

APDR

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F-35 CONNECTIVITY WITH OTHER ASSETS

JOINT AIR
BATTLE MANAGEMENT
SYSTEM

INTERVIEW
FORMER PRIME MINISTER
MALCOLM TURNBULL

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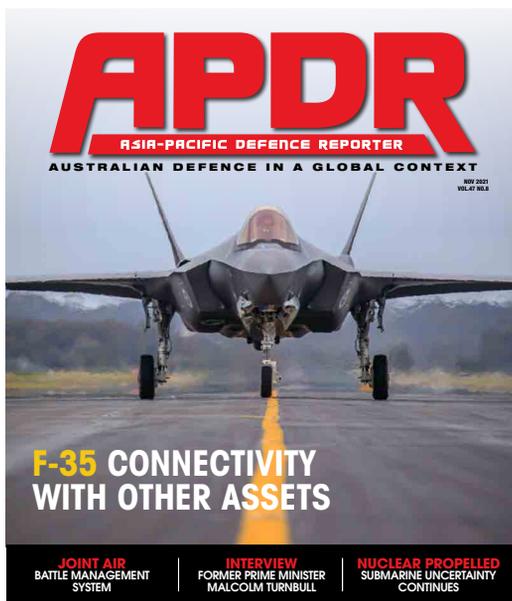
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Cover Description: F-35A Lightning II (A35-038) taxis into RAAF Base Williamtown for the first time after ferrying from the United States. Credit: CoA / Melina Young

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It all seemed so simple in 2017 when the government announced a national shipbuilding plan that would see the continuous production of submarines and surface ships forever. Just four years later very little remains of that strategically vital effort. The underlying philosophy of increasing self-reliance through building sovereign capability seems to have been dropped entirely, without any debate or public discourse.

The most obvious failure is of the Attack class submarine program. Later this decade it would have been employing 2,500 people on site in Adelaide – and multiples of that around the country with subcontractors and suppliers. All of that has been flushed away to pursue the dream of nuclear propulsion. That is at least a 20-year undertaking before any work flows to Australia, if ever.

While fury has been directed at the French, who after all were trying to build a submarine in Australia at the direction of the Royal Australian Navy, the same people have been completely mute when it comes to an even worse failure by the British with the Hunter class frigates. Already that program has been delayed by two years because Britain Inc – government and industry – led a marketing campaign that we incompetent Australians (including APDR) swallowed hook, line and sinker.

This was based on a series of fictions, probably the most important of which was that the parent Type 26 design was fully mature before being put into production. The story was that even before steel had been cut, the UK had invested more than one billion pounds to refine the design and order all of the long lead time items. If that was the case, the money was wasted because a lot of the equipment has come in weighing far more than it should. This

NAVAL SHIPBUILDING PLAN IN TATTERS

is a basic failure in project management that has already caused significant delays.

The second falsehood was that by developing a 3D software 'virtual twin' of the ship, incorporating all the Australian-specific changes could be done by clicking and dragging a mouse. In this fantasy world, changes could be made in Australia, then be sent to the UK, which overnight would incorporate these in the 'virtual twin' and – hey, presto! – the very next day they would flow back to the local design. Either this was pure fiction, or at the very least a grotesque simplification of the truth.

Finally, we were all sold the vision of immediate high levels of local industry content from the first ship onwards. We should have read the fine print. Now it seems that the Australian supply chain will only be used for the Batch 2 ships, which might start to be constructed in the early 2030s. As for the promises that Australian technology would be used on UK programs such as the new Type 31 frigates – they seem to have vanished.

This is the country that can hardly wait to sell us some Astute class nuclear powered submarines. Have one guess where they would be constructed (hint: it won't be Adelaide).

To add to this dismal picture, the public learnt almost by accident that the Pacific Support Vessel – a planned large multi-role ship - will no longer be built in Australia. This was picked up during Senate Estimates and officials tried to explain that industry should be aware of this change because it had been quietly removed from the list of Australian projects. We are never likely to know why because the government is running something like a wartime news blackout.

The service responsible for protecting Australia's national maritime security – the RAN – appears to be almost completely supine, not even trying to turn the disastrous situation around. One would think they would be interested in ramping up capacity – after all we are being threatened by China – by

building some modernised AWDs, or bringing forward the Life of Type Extension of Collins, or constructing more OPVs with anti-ship missiles. None of these things are happening, apparently because there is a Plan that Must Be Followed.

In case readers think we are unfairly picking on the RAN, they are not alone in wasting enormous amounts of money. Army has scrapped their \$2 billion Battle Management System with no immediate replacement in sight. They are prematurely retiring the perfectly good Tiger ARH fleet and spending an unnecessary \$5 billion on buying US Apache attack helicopters, which have the same weapons but are heavier and an older design, making them less agile and shorter range.

Special mention must be made of the RAAF, which having spent around \$2 billion on C-27J tactical airlifters has now decided that they can never be deployed for combat operations. Rather than do the work in Australia, they were flown to the US to have approximately \$1 billion worth of radios and Electronic Warfare Self Protection equipment installed. That very same EWSP suite is the one that now does not work and cannot be replaced. At least the aircraft can still be used for humanitarian missions – but there are far less expensive ways of performing those tasks.

If we allow \$3 billion written off on the Attack class; \$2 billion on the BMS; \$5 billion buying Apaches; and – being charitable - \$1 billion on the C-27s, we are already at \$11 billion without even attempting to calculate the cost of delays to the Hunter class frigates. This is approximately \$400 for every man, woman and child in Australia – something that should get the attention of voters not usually interested in national security. Think of the of hospitals, roads, railways and schools that could be built for that money.

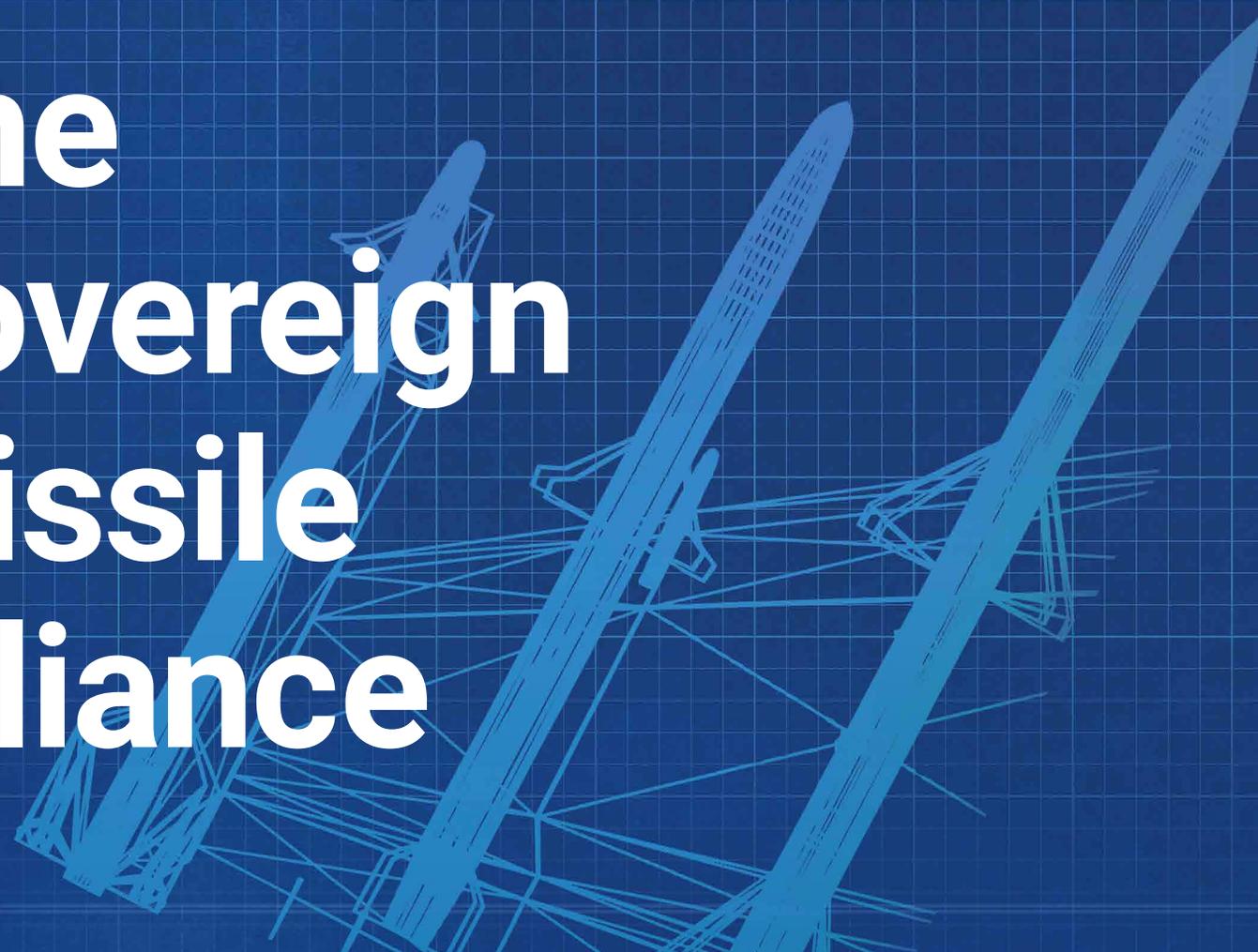
Even if those wasted funds were spent by Defence on itself, it would buy an additional 50 F-35s – at least. Unfortunately, no one seems to care.

PREVIEW
NEXT ISSUE



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Hunter class frigate (BAE Systems image)

LOCAL COMPANIES LOCKED IN TO HUNTER CLASS FRIGATE PROGRAM

2 November 2021

BAE Systems Maritime Australia is pleased to announce businesses in New South Wales, Victoria and South Australia will deliver products into the prototyping phase of the Hunter Class Frigate Program, the nation's largest surface shipbuilding project.

The three companies selected will supply a range of manufactured parts for prototyping blocks now under construction at the Osborne Naval Shipyard in Adelaide. The Hunter Frigate program will deliver nine warships to the Royal Australian Navy (RAN).

Work underway on prototyping blocks is enabling systems, tools, plant, workforce and supplier products to be tested, evaluated and refined, providing a solid operational foundation prior to the commencement of production on the first Hunter Class Frigate.

The companies awarded contracts are:

- Defence Seals & Spares (NSW): supply manhole and access panel gaskets from its Warriewood operations, north of Sydney;
- ABECK Group (Vic): manufacture/supply flowforge gratings from its Dandenong facility;
- PRP Manufacturing (SA): supply/cut gaskets at its Dudley Park plant in Adelaide.

The contracts build on previous prototyping orders with local companies including BlueScope Steel AIS, Infrabuild Steel Centre, Intertek, MG Engineering, Altrad, Novafast International, Century Engineering and

Mackay Consolidated Industries.

The Hunter program is establishing an enduring and uniquely Australian sovereign industrial capability that supports Australia's continuous naval shipbuilding strategy where Australians will independently design, build and sustain the nation's next generation of complex warships.

Companies can engage the Hunter Frigate Program through its Industry Capability Network (ICN) page.

Craig Lockhart, Managing Director, BAE Systems Maritime Australia, said:

"Establishing a competitive, sustainable and resilient supply chain in Australia is critical to the overall success of the Hunter Class Frigate Program.

