralise the deploying platform.

This capability is particularly advantageous in anti submarine warfare, a priority for Australia, where the ability to operate close to an opponent's bases greatly increases effectiveness.

In all scenarios submarines are a force multiplier, facilitating diplomatic action and military preparedness moves to avoid an ultimate confrontation.

During a period of conflict a submarine is able to use its characteristics to undertake a range of measured and precise offensive actions to shape or control a confrontation. In addition to the traditional torpedo, a capable submarine's arsenal extends to the delivery of mobile, highly precise sea mines and land, sea or air strike using missiles.

Across the spectrum of conflict, submarines are an invaluable contribution to the Allied intelligence picture.

In short, a capable submarine, exploiting these characteristics, operated proactively, with initiative and where appropriate, offensively is able to exert a significant deterrent effect.

The Geography

To be able to exploit the initiative gained from their stealth, Australia's submarines must be able to covertly reach a potential opponent's sensitive areas throughout our region. **It is a fact of geography that most of these areas are at long range from Australia.**

Australia should avoid a **dependency** on forward bases to conduct submarine operations; access to such bases cannot be guaranteed. The reduction in operational security through the use of such base reduces the submarine's freedom of action and adds to the hazards faced by our submarines.

The use of a depot ship, requiring a forward base with appropriate protection to support it suffers from similar limitations with the added disadvantages of the diplomatic and strategic indication provided by its deployment. The capital cost of acquisition/sustainment and additional people to crew it also make this a more expensive option.

Independent Operations

It follows from the reality of Geography and the roles that there will no near, friendly base for re-supply or support. Australia's submarines must carry the onboard redundancy, skills and spares to sustain the submarine against a range of mission critical defects.

Defending Closer To Home

Arguments that Australia's submarines should be used defensively and constrained to defending the sea approaches to Australia, using the Indonesian Archipelago as a barrier to channel the approaching opponents would deny Australia the initiative, priceless intelligence and ability to influence the development of a situation that can be gained by imaginative use of a capable submarine force well forward in the high payoff/high risk areas in situations across the whole spectrum of likely contingencies, rather than simply the least likely, 'last-ditch, defend the moat scenario'.

A strategy based on operating submarines within or close to the Indonesian Archipelago also requires Indonesian support or risks attracting Indonesian opposition. It would be a foolish strategy to rely on Indonesian support in all circumstances.

The areas south of the Archipelago is one where we can expect to have a degree of sea and air control. There are other maritime and air platforms in the ADF that can more cost effectively operate in this situation.

There is a also significant possibility that Australian submarines deployed under such a strategy will be in the wrong place at the wrong time and lack the ability to quickly reposition – there are several WW II examples of this situation.

Finally, there are a large number of options for passage through the Archipelago – a large force of submarines would be required to guarantee closing them all off.

Regardless of the size of Australia's submarine force, a 'defend the ditch' strategy surrenders the initiative to the opponent who may well calculate that he should be able to avoid the defending submarines.

A submarine force only able to be deployed close to home foregoes the unique advantages set out above has significantly less deterrent value across the spectrum of contingencies.

The Answer Is YES

Australian submarines must be able to operate independently at long range, with sufficient endurance and able to carry the payloads required for the long duration missions involved, frequently in or through hot tropical waters.

Attachment

How Many Submarines?

The starting points for this discussion are:

- The criticality of the maritime environment for Australia's prosperity,
- The impact of growing regional maritime power and The need to look for capabilities that will give future Australian Governments options to cope in this emerging situation and hence the requirement for long range, long endurance, survivable submarines is the.

This brief addresses the question:
How many submarines does Australia need, to provide sufficient 'strategic impact' to make a potential aggressor avoid a military confrontation with Australia?
The question is an important one given the 'interesting' strategic circumstances ahead of us.
It's worth re-iterating that the submarine's most fundamental, key feature is its stealth. Given this attribute, a well-handled submarine is able to operate without causing fuss in areas where sea and air control isn't assured, and to gain access to areas denied to other platforms.

- Large submarines, such as COLLINS, are able to operate at long range for weeks, carrying a flexible payload of sensors, weapons and specialist personnel.
- A capable submarine force is probably our most potent anti submarine weapon system, perhaps their most demanding role.
- A potent submarine capability creates great uncertainty for an adversary: countering them is difficult, expensive and can't be guaranteed.

Given the unfolding strategic landscape, my starting assumption is that our submarine force must be capable of operating and surviving north of the archipelago, throughout the South China Sea, able to observe, report and if necessary strike. As I argued in Attachment 1, this is the high payoff area, where their impact is greatest and unique amongst ADF assets.
To be able to exploit the initiative gained from their stealth, Australia's submarines must be able to covertly reach sensitive areas throughout our region with sufficient mobility, endurance and payload for the long duration missions involved, frequently in or through demanding tropical waters.
Against this setting how many submarines does Australia require?

Before turning to the calculation I'll make two points based on practical observation that are unlikely to change for the next generation submarine.
The first is the 'rule of three'. Like aircraft and helicopters, submarines operate under a strict maintenance regime, and are designed to provide a high level of serviceability at sea and to avoid catastrophic failure of a key system (and in the worst case, loss of the submarine). Given sufficient qualified personnel, this regime determines submarine availability; from three submarines, typically one will be in maintenance/refit, one will be training/preparing for a

deployment and one will be available for deployment or deployed. Submarines come in threes.

