Unmanned Underwater Vehicle (XLUUV) CONOPS

Com Nav Ops slams another into the next county-

The Navy is embarking on a program to acquire dozens/hundreds of unmanned underwater vehicles (UUV) with [** warning: shocking news ahead! **] no concept of operations (CONOPS) to guide the design. Okay, that was probably the least shocking news you could have read, right? I mean, the Navy hasn't developed a CONOPS for anything other than admiralty promotions in many decades so why would this be any different? We've seen from the LCS program what happens when you commit to a full production program with no CONOPS and no prototype. Way to learn a lesson, Navy.

Since the Navy won't develop a CONOPS, let's see what, if anything, we can come up with, along those lines, for a UUV.

The Navy is developing dozens of different UUV designs in many different sizes. Most are just glorified torpedoes. We'll ignore those as the minor pieces of equipment that they are. Instead, we'll focus on the largest UUV, the extra large unmanned underwater vehicle (XLUUV, also called Orca).

> *… the Navy defines XLUUVs as UUVs with a diameter of more than 84 inches, meaning that XLUUVs are to be too large to be launched from a manned Navy submarine. Consequently, XLUUVs instead will transported to a forward operating port and then launched from pier. The Department of the Navy's March 16, 2021, unmanned campaign framework document states that the XLUUV will be designed "to accommodate a variety of large payloads…." The Navy testified on March 18, 2021, that mines will be the initial payload for XLUUVs. More specifically, the Navy wants to use XLUUVs to, among other things, covertly deploy the Hammerhead mine, a planned mine that would be tethered to the seabed and armed with an antisubmarine torpedo, broadly similar to the Navy's Cold War-era CAPTOR (encapsulated torpedo) mine.[1]*

The XLUUV will be based on the Boeing Echo Voyager with some Navy-specific modifications. That being the case, let's take a look at the Echo Voyager.

> *Echo Voyager is roughly the size of a subway car—it is 51 feet long and has a rectangular cross section of 8.5 feet by 8.5 feet, a weight in the air of 50 tons, and a range of up to 6,500 nautical miles. It can accommodate a modular payload section up to 34 feet in length, increasing its length to as much as 85 feet. A 34-foot modular payload section provides about 2,000 cubic feet of internal payload volume; a shorter (14-foot) section provides about 900 cubic feet.[1]*

Boeing Echo Voyager

Echo Voyager has a maximum speed of 7.8 kts [2] and uses a combination diesel-electric propulsion/power system. On battery, the vessel has a range of 150 miles at 2.6 kts whereupon it must surface and recharge its batteries using its diesel generator.

With a single fuel module in its payload bay, Boeing claims the range is 6,500 miles.[2] I've found no information about the size of the fuel module. The statement that fuel modules are stored in the payload bay is important because that means that the effective payload space is less than the stated specification of 2,000 cu.ft.

The vessel has an obstacle avoidance sonar and inertial guidance.

The maximum dive depth is 11,000 ft.[2]

In 2019, the Navy contracted with Boeing to produce four XLUUVs for $43M which is just under $11M apiece.[2] The contract was later expanded to include a fifth vessel. Funding will come from a Navy Research and Development account similar to the funding mechanism used for the first two LCS.[1]

The preceding description suggests certain operational characteristics that will influence the CONOPS and selection of appropriate missions.

For the poverty stricken Kiwi readers (Australians use a cost is no object model so it is hard to get VFM into the consideration), I would say running with fully kitted and spurred sea gliders as mines that would come in at about USD700k would get you 60 to play with to go and sort some CONOPS, doctrine and tactics for the same price as the Goobies with 4 of these monsters. Plus the added bonus of avoiding that well known loser - the Mark 54

CONOPS Characteristics

Speed – As noted, the vessel is very slow. The maximum speed is 7.8 kts and, presumably, the economical cruising speed is much less. Given the statement about the range on battery being 150 miles at 2.6 kts, this suggests that the cruising speed is 2-3 kts. This has a major impact on operations. For example, pier launch and lack of forward bases means that for Chinese theater operations the nearest launch point (disregarding Japan which is not a guaranteed base of combat operations), Guam, would be around 2100 miles from the South China Sea. Even at the maximum speed of 7.8 kts, the transit time to the South China Sea would be around ten days and a more economical cruising speed of, say, 3 kts, would result in around a thirty day transition time.

Payload – This is a small vessel with a correspondingly small usable payload. Consider the Navy's main postulated mission: laying Hammerhead mines. How many mines could fit in a 2000 cu.ft. payload space? I can't find any specs on the Hammerhead capsule size, however, there is a picture of the Hammerhead package so a reasonable estimate of the package size is possible. Knowing the Mk54 torpedo size, we can visually estimate the overall package size. Assuming the package is sized to fit a 21" torpedo tube, this gives us approximate dimensions of 21" x 21" x 19 ft, for a total of 58 cu.ft. Simple arithmetic tells us that the maximum number of mines that could be carried in the 2000 cu.ft. payload space would be 34. However, there needs to be room to move and secure the mines during loading. It would be reasonable to assume that half the payload space would be dedicated to movement and securing the mines which would reduce the capacity to 17 mines. Some sort of mine handling and ejection mechanism is required and that would further reduce the number of mines. If the fuel module is also stored in the main payload section, the number of mines is even smaller. A reasonable estimate would be a mine capacity of around 12. See, ref [3] for an interesting discussion of this.

Hammerhead Mine Capsule

Range – On the face of it, the claimed range of 6,500 is excellent and suggests that not only can the vessel reach its operating area and return (4200 miles round trip from Guam to the South China Sea) but it will have enough excess range to effectively operate for an extended period within the operating area. However, as noted, the submerged range is only 150 miles on a single battery charge. Thus, in order to achieve the claimed range of 6,500 miles, the vessel will have to surface frequently … a very bad requirement for a submarine operating in enemy waters!

Communications – I've found no mention of communications in any description of the vessel which implies that once launched, the XLUUV will be largely autonomous. Aside from being very dubious about the success of a truly autonomous vessel for any length of time, this suggests that the vessel's usefulness in the surveillance role will be limited as that would require frequent and lengthy transmissions from the UUV back to its port - communications that would quickly pinpoint the vessel's location for the enemy and given the UUV's very slow speed, it would be quickly destroyed.

Concept of Operations (CONOPS)

In attempting to assemble a CONOPS, what do we have to work with? We have a small vessel with a small payload (small on the scale of contributing to a war effort). The vessel, itself, is very slow and unresponsive. As with any submerged vessel, communications will be difficult once a mission is started.

So, what does that suggest for a CONOPS?

It suggests that the only viable missions are those that are very slow developing and can afford to wait for very long periods of time and can be effective with very small payloads.

While various articles have postulated virtually every mission ever conceived in the history of warfare, there are only two viable missions that meet the criteria and constraints described above:

Mine Laying – An XLUUV can be effective as a mine layer but with a significant caveat: it is only useful and effective for a very small area. Typically, mines are deployed in the thousands to tens of thousands for a single field. The very small payload of the XLUUV precludes using it to lay a large field no matter how many XLUUVs we acquire. That only leaves point mining of a very small area such as a channel or entrance to a harbor or a narrow passage between islands. For example, one could imagine productively mining the entrance/exit to a Chinese naval port.

Surveillance – Given the combination of limited sensors, limited field of view, very slow speed (inability to follow a target), and communication issues, the only type of surveillance mission that would make sense is monitoring a very small, restricted area as described in the mine laying section. In such a scenario, the XLUUV becomes, essentially, a static sensor and targets come to it (or not – that's useful information, too). The caution is that any important and restricted area will be heavily patrolled by the enemy. Whether the craft is quiet enough to escape close scrutiny is unknown. It will have to be extremely quiet since it will have no ability to fight back or maneuver to avoid detection. Further, the extremely limited battery life that requires frequent surfacing to recharge is a major liability in this mission. Without knowing exactly how stealthy the XLUUV can be (factoring in frequent surfacing for recharging), surveillance is a pretty iffy mission.

Rationale

Given the lack of worthwhile missions, why is the Navy so enthusiastic about building these UUVs? What is their rationale? Cheapness, compared to a real submarine, is obviously a major factor and if the XLUUV had even a fraction of a real sub's capability, this might make sense … but it does not.

Does the Navy really view these as a cheap replacement for real subs? That would be hard to believe but we're replacing Burkes with small, defenseless, unmanned surface vessels so … maybe. Could they, in some twisted way, view them as a cheap, indirect replacement for surface ships in the overall force structure?

Is it technology for its own sake?

Is it sheer, unmitigated stupidity?

A handful for the limited mine laying mission is reasonable but any more than that cannot be justified and yet the Navy seems committed to a large production run and making these a significant portion of the future fleet structure. It's baffling.

Conclusion

It is very difficult to postulate a worthwhile concept of operations other than the very limited mine laying mission described above, although that single mission does have some value. That does not, however, seem to justify the acquisition of more than a handful of XLUUVs – certainly not the large program the Navy seems to want to pursue.

Acquisition of this XLUUV will require a supply/support logistics train, administration, operators, specialized equipment, specialized maintenance, etc. Does the limited scope of useful missions justify all this? I'm doubtful.

This seems to be yet another case of the Navy jumping on the unmanned technology bandwagon for no demonstrable good reason; technology for the sake of technology.

This also continues the trend of minimizing the value of raw firepower in combat, as the XLUUV offers no significant firepower.