"Each of these three companies bring a unique and important skillset to the construction of frigates in Australia, helping to deliver the best capability to the Navy.

"We look forward to placing more contracts with suppliers across Australia as the program progresses."

AUSTRALIA'S CONTINUED COMMITMENT TO SANCTIONS ENFORCEMENT AGAINST NORTH KOREA

28 October 2021

Royal Australian Navy frigate HMAS Warramunga has joined international efforts to enforce United Nations Security Council sanctions on North Korea.

This is the sixth time Australia has deployed a warship on Operation Argos, Australia's commitment

to the enforcement of these sanctions, since it began in 2018. Operation Argos is an important part of Australia's efforts to support nuclear non-proliferation and the ongoing stability and security of the Indo-Pacific.

Warramunga will monitor and deter North Korea's illegal ship-to-ship transfers of sanctioned goods.

Chief of Joint Operations, Lieutenant General Greg Bilton said the deployment will add weight to Australia's economic and diplomatic pressure on North Korea.

"Enforcing UN sanctions supports the international community's goal of the complete, verifiable and irreversible denuclearisation of North Korea," Lieutenant General Bilton said.

"Australia is committed to the stability and security of our region and will continue to enforce sanctions until North Korea takes concrete steps towards denuclearisation."

Warramunga will contribute to a multinational force including Canada, France, Japan, New Zealand, the United Kingdom and the United States.

The ship is the second to deploy on Operation Argos this year, following the deployment of HMAS Ballarat in May 2021.

Royal Australian Air Force P-8A maritime patrol aircraft have contributed to Operation Argos on nine occasions, most recently in August 2021.

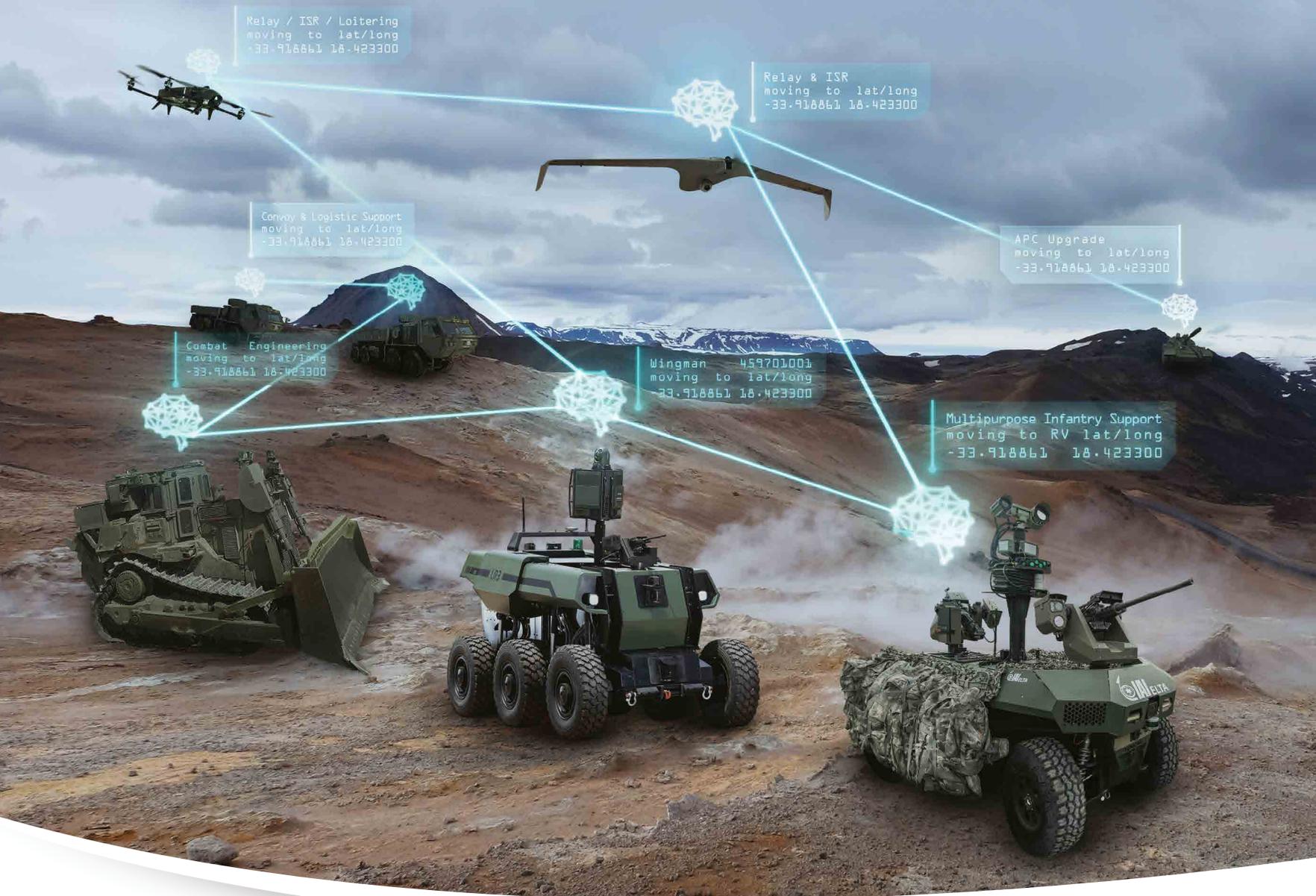
HMAS Warramunga is currently conducting a deployment to Southeast and Northeast Asia, which includes several navy-to-navy engagements with partner nations across the region.

HMAS Warramunga encounters heavy weather enroute to Korea.
Credit: Coa / Yury Ramsey



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(Top to bottom) KRI Sura, HMAS Ararat and KRI Kerapu conduct a coordinated maritime security patrol in the waters between Australia and Indonesia as part of AUSINDO CORPAT 2021. Credit: CoA



AUSTRALIA AND INDONESIA CONDUCT COMBINED MARITIME PATROL

24 October 2021

The Royal Australian Navy (RAN) and the Indonesian Navy (TNI-AL) have completed a coordinated maritime patrol to enhance security along our shared maritime border as part of AUSINDO CORPAT 2021.

The five-day patrol conducted by Armidale Class Patrol Boat HMAS Ararat and TNI-AL vessels KRI Kerapu and KRI Sura was the eleventh iteration of AUSINDO CORPAT and reflected the enduring defence partnership between Australia and Indonesia.

AUSINDO CORPAT took place in the waters between Australia and Indonesia, with a specific focus on the deterrence of illegal fishing.

Commander of the Australian Fleet, Rear Admiral Mark Hammond, said the coordinated patrol demonstrated Australia's enduring commitment to the Indo-Pacific region.

"Indonesia is an essential partner for Australia. We share security challenges and a firm commitment to a rules-based maritime order, underpinned by adherence to international law," Rear Admiral Hammond said.

"AUSINDO CORPAT tested and proved our shared mariner skills, techniques and procedures and refined our ability to work together in cooperative maritime surveillance, security and interdiction."

"By working together, we improve regional

maritime security and promote a stable, inclusive and resilient region based on international law."

The coordinated patrol was conducted in a contactless manner to help prevent the spread of COVID-19.

EM SOLUTIONS NEW ANTENNA DIVERSITY SYSTEM CREATES A STEP CHANGE IN THE RESILIENCE OF NAVAL COMMUNICATIONS

22 October 2021, Brisbane, Australia

EM Solutions, a Brisbane, Australia based subsidiary of Electro Optic Systems Holdings, has completed development of its new satellite terminal antenna diversity system (ADS) by achieving Wideband Global SATCOM (WGS) certification, allowing it to be used with terminals accessing the military WGS.

The ADS is able to automatically sense and switch traffic between dual antennas when one of them is blocked from satellite view, and it can split traffic between the dual antennas – even to different satellites – when both have satellite visibility. The system has previously been certified for operation on the commercial Inmarsat GX network.

EM Solutions CEO Dr Rowan Gilmore, said "The ADS is an important innovation that has been several years in development for our navy customers in Australia, Europe, and the Middle East. If one satellite terminal is blocked from seeing the satellite by the ship's mast or another structure the system automatically directs traffic to a second terminal on the other side of the ship. It also increases the resilience of the link since two terminals and their channels are normally available".

With an eighteen-month order book of satellite terminals to supply to several of the world's navies, EM Solutions is also doubling its factory capacity to accommodate production of the dual systems that the ADS will require. EM Solutions' Cobra terminals are the only maritime terminals available globally that can access both the WGS and other commercial constellations such as Inmarsat GX.

Dr Gilmore added "The ADS is unique technology since it switches the physical path of a channel from multiple modems to the appropriate satellite antenna. Avoiding the use of a router makes switching automatic and prevents any complexities associated with encryption. We believe it will make a step change in the resilience of naval communications."



Caption: HMAS Sydney and USS John Finn conduct a passage exercise in the Southern California Exercise Area in the United States. Credit: CoA



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RAAF F-35S ABLE TO SHARE DATA ACROSS THE GLOBE

Even a decade ago, discussions on the F-35 and other modern aircraft largely revolved around issues of maximum speed, turn rate and range. While still very important factors, in assessing the effectiveness of platforms debate is shifting towards sensor performance and especially the ability to interpret that data and to share it with other assets. Early enthusiasts for the fifth generation F-35 have largely been proven to be correct – that the platform is a game changer, not just for aerial combat but warfare more broadly.



*No. 3 Squadron F-35A Lightning II aircraft taxi into RAAF Base Williamtown from the United States.
Credit: CoA Melina Young*

Because the program for Australia to acquire 72 of them has gone so smoothly – after years of initial uncertainty and criticism – it is now easy to lose sight of just how large the F-35 enterprise is. Prime contractor Lockheed Martin announced on September 29 the delivery of the 700th jet. As they are being produced at least two per week, the figure is now higher. So far, 14 countries are buying them and to date the aircraft have cumulatively flown 430,000 hours.

They are to be found on 21 air bases around the world, including RAAF Williamtown outside Newcastle and eventually Tindall in the Northern Territory. Almost 1,500 pilots and 11,000 maintenance crew have been trained, with more being graduated weekly. The metrics for Australia are less clear, with the office of Defence Minister Dutton bizarrely doing their best to obstruct media inquiries into the program – including by the ABC's 7:30 Report – despite its overwhelming success and contribution to national security.

On the same day as the delivery of the 700th aircraft was announced, Lockheed Martin and

the Joint Program Office – which seeks to look after the interests of all F-35 users – came to a program re-baselining agreement that will increase production to make up for shortfalls largely caused by Covid. The numbers for a military program are staggering: this year alone between 133 and 139 aircraft will come off the Fort Worth production line in Dallas. Next year it will be between 151 and 153; in 2023 it will increase to 156 F-35s per annum – and then stay at that level indefinitely.

To give an idea of scale, less than 600 Eurofighters have been built and production has been thrown a lifeline by a German order for another 38. Less than 200 French Rafales have so far been delivered, though export orders, particularly to India, will see those numbers increase – but they will never come close to the F-35 order book.

Each aircraft has several million dollars worth of Australian componentry and support with companies such as Marand, Ferra, Quickstep, BAE Systems, Rockwell Collins Australia; TAE and RUAG Australia. Work share for the program is calculated strictly on the number of aircraft being purchased

by each country. The JPO says that Australia has a "program of record" of 100 F-35s – though so far 72 have been ordered – and this equates to 3% of the global total that will continue to be built during the next 20 or so years. If the total acquisition cost of this fleet is approximately US \$300 billion, then local industry is in line to receive US \$9 billion of that. Factoring in exchange rates, Australian companies to date have received almost \$2 billion worth of export orders.