The second observation is that a force of six submarines, i.e. typically with three or four available or at sea (1/3 in maintenance/refit under the rule of three) will struggle to achieve sufficient sea days to generate enough of the highly skilled/long training time personnel such as commanding officers, engineers and senior technicians to man the four to five crews *and* provide the essential shore supervisory staff in the Submarine Squadron and policy areas. In support of this contention I'd cite the perennial shortages in these categories across the Oberon and now the Collins submarine force for the 40+ years I've been working in or observing it.

My modelling of these training pipelines demonstrates that a force of at least nine submarines, i.e. typically six at sea is the minimum to achieve a sustainable critical mass of specialist/experienced personnel. The RAN has survived hitherto by lateral recruiting qualified personnel from other navies—not a reliable basis for manning a core capability.
Turning to the maths, this calculation starts with the requirement. Geography is a major factor; it's ~ 3,000 nautical miles from HMAS Stirling in Perth to the southern end of the South China Sea via the three to five choke points on a typical transit route for a conventional submarine. Without being specific about the scenario, it's therefore likely that Australia will wish to be capable of maintaining a deterrent submarine presence at very long ranges, say 3,500 nm.

- For practical deterrence I suggest that Australia should be able to sustain at least two submarines in this area, to offset the risk that a single submarine could be effectively neutralised as a deterrent by its mobility restrictions in the event of counter-detection by adversary forces .
- This would provide maximum strategic effect at lower risk.
- Concurrently, Australia would also wish to provide submarines closer to home in support of Task Force operations, for special force missions or training own ASW units.

The issue of concurrent roles and an 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. So how many submarines does Australia require for a strategic impact given this geography?

Geography helps determine the number of submarines required for a credible deterrent capability. But that's not the end of the story. The characteristics of the submarines themselves are also important.

- For example, the speed of advance is the critical factor in determining how long it will take a submarine to complete the transit to and from a patrol area.
- This speed is determined not only by the submarine's own design, but

also by external factors such as weather, ocean currents, the need to remain covert to achieve the mission and level of ASW surveillance/threat.

- Design features of the submarine, such as hull shape and the rate at which it can recharge its batteries (and their capacity) will determine how it performs in those environments.
- Not all designs are equal; these features are all critical attributes that need to be balanced and optimised in the design of the future submarine.
- My brief summary understates the challenge and complexities involved in achieving this.

The external factors will vary during the course of a transit and the mission profile will be adapted ‘on the fly’ to accommodate these variations.

- Typically the submarine will ‘snort’ (run its diesels to recharge the batteries) at a slow speed and for a limited time, exploiting local acoustic and environmental conditions where possible to reduce counter detection risks, before going deep to run at higher speed using power from the battery to cover the ground.
- To avoid snorting in a high threat/surveillance situation in the choke points enroute to the patrol area, it's possible that an air independent propulsion system may have to be used—though that's generally a limited resource..

To assess the impact of these factors, I've developed a simple model including the time necessary training of crews, maintenance and using assumptions based on typical performance figures made possible by exploiting modern propulsion and battery technologies for the next generation submarine.

- Modelling the transit timing with an allowance for the practical and navigational obstacles indicates that a force of eight high capability future submarines would have to be dedicated to the task to maintain one continuously on task at 3,500 nautical miles.
- Each mission would typically involve 35 days transit to and from the patrol area, in a tactical posture responsive to the threat/surveillance environment, and 35 days on patrol—a total mission time of 70 days.
- Two such missions per year are probably the limit for crew effectiveness and retention. This regime would provide some relief from this cycle and time for other employment.

It'd be prudent to be able to provide at least one additional, operational submarine for other, concurrent tasks such as Task Group support at closer ranges or for own ASW force training. Allowing for the rule of three, this would require a total force of at least 12 submarines.

This calculation illustrates the process of determining the number of submarines Australia might require to deal with a contingency.

- It's at the minimalist end of the spectrum, with little allowance for attrition or the unexpected.
- The strategic situation may also require additional deployed submarines—see my earlier point of maintaining two on patrol at long range.

The cumulative requirement could sustain an argument for a total force of 15 or 18 submarines to provide for attrition and the flexibility to meet a range of circumstances. I should note that the calculation is particularly sensitive to the availability of submarines; these figures are based on 66% (i.e. the one in three rule).

Summing up,

- Twelve submarines is the minimum force size to enable Australia to sustain one deployed at long range in a demanding but practical cycle, provide one operational submarine available for other tasking and have some capacity for ASW training or other contingencies.
- The deployment mix is one for the strategic judgment of the Government of the day and will depend on the circumstances they face.
- As a minimum, for a sustainable manpower base we should have at least nine submarines.

P Briggs
23Sep14

First version of submission no. 17

Submission to The Economics Reference Committee: Naval Shipbuilding Inquiry – Future Submarine Project

30September 2014

RADM P Briggs AO CSC RAN Rtd & CDRE Terence Roach AM RAN Rtd

Introduction

1. This Submission is based on our collective experience in Oberon class submarines, the COLLINS project and developing concepts for Future Submarine (FSM).

- Peter Briggs assisted Deep Blue Tech's (DBT) developments of the A1, A2 and A3 FSM concepts.
- Neither author has a current commercial relationship with any potential FSM designers or builders.

2. The 'Greybeards' salute the recent passing of one of its members; Oscar Hughes whose wise counsel will be sorely missed – his words live on in this submission.