At best, this is a niche mission/craft with a significant cost in terms of acquisition and support.
Therefore a MUST HAVE for a Navy we know quite well

I wonder if one of the NAO recommendations is - AFAP, ensure the colonies subsidise your program; the western arm of Antipodeans are the easiest mark.

This report examines whether the Department has managed to reduce the risks to affordability in its Plan
https://www.nao.org.uk/report/the-equipment-plan-2021-to-2031/

missed this one in January:
Now I get the drumbeat: our current generation SLG haven't got the stamina to attend so many Commissioning Pi55 Ups.
https://www.navyrecognition.com/index.php/focus-analysis/naval-technology/11310-analysis-list-of-chinese-navy-vessels-commissioned-in-2021.html

Can Defence convert money to capability?

from ASPI last week

Marcus indicates he was confused in his final statement; but I'd gathered that earlier when he linked the APS with hard work. APS don't do hard work -they do busy work hard! Real hard! If the top end of town rewarded knowledge versus 'I've got the certificate' based work, Marcus would probably still be over there sipping his brew and looking contentedly at his work as he explains its finer points to the new-joins.

It's a brutal time to be a Commonwealth public servant working on the budget. Portfolio additional estimates statements—the mid-year budget update for portfolio agencies—were tabled on February 11, yet with the 2022–23 budget brought forward to late March to clear the decks for the election, we're only a month and a half away from budget night. In essence, the worker bees have been working on the PAES and next year's budget simultaneously.

So, what can we learn from their hard work? First of all, as we have now become accustomed to seeing, the government has delivered the growing defence funding promised in its strategic documents such as the 2016 white paper and the 2020 strategic update. The issue that we'll come to is whether Defence can spend it—and spend it in ways that deal with our strategic environment.

The main changes in Defence's funding are a $463.1 million no-win, no-loss foreign exchange adjustment to maintain buying power in the face of a declining Australian dollar and $91.8 million more for Operation Covid-19 Assist. Defence is also transferring a further $56.5 million to the Office of the Special Investigator next year. Coming on top of the initial $116.5 million moved from Defence to fund the OSI in last year's mid-year update, it suggests that the investigation of potential war crimes in Afghanistan still has a long way to go.

There's some good news. There are signs that the long trajectory of de-skilling of the public service and outsourcing of core capabilities has finally bottomed out. There's provision for an additional 540 public servants—190 this year and a further 350 next year—to implement crucial new programs such as the sovereign guided weapons enterprise and AUKUS. Hopefully the government has acknowledged that you can't double the size of your capital investment program while gutting your in-house expertise and still hope to be a 'smart buyer', to use Defence's own term. The continuing sorry narrative of project cancellations shows that Defence is far from it. THE problem is that de-skilling has been going on for over a generation and it started with a thump at the initial Commercial Support Program (CSP) and then an almost immediate uppercut via the Defence Efficiency Review DER. So the current top of the town got there by somebody recognizing their traits as useful to that somebody's aims. We can see the traits but we cannot see who that somebody was, maybe we should check with Immigration to see if Loki visited in the 1990s. Doesn't take long for uncertainty to coalesce into very deep pools of error when everything is written off as complex. Reading the words they spruik to the Senators, it seems pretty clear they have no idea what skills they lost; so the big question is how will they re-establish the right ones.

That gets us to Defence's capital investment program. If we cast our minds back to the 2021–22 budget, the key question there was whether Defence could spend the substantially increased capital budget the government was providing it with. In 2020–21 Defence did well in the face of Covid-19 to set spending records in its acquisition programs, but it still fell about $1 billion short of the target. With a further increase of around $3 billion planned for this year, there was always going to be a question mark over Defence and its industry partners' ability to turn that money into capability.

At a high level, the PAES indicate Defence will fall short again. The acquisition program is predicted to come in $815 million under the original budget target. When we consider that the acquisition program should also be spending a big chunk of the $463.1 million foreign exchange adjustment, it looks like it will again fall around $1 billion short.

But it's when we look under the bonnet that things get interesting—and troubling. The military equipment acquisition program looks like it's doing very well, actually passing its $11.2 billion target by $120.6 million (noting that it needs to overspend to address the foreign exchange adjustment). But there's a clear pattern in the top 30 spenders for the year; the big projects are falling well short of their spending goals, and one of the iron laws of project management is when you don't spend, you don't get the capability on schedule.

The F-35A project is missing by $175 million, with only 54 aircraft delivered instead of 56 by the end of 2021–22. Two fewer aircraft may not seem like much, but with the classic Hornet fleet now fully retired, the air force needs every plane it can get. The Triton high-altitude UAV program is $98 million short between equipment and infrastructure.

Spending on the Hawkei protected mobility vehicle is $207 million short, due to a delay caused by a problem with its brakes and supply-chain woes. That means it will spend less than last year even though it's meant to be entering full-rate production. The Boxer combat reconnaissance vehicle similarly is nearly $300 million short of its target and spending less this year than last. Somewhat depressingly, by the end of this financial year the project will still have spent more than $1.8 billion with only the first block of 25 overseas-built vehicles delivered and local construction of the remainder not due to *start*until 2023.

The list goes on. The troubled Hunter frigate program is $123 million under and will barely spend more this year than last. It's not the trajectory you'd want to see as design activity ramps up and purchases of long-lead-time items such as combat-system and propulsion-train elements start. And while the government has made a lot of announcements about long-range missiles, they haven't transformed into spending; the navy's guided weapons subprogram is falling well short of its planned outlay (from $210 million down to $74 million) and is another big program spending less than last year ($190 million). Even a project that is spending and delivering broadly on schedule, the Arafura offshore patrol vessel, isn't delivering lethal capability. A vessel that was massively undergunned in the first place is now being delivered virtually unarmed. Don't worry about it Marcus, history says that girl won't have enough power to keep the crew's phones and game consoles charged; let alone manage any Mighty Mo style Marcus upgun attempt.

And true to form, the MRH-90 helicopter failed to achieve one final time, missing its target by $106 million 'due to delay in its delivery schedule'. Its cancellation did not come soon enough.

Ironically, one of the few big projects that's still forecast to hit its spending target for the year is the future submarine program that was cancelled less than a quarter of the way into the financial year. It's hard to know what to make of that. The PAES says that funds are being transferred to the nuclear-powered submarine taskforce and to cover costs 'associated with transitioning out of contractual arrangements', but will that really use up $981 million this year? In any event, we're still some way from knowing the final cost of the Attack-class saga. If that full amount is actually used up, it will get us perilously close to $3 billion.

The top 30 projects are a combined $1.9 billion under their planned budget for the year. No doubt the pandemic is playing a major role, but overall it's not the sort of narrative that's consistent with the one laid out in the government's 2020 defence strategic update of evaporating warning times and a pressing need for new capabilities delivered faster, not slower than previously planned.

That huge shortfall is offset by some degree by an $860 million increase in spending in the rest of the military equipment program (those projects outside the top 30). That would suggest a significant amount of opportunity spending, but there's nothing in the PAES to say what we're getting for that sum. Is it new stuff like additional Seahawk Romeo helicopters, or is it simply bringing forward spending on things that were already in the plan like tanks? Or something else entirely?

A final admission of my inability to make sense of the document. Table 9 states that the estate and infrastructure program will underachieve by $682.5 million. Yet when one looks at the program in more detail in table 66, it appears to be spending $593.7 million more on individual infrastructure projects than planned in the budget. A large part of that is flowing into the Northern Territory, no doubt providing a welcome Covid-19 stimulus. Defence hasn't responded to my request for an explanation on how you can spend nearly $600 million more than planned but end up nearly $700 million short of what you planned. Perhaps at estimates hearings senators can elicit a plain-English explanation.