The largest single customer for the F-35 is the USAF, with 1,763 A models on order – the same variant as that used by the RAAF. In our region, Japan is the second largest purchaser with plans to buy more than 140 of them; South Korea will receive 40 – and Singapore is testing the waters in a typically cautious way with an order for 12. Companies such as BAE Systems Australia will be part of the regional support network for this fleet – and even though individual aircraft from neighbouring countries are unlikely to come here for maintenance, many of their components will.

As production ramps up, unit cost is continuing to go down. Early aircraft were well over \$100 million each – now they are down to \$77 million. This makes them comparable, or even lower, than 4th generation aircraft such as the F-15; Super Hornet and Eurofighter – particularly considering that each F-35 comes with things such as an internal targeting system while for others it is often an added pod that comes at extra cost.

Because of the sudden cloud of secrecy surrounding the RAAF program our metrics are unclear. Early this year it was known that 33 aircraft had arrived and that another 8 were scheduled for delivery. Assuming that nothing has gone awry, we now have 41 of them. Initial Operational Capability was declared last year, meaning that they are combat ready.

The full sensor capabilities of the aircraft are still being explored. As an example of what can

be achieved, during Exercise Talisman Sabre a RAAF F-35 undergoing acceptance trials in the US sent radar data to a “virtual” Aegis naval combat system on the ground, which was then relayed via a US secure network to Hawaii and then on to Queensland – all in real time. The Aegis radar and fire control system is found on front line USN surface combatants – principally Arleigh Burke destroyers – as well as RAN Hobart class frigates. Aegis is also used by the navies of Japan and South Korea.

The US military has been conducting these types of experiments for some time and it is believed that this is the first time a coalition partner has been involved. Lockheed Martin – which is also the prime contractor for Aegis – said on September 29 that they had supported this bilateral activity:

“In partnership with U.S. Indo Pacific Command, Lockheed Martin’s participation in Talisman Sabre 2021 (TS21) continued the military/industry team’s experimentation efforts to improve joint interoperability between U.S. services and allies.

“The exchange of real-time F-35 data with non-F-35 platforms outside of the United States via the F-35’s multi-function advanced data link directly supports goals presented in the Pacific Deterrence Initiative. This initiative includes using large-scale exercises to pursue innovative experimentation in support of building joint all-domain information sharing capabilities.

“In the 21st century battlespace, dominance will be determined by the ability to securely connect high-tech platforms into one cohesive network that spans every domain – air, land, sea, space and cyber. This recent demonstration strengthens the U.S. military’s interoperability with its allies against the heightened strategic threat environment. Only the F-35 has the ability to reach into austere environments to provide critical real-time information back to allied defence forces.

“Starting with Talisman Sabre in 2019, Lockheed Martin has collaborated with U.S. Indo-Pacific Command on experimentation to enhance kill webs, which are a multitude of sensors that collect, prioritize, process, and share data, then fuse it into a continuously updated display of information for joint forces. The demonstrations conducted during TS21 are further proof of Lockheed Martin’s ability to quickly connect advanced technology, provide commanders more options to meet their objectives, and ensure warfighters have the information needed to quickly make critical decisions in the battlespace.”

Bridget Lauderdale, Lockheed Martin vice president and general manager of the F-35 program added:

“With this demonstration, the F-35 has proven that its sensor fusion capabilities make it the most advanced node in the 21st century warfare network-centric architecture. We are proud to deliver on the expectations of our customers in the Indo-Pacific Command theatre and in Australia and look forward to working with them to build on the capabilities the F-35 has proven thus far.”

– and often far less than that. Given that anti-ship missiles can travel at up to Mach 3 this means that a ship typically has less than 30 seconds to react – and if there are multiple incoming threats even the most capable vessel could be quickly overwhelmed.

However, if one or more F-35s are in theatre, the equation completely changes. Rather than having seconds to react, because the aircraft is detecting



No. 77 Squadron's F-35A Lightning II (A35-040) aircraft arrival into Australia from the United States at RAAF Base Williamtown, NSW. Credit: CoA / Catherine Kelly

Because of the sudden cloud of secrecy surrounding the RAAF program our metrics are unclear.

While the exact scenario was not detailed, in previous US-only exercises an F-35 has used its powerful AESA radar to detect, classify and track a high-speed low-level drone replicating a supersonic anti-ship missile. This information has then been transmitted to an Aegis system identical to one at sea – and it has then fired a defensive missile such as an SM-2 or SM-6 that has destroyed the incoming target without the ship even switching on its radar. The huge advantage in this type of scenario is that an F-35 at altitude has a far greater radar horizon – one of many hundreds of kilometres – compared with an array on or very near the sea surface.

Even allowing for certain atmospheric conditions that can increase radar range, it is highly unlikely that Aegis would be able to detect an incoming low-level target at more than a few dozen kilometres

and tracking missiles from far greater distances, this allows the ship to begin defending itself earlier in the engagement cycle, firing defensive missiles at targets way over the horizon.

This is a subset of network centric warfare being developed in the US known as NIFC-CA: Naval Integrated Fire Control-Counter Air. No wonder acronyms are sometimes preferred. This approach takes advantage of high capacity, secure, data links to move enormous amounts of information quickly around military networks so that all platforms are connected.

There are various other scenarios in which F-35s could act as force multipliers in a network. The Northrop Grumman AN/APG-81 radar can also act as a powerful spot jammer, directing electromagnetic energy very precisely. In the naval engagement described above, as well as relaying



Royal Australian Air Force aircraft No.6 Squadron (SQN) EA-18G Growler, a No.1 SQN F/A-18F Super Hornet and from No.3 SQN, a F-35A Lightning aircraft, fly alongside a United States Air Force B-52H Stratofortress aircraft from the 23rd Expeditionary Bomb Squadron based at Guam, during Exercise Talisman Sabre 2021. Credit: CoA / Andrew Eddie

While the exact scenario was not detailed, in previous US-only exercises an F-35 has used its powerful AESA radar to detect, classify and track a high-speed low-level drone replicating a supersonic anti-ship missile.

data to an Aegis-equipped ship there is no reason why the aircraft itself could not also try and jam the enemy missile or shoot it down. Doing so might give away its own location but there are many

scenarios where that would be an acceptable risk. The F-35 might also be in a position to engage whatever platform launched the anti-ship missiles in the first place.

To date, most of the F-35 experimentation has taken place in the US, though no one doubts that Israel is not far behind. There is no technical reason why Australia could not develop a sovereign network similar to NIFC-CA. As well as equipping the Hobart class Air Warfare Destroyers, Aegis will go on the Hunters – whenever they are being delivered – this time utilising a digital electronically scanned radar suite from Canberra’s CEA, which in some respects is more advanced than US systems. These radars already equip the Anzac frigates, giving them a massive boost in defensive firepower, which will now have to remain in service until the 2040s.

Whether the RAN is interested in going down this path or is comfortable riding on the coat tails of the US is unknown – though since we are in the process of developing a sovereign guided weapons capability it would at least be worth considering our own network for reasons of strategic self-reliance. The local subsidiaries of US companies such as Lockheed Martin, Northrop Grumman and Raytheon would be able to help – along with Saab, CEA and a number of others.

For the record, it needs to be said that the F-35 program is not without continuing critics. In the highly politicised US environment there are still calls for it to be scrapped. In March no less a figure than the Chairman of the Armed Services Committee Democrat Adam Smith described the program as a “rathole” – though it’s unclear precisely what he meant by that – and called for a drastic reduction in the numbers to be purchased in favour of other aircraft. He comes from Seattle – the home of bitter F-35 rival Boeing, maker of the Super Hornet and F-15 families – so one wonders if his views might have been influenced by that.

There are legitimate concerns about availability rates for the aircraft. These are typically more than 70%, making them much better than earlier generation aircraft, but still well short of what was hoped for earlier in the program. Maintenance costs are also higher than expected and are proving difficult to drive down. There are still some technical glitches, though nothing substantial has emerged in the last few years.

On balance, the F-35 has been an excellent choice for the RAAF and for Australian industry. The combat potential of the aircraft is enormous and is continuing to grow. It has been a great success story and it is a pity that the Australian public are being starved of information about how good it has already proven to be.

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HAWK 127 MIGHT BE IN SERVICE FOR A LONG TIME

As the Royal Australian Air Force's fleet of BAE Hawk 127 Lead-in Fighter (LIF) passes two decades of operations, thoughts about what direction fighter pilot training will look like in the future is already on the minds of Defence. This is even as the type has just completed an upgrade to keep it relevant as the RAAF transitions to the F-35.

Australia's association with the aircraft began in June 1997 when the RAAF ordered 33 Hawk 127 under an \$850 million contract to replace the Aermacchi MB-326H then being used to train the service's fighter pilots. Under the contract, the first dozen aircraft were built in the United Kingdom with the remainder in Australia. The first Hawk was delivered in 2000 and the rest followed at a rapid clip, with the last joining the fleet in October 2001.

The aircraft is being operated by the RAAF's No. 76 and No. 79 Squadrons based at RAAF Base Williamtown NSW and RAAF Base Pearce in Western Australia respectively. Both squadrons are part of No. 78 Wing, which serves as the Operational Training Wing of Air Combat Group. In addition to the training role, the RAAF has used the Hawk as a simulated adversary aircraft and anti-ship missiles, providing other Defence assets with an enemy to train against.

The life of the aircraft has been lengthened with the signing in 2013 of a contract between the Commonwealth and BAE Systems United Kingdom (UK) to conduct a multi-million dollar upgrade of the fleet. The LIFCAP Capability Assurance Program, which was completed in May 2019, has brought the RAAF's fleet to a standard like that of the Royal Air Force's new-build Hawk T.2s.

Improvements to the post-LIFCAP aircraft include a software-driven simulated radar, electronic warfare suite, data fusion, use of miniaturised modern avionics, colour display and improved sensor fusion. Together with a full motion simulator delivered as part of the LIFCAP program, the type is continuing to train RAAF pilots for conversion to Super Hornets, Growlers and F-35s.

The RAAF plans to keep the Hawks flying till 2026 but has already kick-started the replacement process when the Commonwealth issued a Request For Information (RFI) from interested parties to respond to its proposed Lead In Fighter Trainer (LIFT) program in July 2020.



Called Air 6002 Phase 1, this is a \$4-\$5 billion program expected to run between 2022 and 2033 to replace the current LIFT capability. The program aims to deliver a solution that will be in service until around 2050 with a primary role of training RAAF fast jet pilots and weapons systems operators (WSOs) in transitioning them from the Pilatus PC-21 to combat aircraft.

The RFI adds that a solution needs to be "configurable and scalable" and would also have a secondary role to support the ADF either as a friendly or adversary force. The latter role means that the selected solution needs to be capable of representing 4th of 4.5-generation forces and able to employ both kinetic and non-kinetic effects.

An additional consideration must be the

increasingly prohibitive costs per flying hour of modern fighter types. This means that air forces are increasingly considering using a trainer type, along with virtual training on simulators equipped with systems approaching that of a combat aircraft to allow pilots to maintain proficiency on the systems without needing to use up scarce and expensive flying time.