3. Our intervention now comes because of the criticality of timely decisions required if a capability gap is to be avoided.

4. This Submission is consistent with the advice the Greybeards have provided to successive Governments since delivering the Future Underwater Warfare Capability, Industry and Political (FUCIP) Study to the Department of Defence in December 2006.

5. The starting point for any analysis is Australia's requirement for a submarine capability.

WHY Submarines for Australia?

The Top Level Capability & Its implications

6. The 2009 and 2012 Defence White Papers both provided an adequate strategic setting, we will not reiterate it here.

7. We need to focus on the stand out attributes of submarines:

- **Able to operate in areas without air or sea control.**
- **Able to watch, listen, evaluate and act where necessary.**
- **These attributes result in a unique intelligence, surveillance and reconnaissance platform, providing an early warning of intentions.**

- **Defending against a capable submarine force is expensive and the outcome uncertain – hence submarines deter an escalation to conflict.**
- **Submarines offer unique options to Government in all scenarios.**
- **Australian Submarines are a valued contribution to Allied efforts.**

8. This capacity is based on the submarine's key attribute - **STEALTH** giving access to sensitive/critical areas denied to other vehicles and surveillance systems.

9. The high pay off areas for submarines are close to an opponent's operating bases and associated training areas. A large submarine is therefore required because of our geography; further discussion is at Attachment 1.

10. Given the right **ENDURANCE** [1] and **PAYLOAD** [2] capacity, submarines offer strategic options in Australia's future, constrained circumstances + huge uncertainty for an opponent -> **DETERRENCE.**

11. To achieve this effect they must:

- Have the endurance, stealth and payload to reach and operate effectively in sensitive areas throughout region.
- Maintain a capability edge over opposing ASW capabilities.
- Be operated proactively, exploiting the initiative gained and where appropriate, acting offensively.

12. Points of note:

- Submarines are the only ADF force element with these characteristics.
- A smaller submarine, or even a large submarine lacking the necessary range, endurance and payload, operating in a sea denial role in our maritime approaches reduces these options to defending against an opponent who has the initiative and offers the Australian Government significantly fewer choices.
- A capability edge over regional submarine and ASW forces requires an enduring/long term defence industry capability for SM R&D, design, construction and support – this national capability is also essential for a parent navy.

Key Issues

Capability Gap

[1] Endurance is a combination of mobility (fuel and energy), habitability (food and crew support systems) and availability of sensor/platform systems (equipments, power, cooling, redundancy and onboard repair capability).
[2] Payload is the capacity/flexibility to carry/deploy specialist personnel teams, a range of weapons, remotely operated vehicles/off-board sensors – the latter are the next capability frontier/force multiplier for submarines.

13. We must avoid a capability gap between COLLINS and an operational FSM capability – two aspects are of particular note:

- The need to avoid a repeat of the Oberon/COLLINS transition drop in the number of operational submarines that decimated the RAN SM Arm manpower in the late 1990s and from which we have only recently recovered.
- A capability gap in the 2030s would leave Australia without an operational edge against growing regional submarine and ASW capabilities.

Life Extension Program for Collins

14. Prevarication by successive Governments has made a Life Extension Program (LEP) for Collins difficult to avoid.

15. We should recognize that a COLLINS LEP would be:

- Expensive and demanding technically.
- Risky - difficult to guarantee the operational outcome/cost/availability.
- N**ot provide the operational edge needed in the 2030s** – 80/90s technology will always struggle against a more modern design.
- Consume scarce resources - time, submarine technical expertise in Industry/Defence and $s – all better spent on FSM.
- Constrain choices for the future – these resources are finite.

16. Whilst a Collins LEP should be considered as a contingency plan, Government would be prudent to keep its options open and:

- **Australia should avoid the risks and unknowns of an LEP if possible.**

SM Design 101 - NO MOTS

17. In simple terms a SM has to have sufficient buoyancy or volume to support its payload when it is underwater, i.e. it is neutrally buoyant.

18. If you add more fuel (or any other payload) then you have to take out an equivalent weight or increase the volume. These adjustments must be positioned so as to maintain the fore and aft balance of the submarine.

19. Simply lengthening it by adding hull sections to add volume only works so far, once you get to a length:beam ratio of 1:11 the shape becomes less efficient, requiring more energy to propel it; it is also less agile and noisier.

20. At this point increasing the volume requires an increased hull diameter – it is no longer the same design!

21. It is safer to let the designer get all your parameters on the table and

design a SM with the volume to carry the payloads required by the capability.

22. Some may see this as a huge risk, but trying to stretch/adapt an existing submarine design with the restrictions this places on the designer is actually more difficult and a higher risk in our opinion.

23. Anything/everything you touch in a SM design interacts with other features of the design. A simple and partial example arising from increasing the volume, eg by adding a hull section for an AIP capability to an existing design:

- More generating capacity is required for the long transits, either larger diesels or more of them.
- These need more fuel.
- If larger diesels are required a larger diameter pressure hull may also be required to accommodate them with the necessary quieting measures.
- Supporting systems such as cooling and switchboards may need to be enhanced, etc.

24. The result is a substantially new design.

25. All the roads lead to this decision point for FSM;

- A MOTS is not feasible, a new design is required (though the DMO has spent several years and $M re-validating the same analysis that preceded the development of the COLLINS design).