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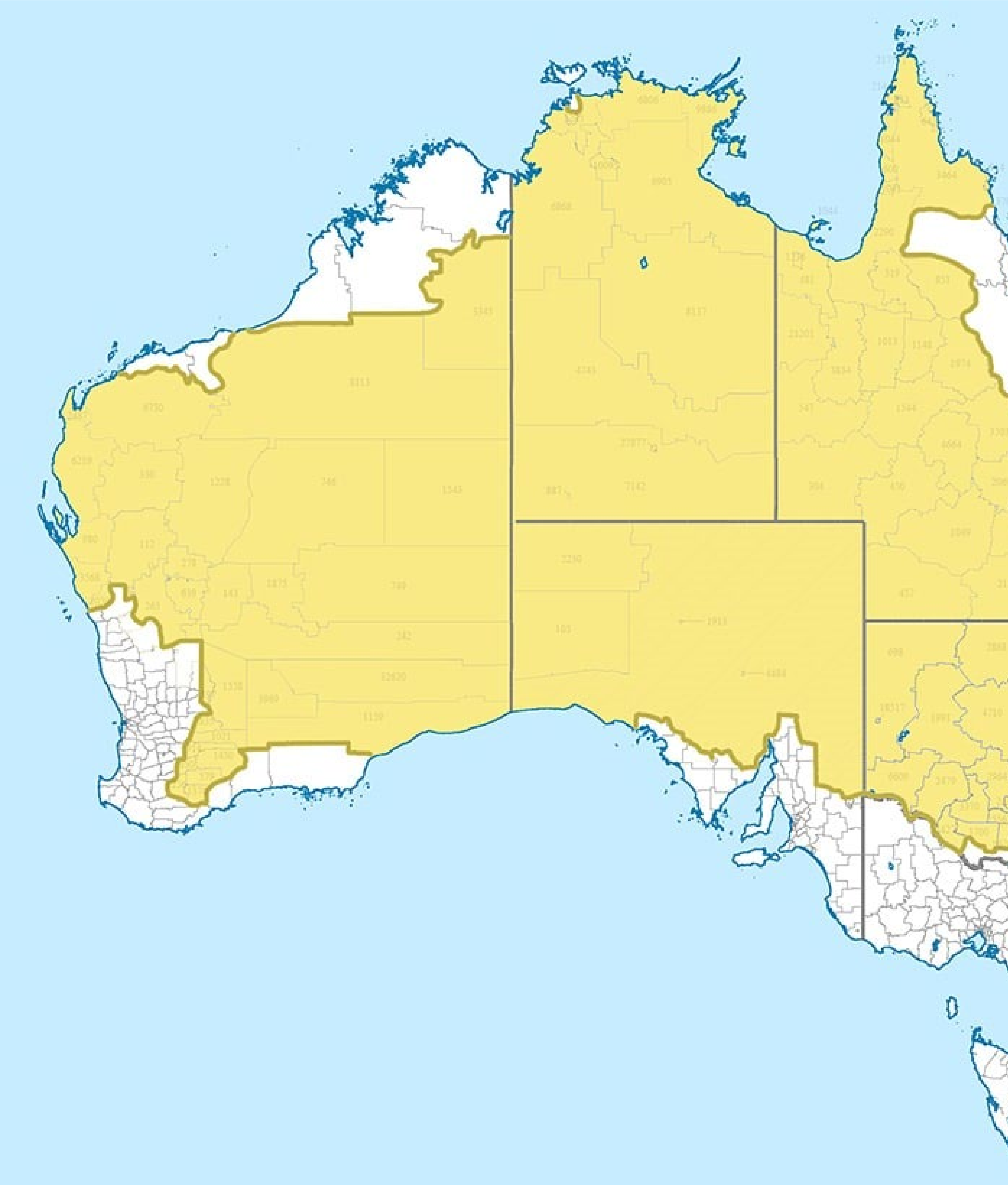
Sea country, climate change and Indigenous knowledge

21 Feb 2022|Mibu FischerNorth of 26° south

I often Talk of the GAFA and the MAMOFA (the Great Australian.../More And More Of...) and this article is a good focus on why I bang on about local knowledge being important in defence of the homeland. I was blessed to work with the Jenners who, for years and years, used to camp for months and months on some pretty barren looking Islands in the Kimberly to Study the local marine fauna. Wealth of info, but you have to weave that info into your own experience for it to mean anything that you can apply to doctrine and tactics, same with what Mibu says. When I worked in the Sponge, it was like way too many of the crowd thought the whole of Australia was like the Kingston precinct. Big ship mentality seemed to mean it was ok to be ignorant about so many things. I just found this reasonably inaccurate but far better than nothing schematic that shows in yellow where <2% of Australia's population live. I'd reckon the whole top of WA should be yellow -I read recently that there are 47000 permanent residents in the patch west of Darwin round to Exmouth Gulf. Back in the 70s, when the west was opening up -the Japanese sent some real heavies down here to find out what the place was - I was detailed off as the driver, the Japanese interpreter, a local Indigeneous diver reflecting the place's history, WA Fisheries wheel Col Ostle and the Japanese visitors had a ball, the DFAT rep was constantly appalled by everybodies' behaviour (especially the tour of the Japanese aircraft shoot up sites of March 1942); seeing a potential international incident every second of their stay. But I reckon those Japanese after their 3 day stay would have gone home knowing more about the NW than anyone I worked with in Canberra. Of course people there probably knew more but I never met them in 27 years in Tinsel Town. The potential of the uninhabited vehicles to do great work in concert with the local indigenous surveillance units just fills me with a longing for somebody at the top to just say 'get on with it'.



Extending beyond Australia's 30,000 kilometres of coastline are millions of hectares of 'sea country', which encompasses the flora and fauna, beliefs and cultural practices of the many Indigenous groups that care for these areas. The Australian coastline has receded over the past 35,000 years, with an estimated two million hectares inundated as climate systems changed. This land, though now submerged, still has significant cultural connections for many traditional custodians.

Aboriginal and Torres Strait Islander peoples hold the knowledge of past responses to climate change, but our ability to continue to add to this body of knowledge is limited.

Past generations were able to freely move and adapt to a changing climate. Today, many Aboriginal and Torres Strait Islander communities that are being impacted and will continue to be impacted by climate change rely on Western management systems, imposed through colonisation, to address the issues they face. On the island of Masig in the Torres Strait, storm surges, higher king tides and rising sea levels are inundating roads, graveyards, freshwater supplies and homes. With current sea-level rise in the region at 6–8 millimetres per year, some islands are likely to become uninhabitable.

The impacts on communities are likely not to end there. The indirect impacts—as a result of ocean acidification, temperature increases on the sea surface and species redistribution—will influence traditional and economic resources, along with culturally important species and practices.

In northern Australia, it's predicted that cultural species such as turtles will suffer nesting site loss due to sea-level rise. Even where nests survive, ocean temperature increases will result in a skewed gender ratio among hatchlings, with the potential for all-female populations in some nesting areas. Among human populations, there will be direct impacts on health from increased heat stress and spread of disease, such as mosquito-borne illnesses.

In the south, the Tasmanian Aboriginal shell-stringing community is already noticing changes to the culturally important species of maireener shells. Western-led scientific studies are yet to confirm whether these changes are linked to climate change, but increased ocean acidification is a likely driver. Decreased abundance and increased shell brittleness may also be caused by increasing ocean temperatures and a reduction in kelp beds due to habitat destruction from invasive sea urchins.

One of the biggest unknowns is the effect that increased storm surges, cyclones and rising tides will have on Australia's coastlines. Climate change and other human activities are reducing the capacity of natural coastal defence systems—such as seagrass meadows, mangroves, saltmarshes, dunes, beaches, shellfish reefs and coral reefs—to protect our shores. Many communities will lose significant cultural sites and species, resources, spiritual connections and food sources. This will have numerous flow-on effects, including impacts to mental health and wellbeing.

The recognition of Indigenous knowledge and traditional ecological knowledge as a science is increasing among natural resource scientists, researchers, managers, practitioners and policy partners, especially since the Black Summer bushfires of 2019–20. While appreciation of the effectiveness of traditional firestick fire-management techniques is expanding across the country, the idea that this knowledge also extends beyond our shores and into our coastal and marine environments is still new for many. In a recent survey, most marine scientists who responded acknowledged the importance of Indigenous engagement, but many were unsure of how to weave it into their research practices.

There are some important considerations for researchers, practitioners and policy partners who want to include an Indigenous perspective in their work. Perhaps foremost among these is reframing the idea that traditional custodians are stakeholders who need to be engaged in addition to and in the same way as other stakeholder groups. Aboriginal and Torres Strait Islander peoples are rights and title holders under international and national frameworks and legislation such as the UN Declaration on the Rights of Indigenous Peoples and the Commonwealth *Native Title Act 1993*. The engagement of Aboriginal and Torres Strait Islander communities needs to reflect these rights and involve traditional custodians in the earliest project stages. Included in these rights is the principle of 'free, prior and informed consent', which is considered standard practice for Indigenous communities.

There's a move towards co-designed and Indigenous-led marine and coastal management. This shift is about balancing the power dynamics and knowledge governance between traditional custodians and government departments, organisations and researchers. The inclusion and use of Indigenous knowledge frameworks are one way to empower and weave Indigenous rights and knowledge into marine and coastal management arrangements. Internationally, the 'Two-eyed seeing' or Etuaptmumk (in Mi'kmaw) framework as explained by Mi'kmaw Elder Albert Marshall is an example of an Indigenous framework that has been used in research. It is a guide to seeing through one eye with strengths and ways of knowing from the Indigenous lens, seeing through the other eye with the strengths of Western ways of knowing and then using both eyes together to find benefits for all. In Australia, the eight-ways pedagogy framework has been used by some scholars.

Aboriginal culture is the longest continuous culture on earth. This continuity means that Aboriginal and Torres Strait Islander cultures are living and can change in response to interactions with different societies, environmental factors, new technologies, changing political beliefs and new discoveries. Adequate weaving of Indigenous knowledge in marine and coastal management must involve Aboriginal and Torres Strait Islander processes and protocols and move beyond only including Indigenous knowledge as content.

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N221-059 TITLE: Directional Acoustic Communications Transmitters

OUSD (R&E) MODERNIZATION PRIORITY: Autonomy
yeah yeah a bit of fun -real life can be a lot simpler if people asked to develop these things had a CONOPS
TECHNOLOGY AREA(S): Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop directional acoustic transmitters that can be scaled for use on medium, large, and extra-large unmanned undersea vehicles (UUVs).

DESCRIPTION: The Navy seeks to develop directional acoustic transmitters for use on UUVs. The commercial market lacks directional transducers appropriate for UUV integration/usage due to lack of commercial demand/use cases for such a capability. The closest commercial equivalents would be spherical arrays targeted for vertical (in water column) applications, but such arrays are not suitable for the UUV applications targeted by the Navy. Directional acoustic transmitters will enable the Navy to more effectively conduct UUV swarming operations by reducing mutual interference, as well as more clandestine communications by directing the transmitted acoustic beam pattern main response axis (MRA) toward the intended receive array. Current commercial UUV transmit/receive transducers project omni-directional acoustic energy in all directions, whereas directional transmitters are generally limited to larger manned platforms such as submarines. Development of directional projectors compatible with size, weight, and power (SWaP) constraints of UUVs is challenging. The available SWaP within UUVs varies greatly by class and design, but rough order of magnitude (ROM) allowances are provided in the table below. It is noted that the values in this table are provided for guidance only – they are not to be considered formalized requirements against which the proposals will be adjudicated.