This means fleet numbers are moving on an inverse path with acquisition and operating costs, with militaries being compelled to buy ever-smaller numbers of high-end combat aircraft. Having a cheaper aircraft with advanced combat systems for pilots to train on in lieu of flying the actual platform becomes an increasingly attractive option, for example numbers show the per flying hour costs of the Leonardo M-346 as being one-tenth of those of the Eurofighter Typhoon.

THE BOEING T-7

Boeing has confirmed that it has responded to the RFI by offering the T-7A Red Hawk that it is developing with Saab to meet the U.S. Air Force's own requirement to replace its increasingly ageing Northrop T-38C Talon fleet.

The Red Hawk is a single-engine, twin tail, tandem seat advanced jet trainer powered by the General Electric F404 engine that powers the RAAF's fleet of F/A-18A/B Classic Hornets. The company adds that the T-7A is a scalable, interoperable and configurable capability, and is ideally suited to address the RAAF's next-generation frontline fast-jet aircraft training requirements.

The USAF requirement is for 351 aircraft and 46 simulators with the first USAF Air Education and Training Command (AETC) squadron to be operational in 2024 with full operating capability due in 2034. However, the USAF requirement is really for a platform for basic training, and a lot of the requirements for a LIFT platform will not be on the T-7As destined for AETC's inventory.

This may change however, as the USAF has

issued and RFI for a trainer to meet its Air Combat Command (ACC) requirement for an “advanced tactical trainer,” which would be procured by Air Combat Command for use as an aggressor aircraft and/or to act as a surrogate aircraft for front-line fighter platforms, providing lower-cost follow-on training for experienced pilots as well as reducing usage of valuable airframe hours of combat aircraft.

This could require a trainer with more power to accommodate sensors like a radar or jammer, increased fuel capability to support longer training missions where pilots use the afterburner more frequently, the ability to use real or simulated weapons, and the integration of virtual or constructed threats.

Boeing is almost certain to enter the T-7 into any competition, which could potentially open the door for the development of a LIFT sub-variant that would be closer to what AIR 6002 Phase 1 is seeking.

The US Navy has also started looking at a similar trainer, which it calls a “Tactical Surrogate Aircraft” that is described as a two-seat “fighter type” jet that can be flown as a companion trainer and as an adversary. This is basically an aggressor aircraft that can play the role of a “bad guy” during training, but it will also need to be able to provide already-qualified aircrew with additional flight time and continuation training.

One of the USN’s key requirements is that the aircraft needs to “simulate and/or replicate current and future fighter aircraft systems” with a potential future buy of 64 jets in a program starting only in 2024 or 2025, while the USAF sees the possibility of buying 100 advanced tactical trainers to start off and an undetermined number of subsequent, 50-aircraft lots.

However, both the USAF and USN have stated that these plans are a thought balloon for now, and they may end up buying more of the more basic trainer that the USAF has already committed to, and any foreign user planning to select the T-7 as a LIFT platform may have to end up deciding on and paying for a T-7 LIFT development pathway.

LEONARDO M-346

Italy’s Leonardo has also confirmed it has led to the RFI with the M-346 Master trainer as the aircraft platform. The M-346 was born out of an Aermacchi collaboration with Russia’s Yakovlev to provide financial and technical support in developing a new trainer that the firm had been developing since 1991 for a Russian requirement.

Aermacchi also gained the right to modify and market the aircraft when it joined the program in 1992, which in its Russian form became the Yak-130,

T-50 Golden Eagle (KAI photo)



for the Western market. However, this partnership collapsed when the Russian participants were unable to provide financial backing.

The Italians walked away with an agreement that each firm would pursue development of the aircraft independently, with Yakovlev receiving US\$77 million for technical documents of the aircraft and holding rights to market their aircraft to the former Soviet republics. The Italian company secured the rights to sell their aircraft to NATO countries and the rest of the world.

The first M-346 prototype rolled out on 7 June 2003 and conducted its maiden flight on 15 July 2004. The M-346 is designed from the outset to be a lead-in fighter trainer. The trainer is powered by a pair of Honeywell F124 turbofan dry engines and is capable of transonic flight without using an afterburner.

It is also scalable and designed for growth. It incorporates a full-authority quadruplex digital fly-by-wire flight control system that, when combined with optimized aerodynamics, enables the aircraft to maintain its full manoeuvrability and controllability at angles of attack in excess of 30°.

Training on the M-346 is also enhanced by its Embedded Tactical Training System (ETTS). The ETTS is capable of emulating various equipment, such as radar, targeting pods, weapons, and electronic warfare systems, as well as interfacing with actual stores and munitions being carried by the jet. In addition, it can also generate realistic friendly and adversary Computer Generated Forces to enhance training.

The system can act in a standalone mode, in which simulated data and scenario information, with threats and targets, is loaded prior to take-off. It can also work in a network, during which data is received and acted upon in real time from ground monitoring stations via the aircraft’s datalink as part of a Ground-Based Training System (GBTS) that is made up of academic training devices, simulators, mission planning and training management systems.

The M-346 has proven to be a popular trainer platform, with Israel, Poland and Singapore joining Italy in operating the type. Azerbaijan, Egypt, Greece, Nigeria, and Turkmenistan have also ordered it. The aircraft is now in the product line of Leonardo following the acquisition and rebranding of Aermacchi in 2017.

In addition to sales, Germany, Japan and Qatar have signed on to the joint Italian-Leonardo International Flight Training School (IFTS) Phase IV (LIFT) pilot training program at the Italian Air Force’s 61° Stormo (61st Wing) base at Italy’s Lecce-Galatina airport.

Leonardo is also developing the multirole M346 Fighter Attack variant (M-346FA) that is equipped with the Leonardo Electronics Grifo M-346 multi-mode fire-control radar and weapons capability. External stores include the IRIS-T and AIM-9 Sidewinder air-to-air missiles, guided bombs and air-to-ground missiles, free-fall bombs, gun, reconnaissance, or targeting pods.

The external stores can be carried on a total of seven hardpoints with a rating of up to 3,000-kg (6,600-lbs) and the armed capability has already

HAWK 127

attracted buyers, with Nigeria and Turkmenistan having the M-346FA on their order books.

KAI T-50

South Korea has made enormous strides as a defence industry player over the past decade, and a series of reforms to the sector beginning in 2018 appears to have cemented that position. The Stockholm International Peace Research Institute (SIPRI), which tabulates and issues an annual report on international arms sales, listed the country in 9th place when using figures from 2016 to 2020, putting the Asian economic powerhouse just behind Israel in its rankings.

This growth has been helped to a large extent by the Korea Aerospace Industries (KAI) T-50 Golden Eagle trainer and its light combat offshoots, which has turned around a series of initial export defeats into a string of successes due to the rapid introduction of combat capability into the original design.

The type is now used by the air forces of Indonesia, Iraq, the Philippines and Thailand alongside South Korea's, with the Philippines having used its FA-50PH fleet to combat Islamic State militants in the southern part of the country in 2018.

KAI has built on its experience in local assembly of Lockheed-Martin F-16s for the South Korean Air Force and building F-15 forward fuselages for Boeing and turned to developing its own aircraft. The T-50 was borne out of a home market requirement for a trainer and light combat aircraft to replace the numerous Cessna A/T-37, Northrop T-38 and F-5E/F then in service.

The basic T-50 shares several design features with the F-16, although it is again powered by the same F404 turbofan that is on the Classic Hornet



FA-50 Fighting Eagle (KAI photo)

and Boeing T-7. The trainer has a top speed of Mach 1.5, and KAI offers alternate engine options in the form of the GE F414 that powers the Boeing F/A-18E/F Super Hornet or even the Eurojet EJ200, which provide 12-25% more thrust than the F404.

Combat-capable variants of the basic T-50 design are the TA-50 and FA-50. The TA-50 is designed as a lead-in fighter trainer and light attack aircraft, with the key difference from the basic design is it's equipped with a three-barrel 20mm cannon and provision for weapons - including the AIM-9 Sidewinder air-to-air missiles, free-fall bombs, precision guided bombs and air-to-ground missiles and various targeting and reconnaissance pods. It is equipped with the Elta EL/M-2032 fire control radar.

The FA-50 meanwhile, is an even more advanced combat variant that possesses more internal fuel capacity, enhanced avionics, a longer radome and a tactical datalink. Future growth options for the TA- and FA-50 include Active Electronically Scanned Array radars and a wider range of weapons such as the MBDA Meteor or ASRAAM air-to-air missiles.

COULD IT BE THE HAWK?

There are other trainer options on the market such as the Textron Scorpion and the Yak-130. But perhaps paradoxically, the existing Hawk fleet might end up being the solution. As it is, the average age of RAAF's Hawk fleet in terms of flying hours, is only around one-third of its verified fatigue life, although there have previously been wing fatigue issues encountered by the fleet.

The RAAF's Head of Air Force Capability Air Vice Marshal Cath Roberts had previously said that keeping the Hawk in service will be one of the options that will be considered for AIR 6002 Phase 1 as Defence continues to define its requirements.

Australia has signed a Commander's Intent agreement with the UK in March 2019 intended to create a "scalable, flexible, sustainable support and capability enhancement solution for the UK and Australian Hawk that delivers the required output at the optimal cost".

A joint team from both countries has been stood up and operating within an agreed framework to deliver a plan that summarises the future support solution, the target price, efficiency levers and the re-investment priorities.

One of the issues they will likely be looking at is the potential replacement of the engine. The Rolls-Royce Adour 871 that powers the Hawk 127 has also encountered cracking issues with the low-bypass turbine, which together with the wing fatigue issues have caused the fleet to be grounded in the past.

While there exists an alternate engine and with it the option to re-engine the Hawk 127s with the Adour 951 that is used by the Hawk T2 and the LIFT versions of the Hawk, the age of the aircraft and previous issues might raise questions about the feasibility of such a step, particularly given the RAAF is seeking to use the LIFT type that is currently under consideration up to 2050, by which time even the youngest Hawk 127 would be 49 years old.



Game-Changing Air Defence Radar System Solutions



SPECTRA – Early Warning & Defense S-Band Digital Radar. Credit: ELTA Systems Ltd.

The range of airborne threats, strategic and tactical, is extensive and growing. Fast, low flying bombers and ballistic missiles, with their very short time to target, have been around since the Second World War and continue to challenge modern air defence systems. More recent dangers include: low RCS manned and unmanned aircraft; hypersonic weapons, including boost glide and scramjet missiles; intelligent, low-flying cruise missiles; loitering munitions; armed drones; and swarms of independent drones working in unison. Some of these newer challenges would not even have been considered relevant less than a decade ago.

It is therefore not surprising that the highly coordinated and accurate attack on Middle Eastern oil facilities in 2019, employing both cruise missiles and suicide drones, exposed serious gaps in the capabilities of current early warning (EW) and Ground-Based Air Defence (GBAD) systems - far beyond any reservations regarding operator readiness and competency. In the face of these perils, legacy sensors are often inadequate and, in some cases, even obsolete. The OODA (observe–orient–decide–act) loop that military tacticians rely upon has become seriously challenged because human intervention is often too slow. High performance radar systems, which provide comprehensive coverage and early detection, and employ high speed computer intelligence to support efficient and timely reaction, are needed to cope with the new reality.