26. The next key questions are:

- What baseline do you wish to start from?
- In our case we have two principal choices - COLLINS with 20 years experience (good and bad) in our operating environment, or another existing design:
  - e.g. Soryu.
- Leading to the second question:
  - Who do you wish to partner with to develop and build FSM?

<u>A Developmental Project</u>

27. Germany, UK, France, Sweden and the USA all use sole source design/builders for their contemporary submarine programs.

- New designs are undertaken as a developmental project, evolving from the current in service experience, often with substantial changes to the platform and systems to accommodate requirement growth or lessons learnt.
- The USN technique is the best described of the project management techniques used. It is termed an Integrated Production, Process Development (IPPD) design/build process.
- IPPD uses a seamless process and avoids the traditional step by step

design process with a period between each phase whilst decisions on proceeding were taken; often leading to delays, design changes and cost escalation. [3]

- Life cycle costs are considered at every stage of development.
- IPPD has resulted in designs being completed much more rapidly than the traditional process.
- Individuals with knowledge of the construction process are involved throughout, minimizing the requirement/costs for re-work.

28. Australia has yet to settle on a design/build process for FSM; precious time and $s have been expended without a clear focus on the steps to deliver a new submarine.

- The DMO's process driven approach developed for 'off the shelf' acquisitions is poorly suited to undertake a developmental project using an IPPD process.

A Japanese Solution?

29. The recent discussion in the press on the possible acquisition of Japanese submarines for Australia to replace the COLLINS Class raises a number of issues:

- There is no publicly available information on the performance, roles and missions of Japanese Submarines.
- Apart from the Air Independent Propulsion system, the platform and combat system components are Japanese, developed in an environment isolated from competition with Western/NATO suppliers amplifying concerns about the level of their performance.
- Hence it is difficult to come to any judgment on how well these submarines could meet Australian capability requirements in our unique operating environment.
- Australia must be absolutely confident that FSM will possess a capability edge throughout their operational lives; their primary purpose, to fight and win, must be paramount.

30. Table 1 below provides a comparison of the Soryu and COLLINS class submarines using publicly available information.

[3] Sustaining US Nuclear Submarine Design Capabilities, *John F Schank, Mark V Arena, Paul DeLuca, Jesse Riposa, Kimberly Curry Hall, Kimberly Curry,* Rand Corporation

Characteristic	Soryu	Collins	FSM Requirement	Remarks
Surface Displacement (tonnes)	2950*	3100	Not less than Collins	Regularly quoted displacement in media for Soryu (4200 tonnes) is submerged displacement, which means that Soryu carries 1300 tonnes of ballast water. Useable space on-board is determined by the surfaced displacement. Without the AIP section, Soryu has less useable volume than Collins. Note: since Soyru is a double hulled design some of the ballast tanks may be convertible to fuel tanks, improving the useable volume calculation.
Range (NM)	6000 @ 6.5 knots	9000 @ 10 knots	Not less than Collins	Australian operations require long distance transit to reach patrol area within a reasonable timeframe. Soryu is not designed for long transits.
Top Speed	Similar	Similar	Similar	
Diesel Generators	2 x 1400 kW	3 x 1400 kW	Not less than Collins	Similar diesel design on Soryu and Collins. Less installed power results in longer snorting time and reduced stealth.
Propulsion	5900 kW	5400 kW	Not less than Collins	The higher installed power on Soryu is required due to the extra ballast water carried when submerged.
Combat System	C2 (Japanese)	AN/BGY-1 (US/Aus)	Updated version of AN/BGY-1 (US/Aus)	US based combat system fully integrated on Collins. Integration of US combat system into Soryu required.
Torpedoes	Type 89 – (Japanese)	MK 48 (US/Aus)	MK 48 (US/Aus)	MK 48 torpedoes fully integrated on Collins. Integration of US combat system into Soryu required.
Missiles	Harpoon	Harpoon	Harpoon	
Crew	65	58		
Legislation and Naval Requirements	Japanese	Australian	Australian	Modification of Soryu is required to meet Australian safety and technical regulatory standards.
Operational Life	16 years	28 years	Not less than Collins	Changes in design and support philosophy required for Soryu. New maintenance program required.

Table 1 – A Comparison of some characteristics of the Soryu and COLLINS Class submarines

32. It is apparent therefore that SORYU would need to be heavily modified to meet the Australian requirements, particularly for long ocean transits and patrols. This would carry cost, performance and schedule risks and will amount to a new design; it will not be a Military Off The Shelf (MOTS) acquisition.

33. The design philosophy is also an important factor to be considered in modifying and owning a submarine:

- The Japanese submarines are reportedly retired at a much earlier age (about 16 or so years) than normally expected in the Western world, which will require Australia to invest heavily in special maintenance and upgrade programs unless we do the same.
- This policy is important; through-life support is the most expensive component of the cost of ownership.

34. The Coles Review highlighted the vital importance of establishing through life logistic support arrangements in Australia during the submarine construction phase. For this to be done successfully it is critical that Australia has full access to those technologies that underpin Australia's Submarine Force strategic interests – otherwise the effectiveness of the new submarines will always be reliant on the relationship with the overseas parent navy and its industry base.

35. COLLINS experience demonstrated that the required transfer of technology can only be gained through the construction of the first submarine in an Australian shipyard and that the associated risks could be successfully managed.