UUV Class	**Medium**	**Large**	**Extra-Large**
ROM Volume:	216 in^3 (6" cube)	1728 in^3 (12" cube)	5832 in^3 (18" cube)
ROM weight in air:	8 lbs	64 lbs	216 lbs
ROM Tx Power:	250W	350W	500W
ROM Standby Power:	5W	10W	20W

These SWaP challenges are exacerbated by the requirement to withstand large hydrostatic pressures experienced during UUV missions. Larger projectors are required to generate narrower/more focused beams, so a prime challenge is optimizing the transmitter to fit within the existing UUV platforms. Another challenge is the pointing of the transmit beam, i.e., its MRA as well as its width while maintaining sidelobe rejection at other angles. For longer ranges (> 1km) acoustic transmission paths are more complex and require knowledge of the environment and a modeling capability. In addition to development of the directional transmitters, proposers should include the pointing method of the resultant beam, control of the beam's sidelobes and the main lobe width, minimizing size, weight, power, and cooling (SWaP-C) associated with the solution, and the novelty of the approach.

The technical merit of the proposed solutions will be evaluated on factors including:

1. Ratio of the energy to the targeted region vs. the energy transmitted over the entire (360°) geographic region
2. Required level of in-situ environmental knowledge in order for the transmitter to point itself and achieve the focused gain described in #1
3. Transmitter gain over a variety of environmental and bathymetric conditions
4. Maximum volume and maximum physical or synthetic transmit aperture dimension
5. Estimated weight of the system
6. Maximum power draw by the transmitter when in use and during standby
7. Suitability of chosen projector technology to operate/survive over the variety of operational depths over which PEO-USC UUVs operate

The company will test the prototype system, first in a controlled laboratory environment, then in an in-water (saltwater) environment, to determine its capability to meet all relevant performance metrics outlined in the Phase II SOW. Testing shall characterize the optimization of directional transducer control, coupled with the communication function, in the presence of interfering and mutual interference of external assets. The company shall demonstrate the prototype system performance in both environments (laboratory and in-water) to the Government and present the results in two separate test reports.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence Security Agency (DCSA), formerly the Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DCSA and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for a directional acoustic transmitter that meets the requirements in the Description. Establish feasibility by developing system diagrams as well as Computer-Aided Design (CAD) models that show the transmitter concept and provide estimated weight and dimensions of the concept. Feasibility will also be established by computer-based simulations that show the transmitter's pointing capabilities are suitable for the project needs. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), develop and deliver a prototype system for in-water testing and measurement/validation of the Phase I performance attributes. Test the prototype system, first in a controlled laboratory environment, then in an in-water (saltwater) environment, to determine its capability to meet all relevant performance metrics outlined in the Phase II SOW. Testing shall characterize the optimization of directional transducer control, coupled with the communication function, in the presence of interfering and mutual interference of external assets. Demonstrate the prototype system performance in both environments (laboratory and in-water) and present the results in two separate test reports to the Government. Use the results to correct any performance deficiencies and refine the prototype into a pre-production design that will meet Navy requirements. P Prepare a Phase III SOW that will outline how the technology will be transitioned for Navy use.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: If successful, in addition to UUV applications, these directional acoustic transmitters could be applied to other unmanned Navy assets including buoys and subsea nodes. These assets have communications requirements, some of which require clandestine communications, for which these directional acoustic transmitters could provide a solution. In addition to such DoD applications, these directional acoustic transmitters could be used in commercial oil, gas, and oceanographic sensing applications, where the prevention of mutual interference between submerged assets is required.

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N221-060 TITLE: Chip Scale Oceanographic Sensor

OUSD (R&E) MODERNIZATION PRIORITY: Microelectronics
another cool toy -at last an answer to my 1988 question in Sydney to the transferee in from MRL
TECHNOLOGY AREA(S): Sensors

OBJECTIVE: Create a chip scale oceanographic sensor that can be integrated onto a ship or unmanned underwater vehicle (UUV) hull to accurately measure ocean water chemistry in real-time.

DESCRIPTION: A new generation of measurement technology is developing new, ultra-compact, ultra-reliable, low-power sensors with accuracy linked by a known degree of error to U.S. standard measurements. Partnerships with industry are developing fabrication processes similar to existing microelectromechanical systems (MEMS) that will manufacture these sensors as a rugged and inexpensive device. These new developments offer a new opportunity for the submarine community to access and utilize environmental data on the outer hull of a submarine. At present, these sensors have not been ruggedized to reliably function in the harsh environments the external hull of a U.S. Navy submarine endures during its service life. This SBIR topic seeks a hull-mounted (i.e., external) chip scale sensor for in-situ monitoring of oceanographic chemical parameters.

To protect against corrosion, a ship's Impressed Current Cathodic Protection (ICCP) distributes electrical energy between sections of the hull. The ICCP control system measures voltages using seawater silver/silver-chloride reference electrodes and adjusts the electrical potentials appropriately. Changes in seawater chemistry near the hull will change the electrical potentials, creating the need for a real-time oceanographic measurement input to the ICCP feedback control. The objective of creating a chip scale sensor should integrate the following threshold oceanographic chemical parameter measurements into a single device without causing interference on the reference electrodes:

- Temperature: 0-50 ± 0.1 °C
- pH: 7-11 ± 0.1
- Conductivity: 1-6 ± 0.001 S/m
- Dissolved oxygen: 1-14.6 ± 0.1 ppm [2]
- Sampling rate of at least one per minute (required)
- Additional chemical parameters of interest include: chloride (±0.1 mg/L), bromide (±0.1 mg/L), sodium (±0.1 mg/L), calcium (±0.1 mg/L), sulfate (±0.1 mg/L), and sulfide (±0.1 mg/L)

These sensors will modernize the ICCP system to provide real-time ambient oceanography measurements that correlate with noise on cathodic protection reference cells. This will enable minimum impressed current emissions while still maintaining cathodic protection of the hull. The Naval Research Lab (NRL) has started modifying the ICCP controller to accept these oceanographic inputs, and has historic studies documenting the correlations between the oceanographic chemical parameters and corrosion polarization curves.

It is essential that the sensors maintain these accuracies under environmental stresses experienced by underwater hulls. These conditions include: temperature 0-50 °C, hydrostatic pressure cycling from 0-10,000 kPa, grade B shock requirements from MIL-DTL-901E [Ref 1] without leakage when subjected to hydrostatic pressure, total suspended solids of 0-120 mg/L, fouling and biofouling over extended deployment periods. Chip scale sensors have been demonstrated for the identified parameters and proposals should identify the sensors that are envisioned for integration. The integrated sensor should fit in a space less than 10.0 cm x 7.5 cm x 5.0 cm, use less than 10 watts of power, meet the Navy's goal of a 20-year lifetime, and utilize low-cost MEMS manufacturing methods. Smaller sensors that meet these requirements will leave space for additional future sensors.

PHASE I: Develop a concept for an integrated sensor that achieves the needed measurement accuracy under temperature and pressure cycling presented in the Description. Determine the feasibility of the concept to meet the described parameters listed in the Description through modeling, simulation, and analysis. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver two prototypes of a chip scale sensors. Modify the sensors as needed and integrate the sensor package into a shipboard ICCP reference electrode holder. Demonstrate the prototype's performance under the necessary environmental stresses: one month in a natural seawater environment where biofouling colonization is prevalent, such as Port Canaveral, FL. Certification of the natural seawater test environment will be conducted by the Naval Research Laboratory and Naval Surface Warfare Center, but the testing and evaluation will be conducted by the performer. Required hydrostatic pressure cycle evaluation will be conducted under laboratory conditions at the Naval Research Laboratory using a seawater pressure chamber. Documentation of all Phase II testing results should include independent parameter measurements documenting required accuracy. Identify the largest costs in manufacturing the sensor and assess cost reduction measures.

Deliver, for the environmental exposure demonstration, two packaged sensors for Navy evaluation.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use through system integration and qualification testing. Integrate the sensor package into the shipboard ICCP architecture and data acquisition system as part of a Temporary Alteration (TEMPALT). Demonstrate environmental exposure operation of the sensor package for a minimum of two years. Implement cost reduction measures and install sensors aboard a ship at multiple reference electrode locations. Mortality analysis and documentation of any failed elements will be required. This sensor can provide a low Size, Weight, Power and Cost (SWAP-C) replacement for existing oceanographic sensors, which are routinely used for oceanographic surveys or environmental ocean monitoring. Reassess and document the largest costs in manufacturing the sensor as well as cost reduction mitigations.