In response ELTA Systems Ltd. (ELTA), the defence electronics subsidiary of IAI, Israel's largest defence and aerospace company,

offers a range of innovative air surveillance and defence solutions for Integrated Air and Missile Defence (IAMD), Medium Range Ground Air Defence (MRGBAD), and Advanced High Speed Missile Defence (AHSMDD). Radar systems constitute the cornerstone of these solutions and ELTA's have earned worldwide recognition with their unique in-house developed techniques and technologies. For example, ELTA pioneered the Active Electronically Scanned Array (AESA) technology used in leading air defence and surveillance systems around the globe, including the well-known Iron Dome.

ELM-2090 TERRA, a strategic Early Warning Dual Band Radar, provides effective capabilities against long range, low RCS targets. TERRA fuses the ELM-2090U ULTRA Radar operating in UHF-band and ELM-2090S SPECTRA Radar operating in S-band into a highly reliable and maintainable unified system, which can be positioned at a single site. TERRA offers extended azimuth coverage: 120° in sector mode and the ability to be mechanically slewed up to 320° while in operation. The system searches and detects aerial threats over UHF-band at very long ranges. After the threat is verified the UHF-band radar transfers the data to the S-band radar for extremely accurate tracking and target acquisition. Acting as a backup, the UHF-band radar continues to track the threat ensuring a high level of reliability. TERRA provides accurate impact and launch point estimation. The flexible system features highly evolved resource management and ECCM capabilities, and is interoperable

with air defence systems, functioning as a high-performance Fire Control Radar (FCR). TERRA also detects, monitors and maps satellites and space debris.

Finally, in order to ensure the detection of small, low flying targets designed to evade ground based radars, ELTA offers advanced Aerostat systems, integrating early warning radars that provide an effective, persistent, look-down capability with ELINT and IFF systems. Mounted on aerostats tethered at an altitude of 3,000 up to 15,000 ft. to achieve an unobstructed view, ELTA's ELM-2083 family employs 3-D, multiple beam, Doppler, AESA radar and passive sensors to cover large sectors of airspace. These systems utilize ELTA's proprietary algorithms to neutralize ground clutter, deal with highly saturated target scenarios, and ensure low false alarm rates. The aerostat systems complement AEW aircraft, offering the advantages of continuous time on station and a tenfold decrease in operating costs.

In summary, ELTA offers a comprehensive range of class leading radar systems to detect, track and classify the most sophisticated airborne threats - current and future – and deliver significantly increased warning time, even against low flying targets. ELTA's operationally proven radars incorporate the latest technologies and techniques, including advanced algorithms, to offer class leading performance at highly competitive costs, and deliver decisive advantages.

For further inquiries please contact us at market@ELTA.co.il.



ULTRA – Early Warning UHF Digital Radar. Credit: ELTA Systems Ltd.

JOINT AIR BATTLE MANAGEMENT SYSTEM STARTING TO TAKE SHAPE

The RAAF now has most of the aircraft it needs for the near future – with the partial exception of EWISR platforms being acquired under Project Peregrine – but is also taking the lead in developing an overarching command and control system to protect Australia and our deployed forces. This is a challenge because few countries have this sort of technology and a strategic decision has been made to find a long-term US industry partner.

Defence says that following the announcement of the down select, Stage 2 of the Competitive Evaluation Process (CEP) has now commenced. CEP Stage 2 is designed as a period of risk reduction, whereby the two companies, Northrop Grumman Australia and Lockheed Martin Australia, will conduct further detailed architectural and other design related activities. The successful strategic partner for the Joint Air Battle Management System (JABMS) is expected to be announced in 2023.

Given the complex nature of JABMS, Defence is also providing all four original CEP participants (the two down-selected plus Boeing Defence Australia and Raytheon Australia) the opportunity to contribute to a 'best of breed' outcome. With no single company having an off-the-shelf system that meets Australian requirements for JABMS, potential exists for all companies to contribute to the end solution either through direct support to the successful strategic partner, or by providing specific assurance and other tasks to Defence. In parallel with CEP Stage 2 the Commonwealth is undertaking a series of additional risk reduction activities with all four industry partners focussing on refinement of JABMS operating and support concepts. These activities will help to further inform the projects' future execution strategy.

Defence has assessed that key Integrated Air and Missile Defence expertise and technology is resident within the United States, and the Department will work with Australian industry and their United States partners to maximise knowledge and technology transfer whilst upskilling Australia's defence workforce.

The operational capability milestones for the AIR6500 series of projects—JABMS, Medium Range Ground Based Air Defence and Advanced High Speed Missile Defence—are classified. However, capability elements will start to be delivered from the mid-2020s onwards. At this stage, all projects are either pre-Gate 0 or Government approval in their capability life cycle.

The Short Range Ground Based Air Defence

project (LAND 19 Phase 7B), in conjunction with industry partners – Raytheon Australia is the prime contractor, with team members CEA and Kongsberg - has performed extremely well to date in maintaining the project schedule throughout the COVID-19 pandemic. The project and industry will continue to assess the schedule risks and the requirement for any mitigation strategies as the enduring impacts of COVID-19 are better understood.

Both AIR6500 and AIR6502 (Medium Range Ground Based Air Defence) aim to optimise Australian Industry content to build a sovereign industrial base through knowledge and technology transfer and upskilling the Australian workforce. Regarding AIR6500, Lockheed Martin Australia and Northrop Grumman Australia will continue to work with Australian industry to develop advanced technical solutions and prototypes as they refine their final proposal for the Joint Air Battle Management System with the aim of optimising Australian Industry Capability. Similarly the AIR6502 RFP asks Industry to specifically address how it will maximise Australian Industry involvement and support the Government's Sovereign Industry Capability Priorities.

The AIR6500 Phase 1 CEP is not a competition to select a design solution for the Joint Air Battle Management System. Defence says it is seeking a strategic partner to work with it and other industry partners to design and implement a Joint Air Battle Management System that will utilise a wide range of technical solutions. However, Defence recognises that each company may propose products that contribute to its core architectural solution. A key element of this activity will be for each company to describe and demonstrate how they will integrate Australian industry into their solution.

LOCKHEED MARTIN AUSTRALIA

Asked for an update, Steve Froelich AIR6500 Program Executive, Lockheed Martin Australia said:

"Since 2016, Lockheed Martin Australia has been highly committed to supporting the Royal Australian

Air Force (RAAF) achieve its vision to transform into a fully fifth-gen-enabled force, where it was first envisaged under Plan Jericho.

"To address evolving threats and exhibit credible military deterrence, military forces must integrate platforms, systems and sensors operating in the sea, land, air, cyber and space to increase the pace and dissemination of information. This is all possible through Joint All Domain Operations or JADO; AIR6500 is one of the first JADO programs in the world. The evolution of LM's experience in global C2 is leading the development of JADO.

"The ultimate peak of the RAAF's transformation is AIR6500, and we have been investing in the program since day one.

"Over the past seven years, we have been building our sovereign AIR6500 presence. We have been growing our Australian workforce in Canberra, Adelaide, Melbourne and Williamstown, establishing partnerships with Australian industry and investing in leading local capabilities.

The company says that in developing a sovereign workforce, it has been focused on tech transfer and upskilling the workforce to mature a legitimate JADO Command and Control Framework based on contemporary technologies and then integrating established systems and platforms. This included bringing world leading experts to Australia to provide expertise in Integrated Air and Missile Defence operations and technology. Mr Froelich says their expertise and knowledge has been imparted to support the upskilling of our Australian team two years ahead of the AIR6500 contract to deliver next gen capabilities to Australia. LMA has established a global engineering team that spans sites across Australia and the USA.

He continued:

"We are absolutely committed to being ready on day one to execute the AIR6500 program. Our program solution will be powered by a sovereign open architecture and tactical cloud that will enable Australia to rapidly add capabilities to

meet emerging operational needs and defeat the next-generation of threats. This will enable LMA to bring a range of best of breed capabilities to meet AIR6500 requirements and to evolve the capability to meet emerging threats.”

“Lockheed Martin Australia is committed to integrating the very best of Australian industry capability into the AIR6500 program solution to ensure we deliver the right solution for the Australian Defence Force to protect Australia's security and our way of life.

“We will continue to collaborate with primes, small to medium enterprises, academia and government to select ‘best of breed’ technologies to deliver a truly sovereign solution for Australia, ensuring Australian industry remains at the heart of shaping the country's future Joint Air Battle Management capability.”

NORTHROP GRUMMAN AUSTRALIA

An update was provided by Christine Zeitz, General Manager Asia Pacific, Northrop Grumman, who said:

“Our Australian-led team has been conducting our risk reduction activity in partnership with the Commonwealth and our growing team of SMEs, committed to designing an open, modular systems architecture to deliver a sovereign Joint Air Battle Management System (JABMS) to the Australian Defence Force.

“We have integrated our team, including twelve Australian SMEs, by utilising our sovereign infrastructure, Parallax Labs. Parallax Labs is our new engineering laboratory that is a distributed secure capability, allowing us to reach back to the US and leverage Northrop Grumman's unmatched expertise in developing multi-mission weapons systems to architect our JABMS solution.

“This systems architecture will be the cornerstone of Australia's integrated air and missile defence (IAMD) capability. Our priority is to work with the Commonwealth to support them selecting the strategic partner to deliver this fifth generation JABMS capability that is enduring, innovative and ultimately, Australian.”

The company's focus for 2022 will be to continue to work with the Commonwealth to execute the risk reduction activity, while continuing to ensure that technology transfer from the US is occurring to invest in developing and fostering a strong Australian industry to support the evolution of the AIR6500 capability through its phases.

“We are committed to growing the capacity

and capability of Australian industry, and our investment in transferring technology from our US parent company is an important part of our AIC commitment.

“We also changed our operating model when I started with the company as General Manager, with P&L responsibility in Australia. The Northrop Grumman leadership of this program has now transferred to our Australian business. The growth in the Northrop Grumman Australian team has been significant to allow the reach back and transfer of decades of expertise, as well as leveraging global investment in integrated air and missile defence capabilities.”

The parent company has a transfer of technology program to Northrop Grumman Australia, while it is working with 12 Australian SMEs in the areas of sensors, artificial intelligence and deployable capabilities to extend to the broader Australian supply chain.

to producing and fielding the systems so that Army soldiers can start to operate this capability. This will give us a great insight, in real time, into how the system can operate and integrate with ADF capability in the future.”

The company says that recently, flight test 6 demonstrated the ability to connect multiple disparate U.S. Army, Marine Corps and Air Force systems that typically operate independently, as well as share data with a U.S. Navy C2 system. This was to enable command and control of the full battle space, which connects the joint force and enhances the coordination of defence and strike strategies.

Apparently, the demonstration allowed users to create a single operations picture, and gives them the ability to leverage whatever launcher is the best available at the time, compared to ones tied to certain sensors. The company says this is game changing technology. It's already making a

“This systems architecture will be the cornerstone of Australia's integrated air and missile defence (IAMD) capability. Our priority is to work with the Commonwealth to support them selecting the strategic partner to deliver this fifth generation JABMS capability that is enduring, innovative and ultimately, Australian.”

Chris Deeble, Executive Director Strategy, Northrop Grumman Australia, continued:

“The Integrated Battle Command System (IBCS) is the centre piece of the US Army's modernisation strategy for air and missile defence and is the foundation of the architecture of our JABMS solution under AIR6500 Phase 1.