36. The cultural differences between European ship and submarine builders have been sufficient to cause significant problems for the COLLINS Class Submarine Project and the Air Warfare Destroyer, as set out in the McIntosh/Prescott Report [4] on COLLINS and the recent Winter/White report on AWD:

- The prospects for difficulties arising from cultural differences with Japan are all too apparent and very real.
- To expect to access all relevant technologies during the course of an overseas build of such a complex vessel as a submarine for the initial collaboration with a country, which has no experience in such matters, is extraordinarily ambitious and inherently risky.

37. A change in design intent, including system design, build strategy and operating and maintenance philosophies (and the associated logistics chains) from the COLLINS to SORYU will introduce extra risk and cost and disruption

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[4] Report to the Minister for Defence on the Collins Class Submarine and Related Matters, *Malcolm Kenneth McIntosh and John B Prescott,* CW of Australia 1999.

to the program and ultimately to the Navy's submarine capability.

- It will also require two submarine programs for very different platforms to be run in parallel, at a much greater cost, until all the Collins submarines are withdrawn from service.

38. Careful, measured consideration of risks must be undertaken - a Japanese solution for the Future Submarine must address these issues. Based on the assessment possible from the limited amount of information available this does not seem to have been done.

39. The practicalities of establishing a transparent dialogue with Japan, a country that has no established protocols with Australia for the exchange of classified, sensitive technical data and which must develop regimes to regulate this dialogue seem to have been ignored. It is certain that this will be a very protracted process.

40. Despite the apparent political attraction to this solution if media statements can be believed, [the 'best conventional submarines in the world' etc.] it seems most unlikely that they are as capable as COLLINS and almost certainly cannot offer the sort of improvements required in Australia's FSM Considerable development would be required before a SORYU or its successor could achieve this.

41. Nor can continuing political support in Japan be assumed, the current positive atmosphere is highly dependent on the personal commitment of the Japanese PM; a position that has changed 14 times in the last 15 years:

- This represents a large and unquantifiable sovereign risk for a FSM program based on a Soryu class submarine.

42. The $20B program cost being used in the media softeners lacks any details or credibility; for example, does it include the 25-30% contingency appropriate for a developmental project with the risks and issues identified above?

43. Finally, all this will take time; time we do not have if a capability gap is to be avoided.

44. We do have time to do it properly - using Collins as an indicator, the contract was signed in 1987 and the first submarine was delivered in 1996. While there were issues to resolve, this was a nine-year design and build program for the first of class from a greenfield site.

- There is still time to deliver the first of class FSM in 2027, providing we stop wasting time and money on fruitless studies and GET ON WITH IT.

Australian Design Environment

45. An Australian design environment would aim to achieve and sustain ownership of the design for future development. It does not mean we undertake the design; rather we should engage a selected major conventional submarine designer to undertake this whilst developing Australian expertise and specialist manpower and transfer the skills and IP necessary to undertake the in service design authority role.

46. Advantages of an Australian design environment include:

- Optimum access to US and European technology:
  - We will require assistance from both sources.
- Allows total cost of ownership to be minimised.
- Strong demonstration of long term investment in Australian engineering and shipbuilding skills.
- Enables cost/capability trade offs + cost and capability caps.
- Essential to obtain real cost as opposed to academic extrapolations.
- Maximises opportunities for DSTO & Australian Industry involvement.
- Best use of our limited resources to manage!

Australian Construction

47. As a starting point for this consideration we will briefly review the results achieved by the COLLINS project:

- The Collins program was completed with an average schedule delay of about 26 months and within 3-4% of the original contract price after allowing for inflation.
  - If all the extra expenditure on improvements is included the project came within 20% of the original budget. [5]
  - This is a commendable result for a development project of this complexity; a contingency of 20-25% would have been reasonable, in which case it would have been within budget.
  - In approving the Project the Government imposed an arbitrarily cost cap, resulting in an effective contingency of <5%, compounding the challenge of rectification of shortcomings.
- The Project's aim to expend at least 70% of expenditure in Australia was comfortably exceeded. [6]

  - "*This money was paid to many sub-contractors large and small throughout Australia, and with the money came new technology and training, and an emphasis on quality control previously foreign to Australian industry.*"

[5] The Collins Submarine Story, *Peter Yule & Derek Woolner,* Cambridge University press, 2008, p325.
[6] Ibid, p327.

- Construction standards, demonstrated by weld rejection rates and hull circularity were excellent, exceeding international norms.
- There were a significant number of design and system defects requiring rectification in the newly built submarines, this was undertaken by ASC, supported by DSTO, the USN and industry.
  - Kockums played a limited role.
  - I believe this was due to its limited R&D capacity, compounded by exhaustion of its contingency for the project and commercial distractions in Sweden; the company was sold shortly afterwards to TKMS.
  - ASC designed the 'fixes' and Kockums, the Designer, subsequently certified these.