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KEYWORDS: Oceanographic chemical analysis; Microelectromechanical Systems; MEMS; Impressed Current Cathodic Protection; Corrosion Protection; Measurement-science sensor; Underwater Electromagnetic Signatures

From: Greg Jones <gregj7993@gmail.com>
Sent: Tuesday, 22 February 2022, 18:37
To: Christopher donald
Subject: Re: 2022-02-23 Wednesday boats

A very good one Daffy (as they all are). Interestingly, and in my research for the paper made contact with Marcus office. Bugger me, he was on the phone within 10 minutes, I read between the line of his questioning

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From: Christopher donald <daffoir587@gmail.com>
Sent: Tuesday, February 22, 2022 4:07:05 PM
To: Christopher donald <cdonald@velocitynet.com.au>
Subject: 2022-02-23 Wednesday boats

Unmanned Underwater Vehicle (XLUUV) CONOPS

Com Nav Ops slams another into the next county-

The Navy is embarking on a program to acquire dozens/hundreds of unmanned underwater vehicles (UUV) with [** warning: shocking news ahead! **] no concept of operations (CONOPS) to guide the design. Okay, that was probably the least shocking news you could have read, right? I mean, the Navy hasn't developed a CONOPS for anything other than admiralty promotions in many decades so why would this be any different? We've seen from the LCS program what happens when you commit to a full production program with no CONOPS and no prototype. Way to learn a lesson, Navy.

Since the Navy won't develop a CONOPS, let's see what, if anything, we can come up with, along those lines, for a UUV.

The Navy is developing dozens of different UUV designs in many different sizes. Most are just glorified torpedoes. We'll ignore those as the minor pieces of equipment that they are. Instead, we'll focus on the largest UUV, the extra large unmanned underwater vehicle (XLUUV, also called Orca).

> *… the Navy defines XLUUVs as UUVs with a diameter of more than 84 inches, meaning that XLUUVs are to be too large to be launched from a manned Navy submarine. Consequently, XLUUVs instead will transported to a forward operating port and then launched from pier. The Department of the Navy's March 16, 2021, unmanned campaign framework document states that the XLUUV will be designed "to accommodate a variety of large payloads…." The Navy testified on March 18, 2021, that mines will be the initial payload for XLUUVs. More specifically, the Navy wants to use XLUUVs to, among other things, covertly deploy the Hammerhead mine, a planned mine that would be tethered to the seabed and armed with an antisubmarine torpedo, broadly similar to the Navy's Cold War-era CAPTOR (encapsulated torpedo) mine.[1]*

The XLUUV will be based on the Boeing Echo Voyager with some Navy-specific modifications. That being the case, let's take a look at the Echo Voyager.

> *Echo Voyager is roughly the size of a subway car—it is 51 feet long and has a rectangular cross section of 8.5 feet by 8.5 feet, a weight in the air of 50 tons, and a range of up to 6,500 nautical miles. It can accommodate a modular payload section up to 34 feet in length, increasing its length to as much as 85 feet. A 34-foot modular payload section provides about 2,000 cubic feet of internal payload volume; a shorter (14-foot) section provides about 900 cubic feet.[1]*

Boeing Echo Voyager

Echo Voyager has a maximum speed of 7.8 kts [2] and uses a combination diesel-electric propulsion/power system. On battery, the vessel has a range of 150 miles at 2.6 kts whereupon it must surface and recharge its batteries using its diesel generator.

With a single fuel module in its payload bay, Boeing claims the range is 6,500 miles.[2] I've found no information about the size of the fuel module. The statement that fuel modules are stored in the payload bay is important because that means that the effective payload space is less than the stated specification of 2,000 cu.ft.

The vessel has an obstacle avoidance sonar and inertial guidance.

The maximum dive depth is 11,000 ft.[2]

In 2019, the Navy contracted with Boeing to produce four XLUUVs for $43M which is just under $11M apiece.[2] The contract was later expanded to include a fifth vessel. Funding will come from a Navy Research and Development account similar to the funding mechanism used for the first two LCS.[1]

The preceding description suggests certain operational characteristics that will influence the CONOPS and selection of appropriate missions.

For the poverty stricken Kiwi readers (Australians use a cost is no object model so it is hard to get VFM into the consideration), I would say running with fully kitted and spurred sea gliders as mines that would come in at about USD700k would get you 60 to play with to go and sort some CONOPS, doctrine and tactics for the same price as the Goobies with 4 of these monsters. Plus the added bonus of avoiding that well known loser - the Mark 54

CONOPS Characteristics

Speed – As noted, the vessel is very slow. The maximum speed is 7.8 kts and, presumably, the economical cruising speed is much less. Given the statement about the range on battery being 150 miles at 2.6 kts, this suggests that the cruising speed is 2-3 kts. This has a major impact on operations. For example, pier launch and lack of forward bases means that for Chinese theater operations the nearest launch point (disregarding Japan which is not a guaranteed base of combat operations), Guam, would be around 2100 miles from the South China Sea. Even at the maximum speed of 7.8 kts, the transit time to the South China Sea would be around ten days and a more economical cruising speed of, say, 3 kts, would result in around a thirty day transition time.

Payload – This is a small vessel with a correspondingly small usable payload. Consider the Navy's main postulated mission: laying Hammerhead mines. How many mines could fit in a 2000 cu.ft. payload space? I can't find any specs on the Hammerhead capsule size, however, there is a picture of the Hammerhead package so a reasonable estimate of the package size is possible. Knowing the Mk54 torpedo size, we can visually estimate the overall package size. Assuming the package is sized to fit a 21" torpedo tube, this gives us approximate dimensions of 21" x 21" x 19 ft, for a total of 58 cu.ft. Simple arithmetic tells us that the maximum number of mines that could be carried in the 2000 cu.ft. payload space would be 34. However, there needs to be room to move and secure the mines during loading. It would be reasonable to assume that half the payload space would be dedicated to movement and securing the mines which would reduce the capacity to 17 mines. Some sort of mine handling and ejection mechanism is required and that would further reduce the number of mines. If the fuel module is also stored in the main payload section, the number of mines is even smaller. A reasonable estimate would be a mine capacity of around 12. See, ref [3] for an interesting discussion of this.

Hammerhead Mine Capsule

Range – On the face of it, the claimed range of 6,500 is excellent and suggests that not only can the vessel reach its operating area and return (4200 miles round trip from Guam to the South China Sea) but it will have enough excess range to effectively operate for an extended period within the operating area. However, as noted, the submerged range is only 150 miles on a single battery charge. Thus, in order to achieve the claimed range of 6,500 miles, the vessel will have to surface frequently … a very bad requirement for a submarine operating in enemy waters!

Communications – I've found no mention of communications in any description of the vessel which implies that once launched, the XLUUV will be largely autonomous. Aside from being very dubious about the success of a truly autonomous vessel for any length of time, this suggests that the vessel's usefulness in the surveillance role will be limited as that would require frequent and lengthy transmissions from the UUV back to its port - communications that would quickly pinpoint the vessel's location for the enemy and given the UUV's very slow speed, it would be quickly destroyed.

Concept of Operations (CONOPS)

In attempting to assemble a CONOPS, what do we have to work with? We have a small vessel with a small payload (small on the scale of contributing to a war effort). The vessel, itself, is very slow and unresponsive. As with any submerged vessel, communications will be difficult once a mission is started.

So, what does that suggest for a CONOPS?

It suggests that the only viable missions are those that are very slow developing and can afford to wait for very long periods of time and can be effective with very small payloads.

While various articles have postulated virtually every mission ever conceived in the history of warfare, there are only two viable missions that meet the criteria and constraints described above:

Mine Laying – An XLUUV can be effective as a mine layer but with a significant caveat: it is only useful and effective for a very small area. Typically, mines are deployed in the thousands to tens of thousands for a single field. The very small payload of the XLUUV precludes using it to lay a large field no matter how many XLUUVs we acquire. That only leaves point mining of a very small area such as a channel or entrance to a harbor or a narrow passage between islands. For example, one could imagine productively mining the entrance/exit to a Chinese naval port.

Surveillance – Given the combination of limited sensors, limited field of view, very slow speed (inability to follow a target), and communication issues, the only type of surveillance mission that would make sense is monitoring a very small, restricted area as described in the mine laying section. In such a scenario, the XLUUV becomes, essentially, a static sensor and targets come to it (or not – that's useful information, too). The caution is that any important and restricted area will be heavily patrolled by the enemy. Whether the craft is quiet enough to escape close scrutiny is unknown. It will have to be extremely quiet since it will have no ability to fight back or maneuver to avoid detection. Further, the extremely limited battery life that requires frequent surfacing to recharge is a major liability in this mission. Without knowing exactly how stealthy the XLUUV can be (factoring in frequent surfacing for recharging), surveillance is a pretty iffy mission.

Rationale

Given the lack of worthwhile missions, why is the Navy so enthusiastic about building these UUVs? What is their rationale? Cheapness, compared to a real submarine, is obviously a major factor and if the XLUUV had even a fraction of a real sub's capability, this might make sense … but it does not.

Does the Navy really view these as a cheap replacement for real subs? That would be hard to believe but we're replacing Burkes with small, defenseless, unmanned surface vessels so … maybe. Could they, in some twisted way, view them as a cheap, indirect replacement for surface ships in the overall force structure?

Is it technology for its own sake?

Is it sheer, unmitigated stupidity?

A handful for the limited mine laying mission is reasonable but any more than that cannot be justified and yet the Navy seems committed to a large production run and making these a significant portion of the future fleet structure. It's baffling.

Conclusion

It is very difficult to postulate a worthwhile concept of operations other than the very limited mine laying mission described above, although that single mission does have some value. That does not, however, seem to justify the acquisition of more than a handful of XLUUVs – certainly not the large program the Navy seems to want to pursue.

Acquisition of this XLUUV will require a supply/support logistics train, administration, operators, specialized equipment, specialized maintenance, etc. Does the limited scope of useful missions justify all this? I'm doubtful.