IBCS is a software-defined, network-enabled command and control system that integrates and optimises every-sensor/best-effector operations built on a Modular and Open Systems Approach (MOSA) network. It's revolutionary in its approach to enabling the acquisition, identification, and engagement of air and missile threats.

“One of the benefits of using this as the basis for our solution offering is that years of rigorous systems integration and development efforts have already been invested in testing system performance and the ability of the war fighter to successfully deploy and use the system. The US Army approved Milestone C at the beginning of 2020, giving Northrop Grumman the ability to move forward with low-rate initial production. In 2022, the U.S. Army will move toward achieving initial operational capability, which means Northrop Grumman will go

great contribution to emerging Joint All Domain Command and Control (JADC2) capabilities, and the reason why other countries, like Poland, are seeking to utilise IBCS as the basis for their air and missile defence capabilities.

Christine Zeitz concluded:

“It's important to us that this program is being run by Northrop Grumman Australia, led by Australians with support from our U.S. Northrop Grumman team. This is important as Australians have the best understanding of our force posture and how best to integrate the Commonwealth's requirements through ASDEFCON. We're adding project management expertise over the top of local know-how and US technology transferred to Australian engineers. This will enhance the capability of our SME partners, growing our sovereign industrial capability and building an architecture that will best integrate into the Australian operational environment.

“We look forward to continuing to collaborate with our industry partners, including Lockheed Martin, Boeing and Raytheon through the phases of AIR6500 to bring the best of breed solution from industry to the Commonwealth.”

THE RAAF'S AIR MOBILITY FLEET

As a large Air Force, the RAAF operates many different types of aircraft, chosen to perform specialist roles. These are summarised into four fleets whose aircraft, despite having differing sizes and capabilities, have certain role commonalities.



HMAS Warramunga's MH-60R Romeo aircraft is being prepared for loading onto a RAAF C-17A aircraft at Christmas Island airport. Credit: CoA

Although this article is focusing on the Air Mobility Fleet it is worthwhile noting the constituents of the four Fleets.

Air Combat comprises fast jet aircraft which enable control of the air and the conduct of precision air strikes. The F-35A Lightning II is the Australian Defence Force's first fifth-generation air combat capability. The EA-18G Growler is an electronic attack aircraft. It is capable of disrupting, deceiving or denying a broad range of military electronic systems, including radars and communications.

Air Force has 24 F/A-18F Super Hornets, which ensure that Australia's air combat capability edge is maintained until the full introduction of the F-35A Lightning II. The F/A-18A (single seat) and F/A-18B (twin seat) Hornets are multi-role fighter aircraft, capable of air-to-air and air-to-ground missions. They are an integral part of Australia's air combat capability, but are gradually being phased out as the F-35A aircraft numbers increase.

The Air Mobility Fleet provide capability including air logistics, airborne ops, special ops, VIP transport, air to air refuelling, search and survivor assistance, aeromedical evacuation, and training.

This fleet will be described in more detail in the next section, although as one would expect it includes front line aircraft C-17A Globemaster III, C-130J Super Hercules and C-27J Spartan. Air-to-air refuelling and strategic air lift is provided by the KC-30A Multi-Role Tanker Transport (MRTT).

Small aircraft in the Air Mobility Fleet include two Boeing Business Jet aircraft and a Dassault Falcon 7X, which are the Special Purpose Aircraft fleet. The KA350 King Air is a modern twin-engine turboprop aircraft and is based at RAAF Base East Sale for multi-engine training and specialist near region operations.

The Intelligence, Surveillance and Reconnaissance Fleet of air surveillance aircraft assist with maritime warfare; aerospace, surveillance and battle space management; and developing our intelligence,

surveillance and reconnaissance and electronic warfare capabilities.

Aircraft include the P-8A Poseidon, based at RAAF Base Edinburgh, and an important part of Australia's future maritime patrol and response strategy as the AP-3C Orions are phased out. The E-7A Wedgetail provides Australia with one of the most advanced air battlespace management capabilities in the world. There are four MC-55A Peregrine aircraft currently on order for electronic warfare support. Coming into service is the Triton Unmanned Aircraft System, a high-altitude long endurance aircraft that will be used for maritime patrol and other surveillance roles.

Finally, the Aviation Training fleet are equipped with world-class aircraft and assets for training that supports and promotes the Air Force. The Pilatus PC-21 is the world's most advanced pilot training aircraft while the Hawk 127 lead-in fighter prepares qualified Air Force pilots for conversion to F/A-18A and F/A-18B Hornets and F/A-18F Super Hornets.

RAAF FRONT-LINE AIR MOBILITY

The C-17A Globemaster III provides the Air Force with an unprecedented capacity for strategic airlift. It allows Australia to rapidly deploy troops, supplies, combat vehicles, heavy equipment and helicopters anywhere in the world. The C-17A can be refuelled in-flight by the KC-30A, extending the Globemaster's range when necessary.

Based at RAAF Base Amberley, all eight C-17As provide a logistics backbone for ADF's operations overseas. This has included operations in the Middle East and Afghanistan, as well as East Timor. They are an integral part of disaster relief and humanitarian missions.

Australia introduced an initial fleet of four C-17As between 2006 and 2008. Additional aircraft were acquired in 2011, 2012, and 2015.

The C-17A Globemaster III is a high-wing four-engine heavy transport aircraft. It is fitted with a cargo bay ramp that allows it to airdrop cargo in-flight, and can operate from unsurfaced runways as short as 3500 feet, just over one kilometre.

Able to carry up to 77 tonnes of cargo, the C-17A's cargo bay can accommodate loads ranging from: an Abrams Tank; four Bushmaster vehicles; or three Black

Only for non-combat missions: a No. 35 Squadron C-27J Spartan, A34-009 on final approach to the airstrip at Mount Bunday Training Area, NT, during Exercise Arnhem Thunder 21. Credit: CoA / Stewart Gould



Because of the bizarre structure of the program, “green” aircraft were purchased from the Italian company Alenia for about \$30 million each – and then transported to the U.S. where another \$60 million per aircraft was spent on modifications – including the installation of the deficient EWSP suite.

Hawk helicopters. It can also be readily converted to a medical rescue aircraft.

The C-130J Super Hercules is a medium-sized tactical air-lifter which can deliver cargo to airfields with short unsurfaced runways, and airdrop cargo and paratroops by parachute.

A fleet of 12 are operated from RAAF Base Richmond. They were delivered to the base between 1999 and 2001. Upgrades to the C-130J have enhanced communications and information-sharing, and improved the aircraft's endurance during battle.

The Australian Defence Force relies extensively on the C-130J when deploying personnel and aid. They can also be used in other roles, such as Search and Survivor Assistance and medical evacuation of civilians.

The C-130J Hercules can carry up to 128 passengers, or eight pallets of cargo. It can work alongside other airlifters, including the C-27J Spartan and C-17A Globemaster III.

The C-27J Spartan bridges the gap between Army helicopters, such as the CH-47F Chinook, and larger Air Force aircraft, such as the C-130J Hercules and C-17A Globemaster III.

Much like the Hercules and Globemaster, the C-27J Spartan can airdrop cargo and paratroops in-flight; airlift a variety of cargo loads; and conduct aeromedical evacuation of sick or wounded personnel.

The first Spartan arrived in Australia in 2015 and the fleet of 10 Spartans, are based in RAAF Base Amberley.

The Spartan will provide airlift of people, equipment and supplies in Australia and throughout the region. It can operate from unsurfaced airstrips, and support humanitarian missions in remote locations.

However, the capabilities of the aircraft have been re-defined away from combat missions, mainly because of deficiencies in the level of electronic warfare self-protection (EWSP) that comes with them. Because of the bizarre structure of the program, “green” aircraft were purchased from the Italian company Alenia for about \$30 million each – and then transported to the U.S. where another \$60 million per aircraft was spent on modifications – including the installation of the deficient EWSP suite.

This appears to be an extremely poor use of taxpayer's money and is something that will be detailed in future editions of APDR.

KC-30A MULTI-ROLE TANKER TRANSPORT

The KC-30A (MRTT) is a heavily modified Airbus A330 airliner, and enables the RAAF to conduct air-to-air refuelling to enhance other aircrafts' flight time and range, and to provide strategic air lift. It features advanced communication and navigation systems, and an electronic warfare self-protection system for shielding against threats from surface-to-air missiles.

The RAAF are currently committed to seven KC-30A aircraft, including two converted ex-Qantas A330s, to be based at RAAF Base Amberley. The total number may grow to nine MRTT aircraft, possibly by converting a further two ex-Qantas A330s.

The KC-30A MRTT is fitted with two forms of air-to-air refuelling systems: an Advanced Refuelling Boom System mounted on the tail of the aircraft; and a pair of all-electric refuelling pods under each wing. These systems are controlled by an Air Refuelling Operator in the cockpit, who can view refuelling on 2D and 3D screens.

The KC-30A can carry a fuel load of more than 100 tonnes, and transfer part of that load to compatible aircraft, including: F-35A Lightning II, E/A-18G Growlers, F/A-18F Super Hornets, F/A-18A/B Hornets, P-8A Poseidon, C-17A Globemaster III and E-7A Wedgetails.

The MRTT can remain 1800 km from its home base, with 50 tonnes of fuel available to offload for up to four hours. Fuel loads can also be moved from one KC-30A to another.

In its transport role, the KC-30A is capable of carrying 270 passengers. It comes with under-floor cargo compartments which can accommodate 34,000 kilograms of military and civilian cargo pallets and containers.

DOMESTIC AND INTERNATIONAL PEACEFUL MOBILITY

The Air Force has a fleet of two Boeing Business Jet (BBJ) aircraft, which were introduced in 2002. They are part of the Special Purpose Aircraft fleet, operated from Defence Establishment Fairbairn in the Australian Capital Territory.

The BBJs provide an agile transport capability that can carry Government and staff within Australia and overseas. The aircraft has seating, a meeting room, working space, and communications facilities.

The BBJ has a crew of up to six (pilot, co-pilot, and up to four crew attendants) and is capable of carrying up to 30 passengers. It has a range of 11,390 km which enables it to fly directly from Canberra to Hong Kong or Tokyo.

TRANSPORT

The KA350 King Air is a modern twin-engine turboprop aircraft and is based at RAAF Base East Sale. They are used extensively for training of Air Force Mission Aircrew and Navy Aviation Warfare Officers at the Air Mission Training School at RAAF Base East Sale.

The KA350 King Air can be configured for a number of specialist roles, including Air Logistic Support, near-region International Engagement, Imagery Acquisition, Base Station Relay, Intelligence Surveillance, Targeting Acquisition, Reconnaissance and Electronic Warfare.

The Air Force's KA350, with a flexible light passenger and cargo transport capability within Australia, supports fisheries patrol activities including multi-national operations to detect illegal fishing and policing economic exclusion zones in the South Pacific.

The Dassault Falcon 7X is a special purpose 14 passenger and VIP transport aircraft which joined the Air Force fleet in April 2019. It has a range of up to 11,000km with a maximum operating speed of Mach 0.8.

The 7X features a high-tech wing, an advanced 'glass cockpit' with a heads-up display and an infrared enhanced vision system. The 7X also includes satellite communications for improved support for Government connectivity whilst airborne.