  - *"It is often forgotten, in the rush to apportion blame for the things that went wrong, that the vast majority of things went right and that Kockums as the designer and ASC as the contractor – with the guidance of the project team – were responsible for these."* [7]

  - ASC subsequently took over the role of in service Designer and continues to discharge this role.
- The majority of the detailed design work for COLLINS was undertaken at ASC, by 40 Australian and 20 Swedes as part of an overall design team of approximately 300. Kockums oversaw the production of the drawings necessary to construct the submarines. [8]
- The spinoffs from COLLINS construction were significant and widespread.
- The availability problems that have caused such poor ongoing public perception of the submarines arose from poor support arrangements.
  - These started when the RAN rejected the Project's logistics support plan in the mid 1990s as too expensive.
  - What followed has proved to be far more expensive – as you would expect!
  - The RAN (and DMO as their agent) struggled to come to grips with their role as a parent Navy.
  - It has taken many years and several reviews [9] to rectify this situation.
- In its final report the Coles Review found a major improvement in COLLINS availability as its recommendations were implemented:

  - *"Submarine availability has improved significantly with the submarine force currently achieving usually two and frequently three submarines materially available on any one day. This steady and measured improvement has provided the opportunity for three submarines to be*

[7] Ibid, p326.
[8] Ibid, p136.
[9] Study Into the Business of Sustaining Australia's Strategic Collins Class Capability, Phase III November 2012, Phase IV March 2014

> *deployed simultaneously at great distances from their home port during 2013, thus stress testing the robustness of the improving logistical support arrangements.*
>
> *Progress towards achieving benchmark performance is equally impressive."* [10]

47. We would argue that viewed against other contemporary submarine projects such as the USN's SEAWOLF or RN's ASTUTE:

- COLLINS was better than average, ie the reality is far better than the public perception.
- COLLINS is a sound starting point for FSM.
- The RAN now has 19 years of experience operating the submarine in our environment to feed into the FSM design development process.

48. There are substantial benefits of construction in Australia, these include:

- Establish the engineering and technical knowledge to support the through life evolution of what will be a uniquely Australian design.
- If the Project is appropriately structured, the Designer function can become a national capability, offering the benefits of an Australian Design Environment cited above.

49. The Senate has previously produced a Report [11] into the costs and benefits of Australian naval construction, these will not be reiterated here, however local construction will be particularly important for FSM given its unique design and strategic importance.

<u>Nuclear Power</u>

50. Australia's requirement for long range transits provides a strong argument for the mobility of a nuclear powered submarine. Adopting nuclear power for FSM is not practical for a number of reasons:

- The manning required for the larger western SSNs (VIRGINIA and ASTUTE), each of which has crew of over 100 (VIRGINIA crew is more than double that of a COLLINS) is not available and may never be sustainably achievable.

[10] Ibid, Progress review – March 2014, page i.
[11] Senate Standing Committee Foreign Affairs, Defence and Trade: Blue water ships: consolidating past achievements, 7 December 2006, Ch 11 Economic Benefits

- The lead time to develop sufficient nuclear engineering knowledge and skills to oversee an acquisition program is probably in the order of 10-15 years.
    - For example, the University of NSW has just reopened Australia's only nuclear engineering faculty following a short sighted decision to close it down in 1975.
- The lead time for an SSN capability would require an LEP for COLLINS with all that would entail for Australia's submarine capability.
- The French Barracuda class SSN currently under construction is much smaller and with a crew of 60 would offer a more practical manning option.
    - The practicality of installing of US weapons and combat system components would be an issue for early resolution in developing this option.

51. Given the lead time, it would be prudent for current planning to consider a nuclear propulsion option for follow on batches of FSM, ie following the replacement of the COLLINS class by 6 conventional submarines, with a possible decision point to then move to nuclear propulsion in subsequent batches.

Conclusions

52. Submarines are a critical strategic capability for the uncertain times ahead.

53. Australia's requirements and geography demand a larger submarine; trying to stretch an existing design is a high risk proposal with limited capability to grow to meet future changes.

54. If possible, Australia should avoid the distraction, expense, risks and capability gap arising from an extension to the life of COLLINS.

55. The current focus on a Japanese solution is misdirected and a distraction from the correct path to achieve the required FSM capability.

56. Selecting the most appropriate design partner is the next key step, this should be done by undertaking a competitive Project Definition Study (PDS) to provide costed, fixed price bids for the design and construction of FSM in Australia, including proposals from the contenders to achieve this in time to avoid an LEP for Collins if practicable:

- An Australian led PDS, utilising reputable European designers is the correct way ahead.
- This would provide Government with the information and maximum options for the key decisions necessary to avoid a capability gap

57. The possibility of a nuclear propulsion option in future acquisition post COLLINS replacement should also be included in the PDS considerations.

58. We should recognize that the standard Defence procurement processes are ill placed to manage the short fuse developmental project that is now required and move to a more efficient structure able to drive a developmental project against the tight time scales now required.

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25Sep14

Attachment:

1. Does Australia need to be able to operate submarines independently at long range?
2. How Many Submarines?

Does Australia need to be able to operate submarines independently at long range?

An excellent question.

Submarine Critical/Unique Characteristics

There are a number of critical and unique submarine characteristics that make submarines so effective.

The first is stealth, the ability for a well handled submarine to exploit the laws of physics and avoid detection enable it to operate in areas where we do not have air or sea control.

It is the only platform in the ADF to be able to do so.

The second is its performance as a sensor platform, particularly a passive sonar platform. In effect a submarine is a large, manned and mobile collection of arrays operating across the spectrum from sub acoustic to visual, able to position for best effect, observe, interpret and react or respond.

My final set of critical characteristics is endurance and payload capacity.

I define ***endurance*** is a combination of ***mobility*** (fuel and energy to complete a transit quickly and securely, undertake a patrol and return), ***habitability*** (food and crew support systems) and ***availability of sensor/platform systems*** (equipments, power, cooling, redundancy and onboard repair capability). This must be accomplished with a workable minimum of fuel, food and systems remaining.