This seems to be yet another case of the Navy jumping on the unmanned technology bandwagon for no demonstrable good reason; technology for the sake of technology.

This also continues the trend of minimizing the value of raw firepower in combat, as the XLUUV offers no significant firepower.

At best, this is a niche mission/craft with a significant cost in terms of acquisition and support.
Therefore a MUST HAVE for a Navy we know quite well

I wonder if one of the NAO recommendations is - AFAP, ensure the colonies subsidise your program; the western arm of Antipodeans are the easiest mark.
This report examines whether the Department has managed to reduce the risks to affordability in its Plan
https://www.nao.org.uk/report/the-equipment-plan-2021-to-2031/

missed this one in January:
Now I get the drumbeat: our current generation SLG haven't got the stamina to attend so many Commissioning Pi55 Ups.
https://www.navyrecognition.com/index.php/focus-analysis/naval-technology/11310-analysis-list-of-chinese-navy-vessels-commissioned-in-2021.html

Can Defence convert money to capability?

from ASPI last week

Marcus indicates he was confused in his final statement; but I'd gathered that earlier when he linked the APS with hard work. APS don't do hard work -they do busy work hard! Real hard! If the top end of town rewarded knowledge versus 'I've got the certificate' based work, Marcus would probably still be over there sipping his brew and looking contentedly at his work as he explains its finer points to the new-joins.

It's a brutal time to be a Commonwealth public servant working on the budget. Portfolio additional estimates statements—the mid-year budget update for portfolio agencies—were tabled on February 11, yet with the 2022–23 budget brought forward to late March to clear the decks for the election, we're only a month and a half away from budget night. In essence, the worker bees have been working on the PAES and next year's budget simultaneously.

So, what can we learn from their hard work? First of all, as we have now become accustomed to seeing, the government has delivered the growing defence funding promised in its strategic documents such as the 2016 white paper and the 2020 strategic update. The issue that we'll come to is whether Defence can spend it—and spend it in ways that deal with our strategic environment.

The main changes in Defence's funding are a $463.1 million no-win, no-loss foreign exchange adjustment to maintain buying power in the face of a declining Australian dollar and $91.8 million more for Operation Covid-19 Assist. Defence is also transferring a further $56.5 million to the Office of the Special Investigator next year. Coming on top of the initial $116.5 million moved from Defence to fund the OSI in last year's mid-year update, it suggests that the investigation of potential war crimes in Afghanistan still has a long way to go.

There's some good news. There are signs that the long trajectory of de-skilling of the public service and outsourcing of core capabilities has finally bottomed out. There's provision for an additional 540 public servants—190 this year and a further 350 next year—to implement crucial new programs such as the sovereign guided weapons enterprise and AUKUS. Hopefully the government has acknowledged that you can't double the size of your capital investment program while gutting your in-house expertise and still hope to be a 'smart buyer', to use Defence's own term. The continuing sorry narrative of project cancellations shows that Defence is far from it. THE problem is that de-skilling has been going on for over a generation and it started with a thump at the initial Commercial Support Program (CSP) and then an almost immediate uppercut via the Defence Efficiency Review

DER. So the current top of the town got there by somebody recognizing their traits as useful to that somebody's aims. We can see the traits but we cannot see who that somebody was, maybe we should check with Immigration to see if Loki visited in the 1990s. Doesn't take long for uncertainty to coalesce into very deep pools of error when everything is written off as complex. Reading the words they spruik to the Senators, it seems pretty clear they have no idea what skills they lost; so the big question is how will they re-establish the right ones.

That gets us to Defence's capital investment program. If we cast our minds back to the 2021–22 budget, the key question there was whether Defence could spend the substantially increased capital budget the government was providing it with. In 2020–21 Defence did well in the face of Covid-19 to set spending records in its acquisition programs, but it still fell about $1 billion short of the target. With a further increase of around $3 billion planned for this year, there was always going to be a question mark over Defence and its industry partners' ability to turn that money into capability.

At a high level, the PAES indicate Defence will fall short again. The acquisition program is predicted to come in $815 million under the original budget target. When we consider that the acquisition program should also be spending a big chunk of the $463.1 million foreign exchange adjustment, it looks like it will again fall around $1 billion short.

But it's when we look under the bonnet that things get interesting—and troubling. The military equipment acquisition program looks like it's doing very well, actually passing its $11.2 billion target by $120.6 million (noting that it needs to overspend to address the foreign exchange adjustment). But there's a clear pattern in the top 30 spenders for the year; the big projects are falling well short of their spending goals, and one of the iron laws of project management is when you don't spend, you don't get the capability on schedule.

The F-35A project is missing by $175 million, with only 54 aircraft delivered instead of 56 by the end of 2021–22. Two fewer aircraft may not seem like much, but with the classic Hornet fleet now fully retired, the air force needs every plane it can get. The Triton high-altitude UAV program is $98 million short between equipment and infrastructure.

Spending on the Hawkei protected mobility vehicle is $207 million short, due to a delay caused by a problem with its brakes and supply-chain woes. That means it will spend less than last year even though it's meant to be entering full-rate production. The Boxer combat reconnaissance vehicle similarly is nearly $300 million short of its target and spending less this year than last. Somewhat depressingly, by the end of this financial year the project will still have spent more than $1.8 billion with only the first block of 25 overseas-built vehicles delivered and local construction of the remainder not due to *start*until 2023.

The list goes on. The troubled Hunter frigate program is $123 million under and will barely spend more this year than last. It's not the trajectory you'd want to see as design activity ramps up and purchases of long-lead-time items such as combat-system and propulsion-train elements start. And while the government has made a lot of announcements about long-range missiles, they haven't transformed into spending; the navy's guided weapons subprogram is falling well short of its planned outlay (from $210 million down to $74 million) and is another big program spending less than last year ($190 million). Even a project that is spending and delivering broadly on schedule, the Arafura offshore patrol vessel, isn't delivering lethal capability. A vessel that was massively undergunned in the first place is now being delivered virtually unarmed. Don't worry about it Marcus, history says that girl won't have enough power to keep the crew's phones and game consoles charged; let alone manage any Mighty Mo style Marcus upgun attempt.

And true to form, the MRH-90 helicopter failed to achieve one final time, missing its target by $106 million 'due to delay in its delivery schedule'. Its cancellation did not come soon enough.

Ironically, one of the few big projects that's still forecast to hit its spending target for the year is the future submarine program that was cancelled less than a quarter of the way into the financial year. It's hard to know what to make of that. The PAES says that funds are being transferred to the nuclear-powered submarine taskforce and to cover costs 'associated with transitioning out of contractual arrangements', but will that really use up $981 million this year? In any event, we're still some way from knowing the final cost of the Attack-class saga. If that full amount is actually used up, it will get us perilously close to $3 billion.

The top 30 projects are a combined $1.9 billion under their planned budget for the year. No doubt the pandemic is playing a major role, but overall it's not the sort of narrative that's consistent with the one laid out in the government's 2020 defence strategic update of evaporating warning times and a pressing need for new capabilities delivered faster, not slower than previously planned.

That huge shortfall is offset by some degree by an $860 million increase in spending in the rest of the military equipment program (those projects outside the top 30). That would suggest a significant amount of opportunity spending, but there's nothing in the PAES to say what we're getting for that sum. Is it new stuff like additional Seahawk Romeo helicopters, or is it simply bringing forward spending on things that were already in the plan like tanks? Or something else entirely?