FRONT LINE AIR MOBILITY – A COMPARISON BETWEEN QUAD PARTNER FLEETS PLUS UNITED KINGDOM

This comparison is intended to show the relative size of Australia's front line mobility aircraft fleet compared with the air forces of India, Japan, United Kingdom and United States. In some countries land and maritime forces also have air mobility fleets but these have not been included.

The scope is restricted to three categories – inter-theatre (between home base and operational areas), intra-theatre (within an operational area) and battleground (short range tasks often on short dirt runways) plus the tankers that provide extra range for aircraft in transit.

To ensure that the aircraft numbers are included on a common basis, the data has been sourced from 'World Air Forces 2021' published by Flight International magazine and available on the internet.

The Royal Australian Air Force's front-line and tanker air mobility fleet was described in detail in the previous section, but is summarised here for ease of comparison. The RAAF's 8 C-17A Globemaster III aircraft do the heavy international lifting, while 12 C-130J's fly principally within an operational area. The 10 C-27J Spartans are tasked almost

exclusively to short range operations, carrying relatively light loads, often between poorly formed airfields. These transport aircraft are supported by six A330 KC-30A MRTT tankers.

The Indian Air Force has transport aircraft from two main sources. The United States have supplied 11 C-17 Globemaster III and 12 C-130J Hercules but India does not appear to have ordered a suitable tanker aircraft for these two types, despite several cancelled tanker acquisition programs. Their 104 Antonov AN-32 aircraft have outstanding take-off characteristics in hot and high conditions, up to 55°C and 4,500m elevation, making them suitable for use as a medium tactical military transport role. Operating as a cargo transport



A No. 33 Squadron pilot onboard a KC-30A Multi-Role Tanker Transport aircraft prior to an air to air refuelling sortie in Queensland, during Exercise Talisman Sabre 2021. Credit: CoA / Ben Dempster

over the short and medium range air routes, the An-32 is suitable for air-dropping cargo, passenger carrying, medevac, firefighting, skydiving or paratrooping roles. Also, from Russia they have 17 Ilyushin IL-76MDs, supported by 6 Il-78MKI tankers.

The Japan Air Self-Defence Force has 15 locally manufactured Kawasaki C1 transports, with 9 of their successor model C2 and 11 more on order. The total number of C2s will ultimately reach 40 for this advanced military aircraft. It can transport troops, drop supplies and undertake medical evacuation during the day and night, even in hostile environments. 4 767 (KC-46A) and 4 767 (KC-767J) tankers provide in-flight refuelling capability for the C1s and C2s. Japan also has 14 C-130H aircraft, supported by 2 KC-130H tankers.

The United Kingdom's Royal Air Force has 2 A330 transports, 19 A400M heavy transports with 2 more on order, 8 C-17s and 14 C-130Js. There are 9 A330 MRTT tankers in two versions, designated Voyager KC2 and Voyager KC3. The former is fitted with two Cobham 905E under-wing refuelling pods, the latter with a Cobham 805E Fuselage Refuelling Unit in addition to the under-wing pods; none are fitted with the Aerial Refuelling Boom System.

The United States Air Force as one would expect has a wide range of aircraft. There are 222 C-17s,

182 C-130Hs and 136 C-130Js with 14 on order and a further 27 predicted to be ordered. Tanker numbers are large with 36 767 (KC-46A) in service with a further 26 on order and possibly an additional 108 to be ordered in future years. Additional tanker types are 58 DC-10 (KC-10), 14 MC-130H and 51 MC-130J with 10 more on order and an additional 13 likely to be ordered in future years. The venerable KC-135R/T Stratocruiser, now re-engined, has been at the heart of USAF aerial refuelling for 60 years. These KC-135s are capable of refuelling two receiver aircraft at the same time from flying booms trailing from each wing. Air Mobility Command manages an inventory of 396 Stratotankers, of which the Air Force Reserve and Air National Guard fly 243 aircraft in support of AMC's mission.

FUTURE ROLES FOR UNMANNED AERIAL VEHICLES?

The Triton Unmanned Aircraft System is a high-altitude long endurance aircraft that will be used by the RAAF for maritime patrol and other surveillance roles. They can support airborne missions for as long as 24 hours, something a single cockpit pilot cannot achieve. The seven Tritons will be flown by qualified Air Force pilots from a ground station, supported by a co-pilot.

Sensor suite information is gathered by a 360-degree view of its surroundings for over 2000 nautical miles. That information will be analysed and communicated by operational staff.

The Commonwealth at the end of 2019 announced the selection of the General Atomics Aeronautical Systems MQ-9B Sky Guardian as its preferred version of the Predator B for the RAAF's Project AIR 7003 medium-altitude long-endurance armed remotely piloted aircraft system requirement.

When the author was on a 2013 sponsored visit to Sikorsky (now part of Lockheed Martin) at Owego, upstate New York, to view ADF's first MH-60R Seahawk helicopter just finished manufacture, he witnessed an unmanned Kaman K-MAX helicopter with an underslung load conduct a demonstration resupply flight. At this time the U.S. Marines had two operational in Afghanistan. They can carry a 2700 kg under-slung load during an up to 12-hour mission 500 km away from the operating base and return home without refuelling.

APDR asked Defence 'Does the ADF have any plans to introduce large unmanned helicopters for moving freight by air into highly contested areas?' 22 days later no response had been received from Defence Media, which suggests they put this question in the "Nothing to say" basket and have just ignored the enquirer.

MIKE YEO // MELBOURNE

RAN ORDERS ANOTHER DOZEN MH-60R SEAHAWKS

The Royal Australian Navy's Sikorsky MH-60R program has been an undeniable success story. The Navy currently operates a fleet of 24 MH-60Rs from HMAS Albatross in Nowra, NSW split among two squadrons, with 725 Squadron primarily assigned to training duties while sister unit 816 Squadron handles operational duties. The helicopters were ordered from the United States under the AIR 9000 Phase 8 Future Naval Aviation Combat System Helicopter program in 2011 to replace older S-70B Seahawks and delivered to Australia between 2013 and 2016.

The helicopters were acquired under the U.S. Foreign Military Sales (FMS) program and were meant to be the Navy's primary antisubmarine helicopter operating from its surface combatants. Since then, the type has proven its worth in many other roles and the Navy has subsequently integrated the MH-60R onto a range of vessels that were not included in the original plans when Australia decided to acquire the type.

These include the RAN's support ships as well as the Canberra-class landing helicopter docks and will certainly include other ships coming downstream for a variety of missions. The diverse mission-sets range from maritime domain awareness, electronic warfare, vertical replenishment as well as search and rescue, thanks to its extensive onboard suite of networked systems.

The systems include the Telephonics AN/APS-153 multi-mode radar, Hawklink datalink, ALFS, Orbital ATK (now part of Northrop Grumman) AN/AAR-47 Missile Approach Warning System (MAWS), Raytheon AN/AAS-44 electro-optical system that also integrates FLIR and laser rangefinder, and the Thales/Raytheon AN/AQS-22 Airborne Low Frequency Sonar (ALFS).

Weapons carried by the MH-60R also reflect its multi-mission capability, with the Raytheon Mk.54 lightweight torpedo being the primary anti-submarine weapon. For surface warfare the helicopter can utilise the Lockheed-Martin AGM-114N Hellfire air-to-surface missile and BAE Advanced Precision Kill Weapon System (APKWS) laser-guided rocket.

Defence's 2020 Force Structure Review referenced the MH-60R with a confirmation that investment will continue in the "acquisition and through-life upgrades of the MH-60R anti-submarine helicopter" with \$1.5-2.3 billion earmarked for capability assurance beyond 2035.

This is on top of another \$1.5 billion for a "logistics helicopter" between 2025 to 2030 to "expand and rationalise the support and logistics



HMAS Ballarat's embarked MH-60R helicopter, "Athena", winches Able Seaman Electronic Warfare Britney Szilagyi from the flight deck during a Regional Presence Deployment in the Indian Ocean. Credit: CoA / Ernesto Sanchez

helicopter fleet consistent with the expectations for larger naval operations."

The latter has since been revealed to be for the 12 additional MH-60Rs that the US State Department had approved on the 8th of October. Of note in the request was that the helicopters would have provisions for the Airborne Low Frequency Sonars (ALFS) but the sonars themselves were not specified, suggesting that the new helicopters were not being sought primarily for anti-submarine warfare (ASW).

Defence has subsequently confirmed that the FMS request was made under Project Sea 9100 Phase 1 (Embarked Logistics Support Helicopter Capability),

but also stating that the Navy will divest itself of the MRH-90 Taipan from its current role as the primary shipboard logistics helicopter.

Despite its versatility, the MH-60R is perhaps less than ideal for the role, given its cabin and cabin door is smaller than that of the MRH-90, with the door mounted on the starboard side. The US Navy uses the MH-60S Knighthawk, which is based on the airframe of a UH-60 Blackhawk with a bigger cabin and doors on both sides, in the fleet logistics role, but production of the model has already ended.

In its acquisition of the MH-60Rs, known locally as the Romeo via the FMS channels, Defence has chosen to keep its development pathway close to that of the U.S. Navy's fleet of helicopters. Under the MH-60R Capability Assurance Program (Project SEA 5510) the Navy has aligned its aircraft configuration with that of the US Navy to ensure commonality and interoperability between the aircraft of two navies.

This has helped in enhancing interoperability between the allies, with the helicopters from both navies able to go out to sea and work together to carry out a mission using common systems and broadly similar tactics and procedures.

The sustainment model the two navies are using for their respective helicopter fleets are also similar. Australia signed up for 10-year agreement with U.S. Navy to support the whole MH-60R system in 2018 with the work being conducted locally by Sikorsky Australia, and the RAN can plug into the USN's system and access parts from an American ship if needed.

The news of more helicopters was however tempered by the loss of one of the existing airframes when it ditched into the Philippine Sea during a Regional Presence Deployment on the 13th of October while operating from the destroyer HMAS Brisbane. All three crew were swiftly rescued, and the fleet was temporarily grounded, but the order was reversed five days later.



An MH-60R from Helicopter Maritime Strike Squadron 78, embarked in USS Carl Vinson, conducts a Cross Deck Exercise on HMAS Ballarat's flight deck during Exercise MALABAR in the Indian Ocean. Credit: Ernesto Sanchez

REGIONAL THREAT

The somewhat belated realisation of a shift in the regional geopolitical situation has increased the need for the RAN and RAAF to maintain and even step up its ASW game and comes as diesel-electric attack submarines are increasingly sought by regional navies. The increase in numbers of submarines entering service in the region is matched only by a corresponding increase in their capabilities.

While many of these new and more capable submarines are in the hands of nations closely aligned to Australia such as Japan's lithium battery-powered Taigei-class and Singapore's Type 218SG (Invincible-class) boats, other less-friendly Indo-Pacific countries are also pushing forward with programs.

Needless to say, China is one of these countries. The introduction of modern, capable submarines has been a vital component of the People's Liberation Army Navy (PLAN) amazing modernisation over the past two decades, and China has gone from operating old, noisy boats that sometimes posed a bigger danger to its crews than to the enemy, to rapidly putting new classes of conventional-and nuclear-powered vessels into service.

This has no doubt been helped by the acquisition of 12 Kilo-class diesel-electric attack submarines (SSK) from Russia beginning in the late 1990s. The two initial boats were of the standard Project 877 export-standard while the remaining ten are Improved Kilos (Project 636). All ten boats were

delivered by around 2007.