I define ***payload capacity*** is the ability, ***flexibility*** and ***adaptability*** to enable the submarine to carry and deploy a range of payloads such as specialist personnel teams, a range of weapons and remotely operated vehicles/off-board sensors – the latter are the next capability frontier/force multiplier for submarines.

In summary, a capable submarine is the ultimate stealth platform, able to operate without fuss in areas where sea and air control is not assured and to gain access to areas denied to others.

Exploiting The Unique Impact Of Submarines

A submarine operated to exploit these characteristics can create great uncertainty for an opponent.

It is able observe operations in key training and trial areas otherwise denied to comprehensive observation across all spectra, providing long term intelligence of intentions and capabilities.

During a period of tension they are able to report deployments, providing an invaluable indication and warning and enable counteraction to neutralise the deploying platform.

This capability is particularly advantageous in anti submarine warfare, a priority for Australia, where the ability to operate close to an opponent's bases greatly increases effectiveness.

In all scenarios submarines are a force multiplier, facilitating diplomatic action and military preparedness moves to avoid an ultimate confrontation.

During a period of conflict a submarine is able to use its characteristics to undertake a range of measured and precise offensive actions to shape or control a confrontation. In addition to the traditional torpedo, a capable submarine's arsenal extends to the delivery of mobile, highly precise sea mines and land, sea or air strike using missiles.

Across the spectrum of conflict, submarines are an invaluable contribution to the Allied intelligence picture.

In short, a capable submarine, exploiting these characteristics, operated proactively, with initiative and where appropriate, offensively is able to exert a significant deterrent effect.

The Geography

To be able to exploit the initiative gained from their stealth, Australia's submarines must be able to covertly reach a potential opponent's sensitive areas throughout our region. **It is a fact of geography that most of these areas are at long range from Australia.**

Australia should avoid a **dependency** on forward bases to conduct submarine operations; access to such bases cannot be guaranteed. The reduction in operational security through the use of such base reduces the submarine's freedom of action and adds to the hazards faced by our submarines.

The use of a depot ship, requiring a forward base with appropriate protection to support it suffers from similar limitations with the added disadvantages of the diplomatic and strategic indication provided by its deployment. The capital cost of acquisition/sustainment and additional people to crew it also make this a more expensive option.

Independent Operations

It follows from the reality of Geography and the roles that there will no near, friendly base for re-supply or support. Australia's submarines must carry the onboard redundancy, skills and spares to sustain the submarine against a range of mission critical defects.

Defending Closer To Home

Arguments that Australia's submarines should be used defensively and constrained to defending the sea approaches to Australia, using the Indonesian Archipelago as a barrier to channel the approaching opponents would deny Australia the initiative, priceless intelligence and ability to influence the development of a situation that can be gained by imaginative use of a capable submarine force well forward in the high payoff/high risk areas in situations across the whole spectrum of likely contingencies, rather than simply the least likely, 'last-ditch, defend the moat scenario'.

A strategy based on operating submarines within or close to the Indonesian Archipelago also requires Indonesian support or risks attracting Indonesian opposition. It would be a foolish strategy to rely on Indonesian support in all circumstances.

The areas south of the Archipelago is one where we can expect to have a degree of sea and air control. There are other maritime and air platforms in the ADF that can more cost effectively operate in this situation.

There is a also significant possibility that Australian submarines deployed under such a strategy will be in the wrong place at the wrong time and lack the ability to quickly reposition – there are several WW II examples of this situation.

Finally, there are a large number of options for passage through the Archipelago – a large force of submarines would be required to guarantee closing them all off.

Regardless of the size of Australia's submarine force, a 'defend the ditch' strategy surrenders the initiative to the opponent who may well calculate that he should be able to avoid the defending submarines.

A submarine force only able to be deployed close to home foregoes the unique advantages set out above has significantly less deterrent value across the spectrum of contingencies.

The Answer Is YES

Australian submarines must be able to operate independently at long range, with sufficient endurance and able to carry the payloads required for the long duration missions involved, frequently in or through hot tropical waters.

Attachment

How Many Submarines?

The starting points for this discussion are:

- The criticality of the maritime environment for Australia's prosperity,
- The impact of growing regional maritime power and The need to look for capabilities that will give future Australian Governments options to cope in this emerging situation and hence the requirement for long range, long endurance, survivable submarines is the.

This brief addresses the question:
How many submarines does Australia need, to provide sufficient 'strategic impact' to make a potential aggressor avoid a military confrontation with Australia?
The question is an important one given the 'interesting' strategic circumstances ahead of us.
It's worth re-iterating that the submarine's most fundamental, key feature is its stealth. Given this attribute, a well-handled submarine is able to operate without causing fuss in areas where sea and air control isn't assured, and to gain access to areas denied to other platforms.

- Large submarines, such as COLLINS, are able to operate at long range for weeks, carrying a flexible payload of sensors, weapons and specialist personnel.
- A capable submarine force is probably our most potent anti submarine weapon system, perhaps their most demanding role.
- A potent submarine capability creates great uncertainty for an adversary: countering them is difficult, expensive and can't be guaranteed.

Given the unfolding strategic landscape, my starting assumption is that our submarine force must be capable of operating and surviving north of the archipelago, throughout the South China Sea, able to observe, report and if necessary strike. As I argued in Attachment 1, this is the high payoff area, where their impact is greatest and unique amongst ADF assets.
To be able to exploit the initiative gained from their stealth, Australia's submarines must be able to covertly reach sensitive areas throughout our region with sufficient mobility, endurance and payload for the long duration missions involved, frequently in or through demanding tropical waters.
Against this setting how many submarines does Australia require?