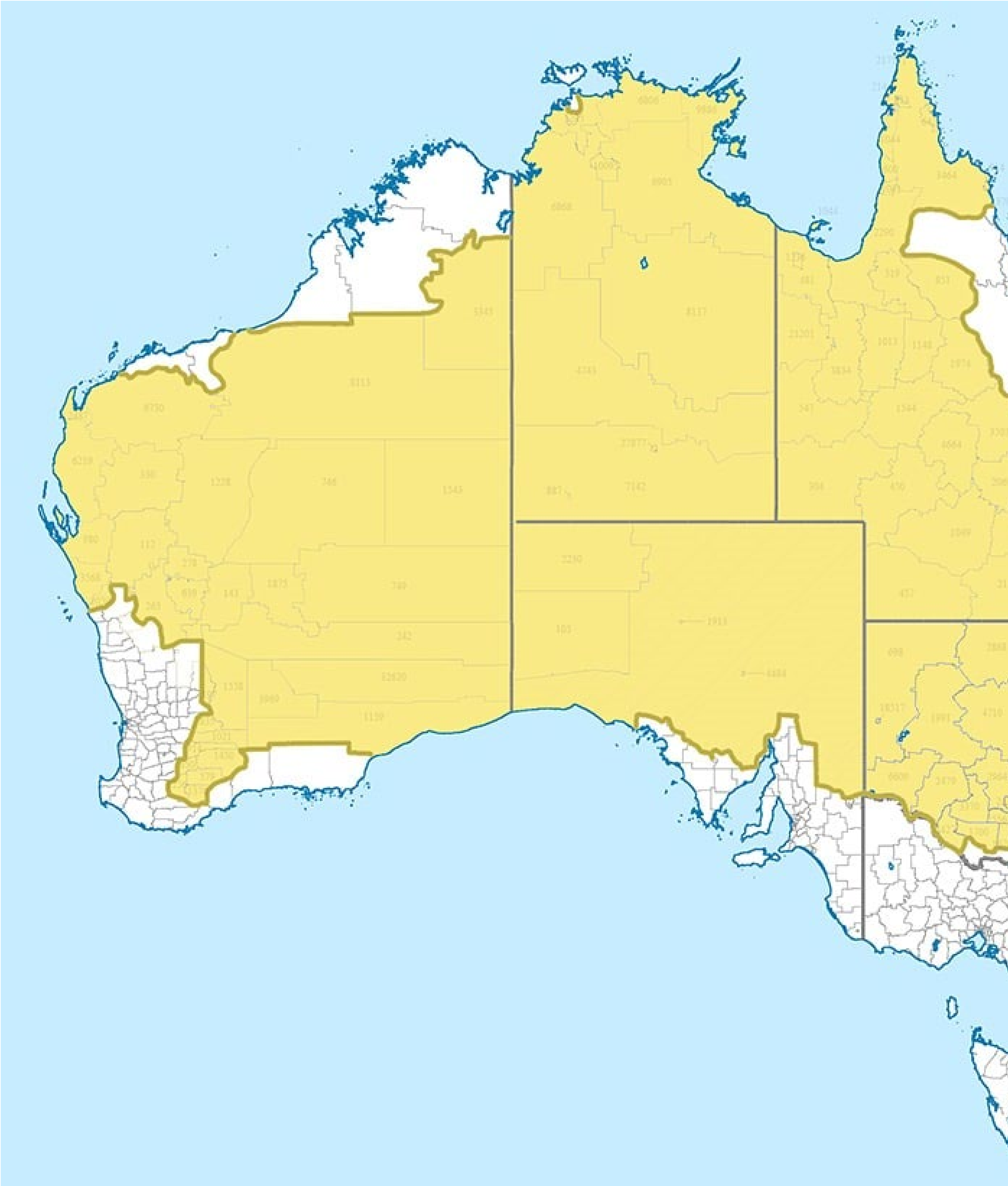
A final admission of my inability to make sense of the document. Table 9 states that the estate and infrastructure program will underachieve by $682.5 million. Yet when one looks at the program in more detail in table 66, it appears to be spending $593.7 million more on individual infrastructure projects than planned in the budget. A large part of that is flowing into the Northern Territory, no doubt providing a welcome Covid-19 stimulus. Defence hasn't responded to my request for an explanation on how you can spend nearly $600 million more than planned but end up nearly $700 million short of what you planned. Perhaps at estimates hearings senators can elicit a plain-English explanation.

***Marcus Hellyer** is ASPI's senior analyst for defence economics and capability.

Sea country, climate change and Indigenous knowledge

21 Feb 2022|Mibu FischerNorth of 26° south

I often Talk of the GAFA and the MAMOFA (the Great Australian.../More And More Of...) and this article is a good focus on why I bang on about local knowledge being important in defence of the homeland. I was blessed to work with the Jenners who, for years and years, used to camp for months and months on some pretty barren looking Islands in the Kimberly to Study the local marine fauna. Wealth of info, but you have to weave that info into your own experience for it to mean anything that you can apply to doctrine and tactics, same with what Mibu says. When I worked in the Sponge, it was like way too many of the crowd thought the whole of Australia was like the Kingston precinct. Big ship mentality seemed to mean it was ok to be ignorant about so many things. I just found this reasonably inaccurate but far better than nothing schematic that shows in yellow where <2% of Australia's population live. I'd reckon the whole top of WA should be yellow -I read recently that there are 47000 permanent residents in the patch west of Darwin round to Exmouth Gulf. Back in the 70s, when the west was opening up -the Japanese sent some real heavies down here to find out what the place was - I was detailed off as the driver, the Japanese interpreter, a local Indigeneous diver reflecting the place's history, WA Fisheries wheel Col Ostle and the Japanese visitors had a ball, the DFAT rep was constantly appalled by everybodies' behaviour (especially the tour of the Japanese aircraft shoot up sites of March 1942); seeing a potential international incident every second of their stay. But I reckon those Japanese after their 3 day stay would have gone home knowing more about the NW than anyone I worked with in Canberra. Of course people there probably knew more but I never met them in 27 years in Tinsel Town. The potential of the uninhabited vehicles to do great work in concert with the local indigenous surveillance units just fills me with a longing for somebody at the top to just say 'get on with it'.



Extending beyond Australia’s 30,000 kilometres of coastline are millions of hectares of ‘sea country’, which encompasses the flora and fauna, beliefs and cultural practices of the many Indigenous groups that care for these areas. The Australian coastline has receded over the past 35,000 years, with an estimated two million hectares inundated as climate systems changed. This land, though now submerged, still has significant cultural connections for many traditional custodians.

Aboriginal and Torres Strait Islander peoples hold the knowledge of past responses to climate change, but our ability to continue to add to this body of knowledge is limited.

Past generations were able to freely move and adapt to a changing climate. Today, many Aboriginal and Torres Strait Islander communities that are being impacted and will continue to be impacted by climate change rely on Western management systems, imposed through colonisation, to address the issues they face. On the island of Masig in the Torres Strait, storm surges, higher king tides and rising sea levels are inundating roads, graveyards, freshwater supplies and homes. With current sea-level rise in the region at 6–8 millimetres per year, some islands are likely to become uninhabitable.

The impacts on communities are likely not to end there. The indirect impacts—as a result of ocean acidification, temperature increases on the sea surface and species redistribution—will influence traditional and economic resources, along with culturally important species and practices.

In northern Australia, it's predicted that cultural species such as turtles will suffer nesting site loss due to sea-level rise. Even where nests survive, ocean temperature increases will result in a skewed gender ratio among hatchlings, with the potential for all-female populations in some nesting areas. Among human populations, there will be direct impacts on health from increased heat stress and spread of disease, such as mosquito-borne illnesses.

In the south, the Tasmanian Aboriginal shell-stringing community is already noticing changes to the culturally important species of maireener shells. Western-led scientific studies are yet to confirm whether these changes are linked to climate change, but increased ocean acidification is a likely driver. Decreased abundance and increased shell brittleness may also be caused by increasing ocean temperatures and a reduction in kelp beds due to habitat destruction from invasive sea urchins.

One of the biggest unknowns is the effect that increased storm surges, cyclones and rising tides will have on Australia's coastlines. Climate change and other human activities are reducing the capacity of natural coastal defence systems—such as seagrass meadows, mangroves, saltmarshes, dunes, beaches, shellfish reefs and coral reefs—to protect our shores. Many communities will lose significant cultural sites and species, resources, spiritual connections and food sources. This will have numerous flow-on effects, including impacts to mental health and wellbeing.

The recognition of Indigenous knowledge and traditional ecological knowledge as a science is increasing among natural resource scientists, researchers, managers, practitioners and policy partners, especially since the Black Summer bushfires of 2019–20. While appreciation of the effectiveness of traditional firestick fire-management techniques is expanding across the country, the idea that this knowledge also extends beyond our shores and into our coastal and marine environments is still new for many. In a recent survey, most marine scientists who responded acknowledged the importance of Indigenous engagement, but many were unsure of how to weave it into their research practices.

There are some important considerations for researchers, practitioners and policy partners who want to include an Indigenous perspective in their work. Perhaps foremost among these is reframing the idea that traditional custodians are stakeholders who need to be engaged in addition to and in the same way as other stakeholder groups. Aboriginal and Torres Strait Islander peoples are rights and title holders under international and national frameworks and legislation such as the UN Declaration on the Rights of Indigenous Peoples and the Commonwealth *Native Title Act 1993*. The engagement of Aboriginal and Torres Strait Islander communities needs to reflect these rights and involve traditional custodians in the earliest project stages. Included in these rights is the principle of 'free, prior and informed consent', which is considered standard practice for Indigenous communities.

There's a move towards co-designed and Indigenous-led marine and coastal management. This shift is about balancing the power dynamics and knowledge governance between traditional custodians and government departments, organisations and researchers. The inclusion and use of Indigenous knowledge frameworks are one way to empower and weave Indigenous rights and knowledge into marine and coastal management arrangements. Internationally, the 'Two-eyed seeing' or Etuaptmumk (in Mi'kmaw) framework as explained by Mi'kmaw Elder Albert Marshall is an example of an Indigenous framework that has been used in research. It is a guide to seeing through one eye with strengths and ways of knowing from the Indigenous lens, seeing through the other eye with the strengths of Western ways of knowing and then using both eyes together to find benefits for all. In Australia, the eight-ways pedagogy framework has been used by some scholars.

Aboriginal culture is the longest continuous culture on earth. This continuity means that Aboriginal and Torres Strait Islander cultures are living and can change in response to interactions with different societies, environmental factors, new technologies, changing political beliefs and new discoveries. Adequate weaving of Indigenous knowledge in marine and coastal management must involve Aboriginal and Torres Strait Islander processes and protocols and move beyond only including Indigenous knowledge as content.

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N221-059 TITLE: Directional Acoustic Communications Transmitters

OUSD (R&E) MODERNIZATION PRIORITY: Autonomy
yeah yeah a bit of fun -real life can be a lot simpler if people asked to develop these things had a CONOPS
TECHNOLOGY AREA(S): Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop directional acoustic transmitters that can be scaled for use on medium, large, and extra-large unmanned undersea vehicles (UUVs).

DESCRIPTION: The Navy seeks to develop directional acoustic transmitters for use on UUVs. The commercial market lacks directional transducers appropriate for UUV integration/usage due to lack of commercial demand/use cases for such a capability. The closest commercial equivalents would be spherical arrays targeted for vertical (in water column) applications, but such arrays are not suitable for the UUV applications targeted by the Navy. Directional acoustic transmitters will enable the Navy to more effectively conduct UUV swarming operations by reducing mutual interference, as well as more clandestine communications by directing the transmitted acoustic beam pattern main response axis (MRA) toward the intended receive array. Current commercial UUV transmit/receive transducers project omni-directional acoustic energy in all directions, whereas directional transmitters are generally limited to larger manned platforms such as submarines. Development of directional projectors compatible with size, weight, and power (SWaP) constraints of UUVs is challenging. The available SWaP within UUVs varies greatly by class and design, but rough order of magnitude (ROM) allowances are provided in the table below. It is noted that the values in this table are provided for guidance only – they are not to be considered formalized requirements against which the proposals will be adjudicated.

UUV Class	**Medium**	**Large**	**Extra-Large**
ROM Volume:	216 in^3 (6" cube)	1728 in^3 (12" cube)	5832 in^3 (18" cube)
ROM weight in air:	8 lbs	64 lbs	216 lbs
ROM Tx Power:	250W	350W	500W
ROM Standby Power:	5W	10W	20W

These SWaP challenges are exacerbated by the requirement to withstand large hydrostatic pressures experienced during UUV missions. Larger projectors are required to generate narrower/more focused beams, so a prime challenge is optimizing the transmitter to fit within the existing UUV platforms. Another challenge is the pointing of the transmit beam, i.e., its MRA as well as its width while maintaining sidelobe rejection at other angles. For longer ranges (> 1km) acoustic transmission paths are more complex and require knowledge of the environment and a modeling capability. In addition to development of the directional transmitters, proposers should include the pointing method of the resultant beam, control of the beam's sidelobes and the main lobe width, minimizing size, weight, power, and cooling (SWaP-C) associated with the solution, and the novelty of the approach.

The technical merit of the proposed solutions will be evaluated on factors including:

1. Ratio of the energy to the targeted region vs. the energy transmitted over the entire (360°) geographic region
2. Required level of in-situ environmental knowledge in order for the transmitter to point itself and achieve the focused gain described in #1
3. Transmitter gain over a variety of environmental and bathymetric conditions
4. Maximum volume and maximum physical or synthetic transmit aperture dimension
5. Estimated weight of the system
6. Maximum power draw by the transmitter when in use and during standby
7. Suitability of chosen projector technology to operate/survive over the variety of operational depths over which PEO-USC UUVs operate

The company will test the prototype system, first in a controlled laboratory environment, then in an in-water (saltwater) environment, to determine its capability to meet all relevant performance metrics outlined in the Phase II SOW. Testing shall characterize the optimization of directional transducer control, coupled with the communication function, in the presence of interfering and mutual interference of external assets. The company shall demonstrate the prototype system performance in both environments (laboratory and in-water) to the Government and present the results in two separate test reports.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence Security Agency (DCSA), formerly the Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DCSA and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for a directional acoustic transmitter that meets the requirements in the Description. Establish feasibility by developing system diagrams as well as Computer-Aided Design (CAD) models that show the transmitter concept and provide estimated weight and dimensions of the concept. Feasibility will also be established by computer-based simulations that show the transmitter's pointing capabilities are suitable for the project needs. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Based on the results of Phase I and the Phase II Statement of Work (SOW), develop and deliver a prototype system for in-water testing and measurement/validation of the Phase I performance attributes. Test the prototype system, first in a controlled laboratory environment, then in an in-water (saltwater) environment, to determine its capability to meet all relevant performance metrics outlined in the Phase II SOW. Testing shall characterize the optimization of directional transducer control, coupled with the communication function, in the presence of interfering and mutual interference of external assets. Demonstrate the prototype system performance in both environments (laboratory and in-water) and present the results in two separate test reports to the Government. Use the results to correct any performance deficiencies and refine the prototype into a pre-production design that will meet Navy requirements. P Prepare a Phase III SOW that will outline how the technology will be transitioned for Navy use.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: If successful, in addition to UUV applications, these directional acoustic transmitters could be applied to other unmanned Navy assets including buoys and subsea nodes. These assets have communications requirements, some of which require clandestine communications, for which these directional acoustic transmitters could provide a solution. In addition to such DoD applications, these directional acoustic transmitters could be used in commercial oil, gas, and oceanographic sensing applications, where the prevention of mutual interference between submerged assets is required.

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N221-060 TITLE: Chip Scale Oceanographic Sensor

OUSD (R&E) MODERNIZATION PRIORITY: Microelectronics
another cool toy -at last an answer to my 1988 question in Sydney to the transferee in from MRL
TECHNOLOGY AREA(S): Sensors

OBJECTIVE: Create a chip scale oceanographic sensor that can be integrated onto a ship or unmanned underwater vehicle (UUV) hull to accurately measure ocean water chemistry in real-time.

DESCRIPTION: A new generation of measurement technology is developing new, ultra-compact, ultra-reliable, low-power sensors with accuracy linked by a known degree of error to U.S. standard measurements. Partnerships with industry are developing fabrication processes similar to existing microelectromechanical systems (MEMS) that will manufacture these sensors as a rugged and inexpensive device. These new developments offer a new opportunity for the submarine community to access and utilize environmental data on the outer hull of a submarine. At present, these sensors have not been ruggedized to reliably function in the harsh environments the external hull of a U.S. Navy submarine endures during its service life. This SBIR topic seeks a hull-mounted (i.e., external) chip scale sensor for in-situ monitoring of oceanographic chemical parameters.

To protect against corrosion, a ship's Impressed Current Cathodic Protection (ICCP) distributes electrical energy between sections of the hull. The ICCP control system measures voltages using seawater silver/silver-chloride reference electrodes and adjusts the electrical potentials appropriately. Changes in seawater chemistry near the hull will change the electrical potentials, creating the need for a real-time oceanographic measurement input to the ICCP feedback control. The objective of creating a chip scale sensor should integrate the following threshold oceanographic chemical parameter measurements into a single device without causing interference on the reference electrodes:

- Temperature: 0-50 ± 0.1 °C
- pH: 7-11 ± 0.1
- Conductivity: 1-6 ± 0.001 S/m
- Dissolved oxygen: 1-14.6 ± 0.1 ppm [2]
- Sampling rate of at least one per minute (required)
- Additional chemical parameters of interest include: chloride (±0.1 mg/L), bromide (±0.1 mg/L), sodium (±0.1 mg/L), calcium (±0.1 mg/L), sulfate (±0.1 mg/L), and sulfide (±0.1 mg/L)

These sensors will modernize the ICCP system to provide real-time ambient oceanography measurements that correlate with noise on cathodic protection reference cells. This will enable minimum impressed current emissions while still maintaining cathodic protection of the hull. The Naval Research Lab (NRL) has started modifying the ICCP controller to accept these oceanographic inputs, and has historic studies documenting the correlations between the oceanographic chemical parameters and corrosion polarization curves.

It is essential that the sensors maintain these accuracies under environmental stresses experienced by underwater hulls. These conditions include: temperature 0-50 °C, hydrostatic pressure cycling from 0-10,000 kPa, grade B shock requirements from MIL-DTL-901E [Ref 1] without leakage when subjected to hydrostatic pressure, total suspended solids of 0-120 mg/L, fouling and biofouling over extended deployment periods. Chip scale sensors have been demonstrated for the identified parameters and proposals should identify the sensors that are envisioned for integration. The integrated sensor should fit in a space less than 10.0 cm x 7.5 cm x 5.0 cm, use less than 10 watts of power, meet the Navy's goal of a 20-year lifetime, and utilize low-cost MEMS manufacturing methods. Smaller sensors that meet these requirements will leave space for additional future sensors.

PHASE I: Develop a concept for an integrated sensor that achieves the needed measurement accuracy under temperature and pressure cycling presented in the Description. Determine the feasibility of the concept to meet the described parameters listed in the Description through modeling, simulation, and analysis. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver two prototypes of a chip scale sensors. Modify the sensors as needed and integrate the sensor package into a shipboard ICCP reference electrode holder. Demonstrate the prototype's performance under the necessary environmental stresses: one month in a natural seawater environment where biofouling colonization is prevalent, such as Port Canaveral, FL. Certification of the natural seawater test environment will be conducted by the Naval Research Laboratory and Naval Surface Warfare Center, but the testing and evaluation will be conducted by the performer. Required hydrostatic pressure cycle evaluation will be conducted under laboratory conditions at the Naval Research Laboratory using a seawater pressure chamber. Documentation of all Phase II testing results should include independent parameter measurements documenting required accuracy. Identify the largest costs in manufacturing the sensor and assess cost reduction measures.

Deliver, for the environmental exposure demonstration, two packaged sensors for Navy evaluation.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use through system integration and qualification testing. Integrate the sensor package into the shipboard ICCP architecture and data acquisition system as part of a Temporary Alteration (TEMPALT). Demonstrate environmental exposure operation of the sensor package for a minimum of two years. Implement cost reduction measures and install sensors aboard a ship at multiple reference electrode locations. Mortality analysis and documentation of any failed elements will be required. This sensor can provide a low Size, Weight, Power and Cost (SWAP-C) replacement for existing oceanographic sensors, which are routinely used for oceanographic surveys or environmental ocean monitoring. Reassess and document the largest costs in manufacturing the sensor as well as cost reduction mitigations.

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KEYWORDS: Oceanographic chemical analysis; Microelectromechanical Systems; MEMS; Impressed Current Cathodic Protection; Corrosion Protection; Measurement-science sensor; Underwater Electromagnetic Signatures