Before turning to the calculation I'll make two points based on practical observation that are unlikely to change for the next generation submarine.
The first is the 'rule of three'. Like aircraft and helicopters, submarines operate under a strict maintenance regime, and are designed to provide a high level of serviceability at sea and to avoid catastrophic failure of a key system (and in the worst case, loss of the submarine). Given sufficient qualified personnel, this regime determines submarine availability; from three submarines, typically one will be in maintenance/refit, one will be training/preparing for a

deployment and one will be available for deployment or deployed. Submarines come in threes.

The second observation is that a force of six submarines, i.e. typically with three or four available or at sea (1/3 in maintenance/refit under the rule of three) will struggle to achieve sufficient sea days to generate enough of the highly skilled/long training time personnel such as commanding officers, engineers and senior technicians to man the four to five crews *and* provide the essential shore supervisory staff in the Submarine Squadron and policy areas. In support of this contention I'd cite the perennial shortages in these categories across the Oberon and now the Collins submarine force for the 40+ years I've been working in or observing it.

My modelling of these training pipelines demonstrates that a force of at least nine submarines, i.e. typically six at sea is the minimum to achieve a sustainable critical mass of specialist/experienced personnel. The RAN has survived hitherto by lateral recruiting qualified personnel from other navies—not a reliable basis for manning a core capability.
Turning to the maths, this calculation starts with the requirement. Geography is a major factor; it's ~ 3,000 nautical miles from HMAS Stirling in Perth to the southern end of the South China Sea via the three to five choke points on a typical transit route for a conventional submarine. Without being specific about the scenario, it's therefore likely that Australia will wish to be capable of maintaining a deterrent submarine presence at very long ranges, say 3,500 nm.

- For practical deterrence I suggest that Australia should be able to sustain at least two submarines in this area, to offset the risk that a single submarine could be effectively neutralised as a deterrent by its mobility restrictions in the event of counter-detection by adversary forces .
- This would provide maximum strategic effect at lower risk.
- Concurrently, Australia would also wish to provide submarines closer to home in support of Task Force operations, for special force missions or training own ASW units.

The issue of concurrent roles and an 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. So how many submarines does Australia require for a strategic impact given this geography?

Geography helps determine the number of submarines required for a credible deterrent capability. But that's not the end of the story. The characteristics of the submarines themselves are also important.

- For example, the speed of advance is the critical factor in determining how long it will take a submarine to complete the transit to and from a patrol area.
- This speed is determined not only by the submarine's own design, but

also by external factors such as weather, ocean currents, the need to remain covert to achieve the mission and level of ASW surveillance/threat.

- Design features of the submarine, such as hull shape and the rate at which it can recharge its batteries (and their capacity) will determine how it performs in those environments.
- Not all designs are equal; these features are all critical attributes that need to be balanced and optimised in the design of the future submarine.
- My brief summary understates the challenge and complexities involved in achieving this.

The external factors will vary during the course of a transit and the mission profile will be adapted 'on the fly' to accommodate these variations.

- Typically the submarine will 'snort' (run its diesels to recharge the batteries) at a slow speed and for a limited time, exploiting local acoustic and environmental conditions where possible to reduce counter detection risks, before going deep to run at higher speed using power from the battery to cover the ground.
- To avoid snorting in a high threat/surveillance situation in the choke points enroute to the patrol area, it's possible that an air independent propulsion system may have to be used—though that's generally a limited resource..

To assess the impact of these factors, I've developed a simple model including the time necessary training of crews, maintenance and using assumptions based on typical performance figures made possible by exploiting modern propulsion and battery technologies for the next generation submarine.

- Modelling the transit timing with an allowance for the practical and navigational obstacles indicates that a force of eight high capability future submarines would have to be dedicated to the task to maintain one continuously on task at 3,500 nautical miles.
- Each mission would typically involve 35 days transit to and from the patrol area, in a tactical posture responsive to the threat/surveillance environment, and 35 days on patrol—a total mission time of 70 days.
- Two such missions per year are probably the limit for crew effectiveness and retention. This regime would provide some relief from this cycle and time for other employment.

It'd be prudent to be able to provide at least one additional, operational submarine for other, concurrent tasks such as Task Group support at closer ranges or for own ASW force training. Allowing for the rule of three, this would require a total force of at least 12 submarines.

This calculation illustrates the process of determining the number of submarines Australia might require to deal with a contingency.

- It’s at the minimalist end of the spectrum, with little allowance for attrition or the unexpected.
- The strategic situation may also require additional deployed submarines—see my earlier point of maintaining two on patrol at long range.

The cumulative requirement could sustain an argument for a total force of 15 or 18 submarines to provide for attrition and the flexibility to meet a range of circumstances. I should note that the calculation is particularly sensitive to the availability of submarines; these figures are based on 66% (i.e. the one in three rule).

Summing up,

- Twelve submarines is the minimum force size to enable Australia to sustain one deployed at long range in a demanding but practical cycle, provide one operational submarine available for other tasking and have some capacity for ASW training or other contingencies.
- The deployment mix is one for the strategic judgment of the Government of the day and will depend on the circumstances they face.
- As a minimum, for a sustainable manpower base we should have at least nine submarines.

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