The Kilos are armed with a mixture of torpedoes and Russia's 3M54 Club-S anti-ship/land-attack cruise missile and are joined in PLAN by several domestically built submarine classes. The newest of these is the Type 039 (Song-class) and 039A (Yuan-class) boats.

Despite the similar nomenclature, there is very little similarity between the sub-types, with the latter class inheriting only the tail design of the former. The newer Yuan class is bigger, dives deeper and features improved noise reduction features, and is further divided into four sub-classes with minor differences such as the addition of flank sonar arrays or changes to the configuration of the conning tower.

The PLAN also has nuclear-powered attack submarines (SSN) for operations further afield. The 7,000-tonne Type 093 and 093G (both known as the Shang-class), which are equipped with vertical-launch tubes for cruise missiles in addition to torpedoes, is rapidly being introduced into service, replacing older hulls.

Chinese sources saying that the 093s are as quiet as the improved Los Angeles-class or Russian Akula-class SSNs. The U.S. Navy's Office of Naval Intelligence (ONI) puts their noise level as on par with the 1970s-era Soviet Project 671RTM/RTMK (Victor III) SSN. The Chinese appear to be not fully satisfied with the design, for Type 093G production has stopped after three boats and the PLAN is moving on to developing a new class of SSNs known

as the Type 095.

Performing the sea-based nuclear deterrent role for the PLAN is the Type 094 (Jin-class) nuclear-powered ballistic missile submarine (SSBN). These 11,000-tonne boats each carry 12 JL-2 nuclear-tipped submarine-launched ballistic missiles, each with a range of 7,000 kilometres (4,500 miles), in theory putting the RAN's major bases at Sydney and Fremantle in range from waters west of Taiwan.

Owing to a lack of prominent identifying features or pennant numbers painted on China's submarines, it is almost impossible to independently keep track of the number of them in service. However, the Pentagon's 2019 China Military Power Report says the PLAN has 50 SSKs, six SSNs and four SSBNs, although open-source investigations have suggested the current figure for the latter is likely to be six.

BI-STATIC/MULTI-STATIC ASW

Anti-submarine warfare has always been a cat-and-mouse game and requires team effort from a host of players that include surface ships, fixed and/or rotary wing aircraft. It is also a constant race between making submarines harder to find and ASW systems that improve the ability to detect their quarry.

Today major enabler that is emerging in the field of submarine-hunting is the concept of multi-static ASW. This involves one or more active emitters, a larger number of passive receivers and potentially a range of platforms, turning it into a collaborative sensor network.

In theory, only the active sensors will be visible to the submarine in such a scenario, leaving it unaware of the number of sensors looking (or rather, listening) for it. This would render the effectiveness of classic evasive manoeuvres like minimising the surface area facing pinging sonar into a game of chance.

Other advantages include excellent triangulation of the position and its tracking, extended (or flexible) echo range by optimally positioning the transmitter and receiver, and the potential for making the receiver stealthier by being passive rather than active.

One of the easier ways to enact multistatic ASW is through the employment of sonobuoys. Sonobuoys are air launched expendable, electro-mechanical acoustic sensors designed to relay underwater sounds of ships and submarines and enable ASW forces to detect and track submarines operating in open ocean and in coastal areas of interest.

These sensors can be dropped by fixed wing aircraft or ASW helicopters in a fixed pattern, which can then send back any detected acoustic signatures to friendly ASW forces by radio link, to determine the exact locations of enemy submarines. Information from these systems can help enable

precision attacks with air-launched torpedoes.

The current standard U.S./NATO multistatic sonobuoy is the AN/SSQ-125 made by ERAPSCO, a joint venture between Sparton Corp. and Ultra Electronics. The AN/SSQ-125 acts as a source in a multistatic field, and can generate a variety of waveforms, and is designed to work with the AN/SSQ-53F Directional Frequency Analysis and Recording (DIFAR) sonobuoy.

The AN/SSQ-125's RF channel can be programmed to any of the standard sonobuoy operating channels. At any time after deployment, the AN/SSQ-125 can be commanded to change its operating parameters or depth (deeper only), generate a ping, or scuttle.

CAE MAD-XR

A magnetic anomaly detector (MAD) is an instrument used to detect minute variations in the Earth's magnetic field. The term refers specifically to magnetometers used by military forces to detect submarines (a mass of ferromagnetic material creates a detectable disturbance in the magnetic field); military MAD equipment is a descendant of geomagnetic survey or aeromagnetic survey instruments used to search for minerals by detecting their disturbance of the normal earth-field when a large metallic object such as a submarine is nearby.

MADs were part of a variety of equipment in the toolkit of the ASW world. Up till now they have mainly been fitted to larger aircraft such as the Lockheed-Martin P-3 Orion or on helicopters such as the Sikorsky SH-60 Seahawk. The latter, designated the AN/ASQ-81, is an external store resembling a small rocket and was commonly referred to as an "MAD bird".

The AN/ASQ-81 MAD bird is towed behind and below the helicopter when in use and is deemed too heavy for the MH-60R especially given its reeling machine is in the 100-lb (220-kg) weight class. Instead, in November 2020 Lockheed Martin awarded CAE a contract to supply its Magnetic Anomaly Detection-Extended Role (MAD-XR) for the US Navy's MH-60Rs.

The MAD-XR will complement the AN/ASQ-22 ALFS, adding an additional sensor layer on to the MH-60R's anti-submarine mission. The key advantage of the new system is that it is reduced in size, weight and power requirements compared with its predecessors.

This is illustrated by the MAD-XR weighing in at just 1.5kg – a fraction of the 27kg of the earlier AN/ASQ-508A MAD. This means that the new sensor can be integrated with helicopters, small UAS, and small fixed-wing aircraft, a key consideration in



HMAS Canberra's embarked MH-60R helicopter, 'Athena', launches decoy flares in a capability demonstration, as the ship sails through the Timor Sea. Credit: CoA / Nadav Harel

today's environment.

CAE has also developed new software that allows for submarine location in the form of lateral and vertical separation (left/right indication) at the closest point of approach (CPA), opening the route for the capability to recommend a tactical flight path to the crew for optimizing target localization and detection.

The inclusion of high bandwidth frequency to digital conversion provides better detection due to reduced background noise in higher frequencies as well as potential classification on the signature of the submarine.

"Over the past several years we have conducted several trials with the U.S. Navy to confirm the capabilities of the MAD-XR system on the MH-60R helicopter," Lockheed Martin's director Naval Helicopter Programs, Thomas M Kane said in a statement. "Adding this to the MH-60R's sensor suite will further advance the capabilities of the world's most advanced anti-submarine warfare helicopter."

CAE's Group President Defence & Security, Daniel Gelston added, "The integration of our MAD-XR system on the US Navy's MH-60R helicopter is testament to its powerful magnetic detection abilities. The MAD-XR system can provide defence forces with enhanced capabilities for operational missions such as submarine detection and search and rescue."

The CAE MAD-XR prototype was successfully flown in 2013 and its performance matched that of the AN/ASQ-508, with flight trials on MH-60R completed in early 2017. Phase 1 of the contract will

see the MAD-XR integrated with six MH-60Rs and, if successful, the sensor will be rolled out across the US Navy's fleet.

CAE also touts other utilities for the MAD-XR, even in the land domain for overland surveillance and detection. The company been exploring it as a possible solution for land-based surveillance and detection and suggests that with a MAD system mounted on a ground vehicle or UAV, the system could detect a variety of land targets such as armoured vehicles or artillery.

It further adds that the MAD system is capable of detecting metallic objects through walls, buried underground, or hidden in dense forest canopies. With Australia opting to tack on closely to the USN's MH-60R program, the MAD-XR might be something the RAN will look to acquire for its Romeo roadmap down the road as submarines continue to proliferate in the wider IndoPacific region and the potential threat to Australia's sea lanes gains more awareness.

The MH-60R is regarded as one of the best, if not the best ASW helicopters in service today, being able to trace its lineage to a family of highly developed shipborne anti-submarine helicopters that has been constantly improved since the 1980s.

With the capabilities of the RAN's helicopters tied to that of the U.S., it is hoped that some of the painful experiences the Navy encountered in sustaining and enhancing the capabilities of the older S-70B-2s that were retired in 2017 can be avoided and ensure that a continuous development pathway through to the Planned Withdrawal Date of the type, which is currently slated for the 2040s.



Army Tiger ARH. Credit: CoA / Bill Solomou

GEOFF SLOCOMBE // VICTORIA

FULL SPECTRUM ADF HELICOPTER PILOT TRAINING

The Australian Defence Force is a very experienced military helicopter operator.

While the Royal Australian Air Force (RAAF) does not possess any helicopters, the Royal Australian Navy (RAN) now operates 23 MH-60R 'Romeo' combat helicopters, after one was lost recently, and six MRH90 Taipans. The Australian Army currently have 22 ARH Tigers, 41 MRH90 Taipans, 20 UH-60 Black Hawks (being de-commissioned by the end of 2021) and 12 CH-47F Chinooks.

This fleet will grow with the 22 Tiger helicopters to be retired at least a decade early to be replaced by 29 AH-64E Apaches, at a cost of \$5 billion. In a similar swap of European for U.S. technology, the RAN will stop using their Taipans and will instead purchase an additional 12 MH-60Rs.

Initial helicopter pilot training, which is based at RAN 733 Squadron at HMAS Albatross, Nowra NSW, is conducted utilising 15 Eurocopter EC135 T2+ aircraft for both Navy and Army trainees.

APDR sought comments from Commodore Don Dezentje RAN, Commander of the RAN's Fleet Air Arm, on the importance of excellent initial and advanced helicopter pilot training for Navy.

Commodore Dezentje responded:

'A joint approach to pilot training enables Navy's people to obtain the necessary skills and experience to operate world class complex helicopters in the maritime environment in order to deliver aviation combat power in support of broader naval power requirements.

'Operating in a crewed environment with Aviation Warfare Officers and Sensor Operators, Navy aircraft roles include anti-submarine warfare, anti-surface warfare, maritime strike, maritime support, and Humanitarian Aid and Disaster Relief Operations.

'Whilst manned aircraft currently form the core of Navy aviation capabilities, unmanned aircraft systems are being operated on shore and at sea. These systems are being flown by Remote Pilot Warfare Officers. Their training is conducted at Nowra in 723 and 822X Squadrons.

'Collectively manned and unmanned aviation systems will provide the future aviation combat systems that support Navy's requirement to deliver naval power to fight and win at sea.'

The RAN is set to dump its troubled fleet of European-made MRH90 Taipan helicopters. Australia's MRH90s were first acquired from

2006 but have suffered from poor availability since entering service, forcing the Army to recently lease interim helicopters for training and non-combat transport roles.

Last year, parliament was told the door on the MRH90 was too narrow to allow its gun to fire while troops were descending, and that a third round of remedial work was being carried out on the fleet.

Navy sees the solution to this problem is to acquire a further 12 MH-60R Seahawks to replace the withdrawn MRH90s. Since the RAN already operates 23 MH-60R Seahawks this next purchase would mean a common fleet of 35 aircraft.

During October this year the US State Department cleared Australia's request to buy these additional Sikorsky-built multirole naval helicopters along with related equipment and support services under a potential \$US 985 million foreign military sales agreement.

The possible transaction will include aircraft components such as T-700-GE-401C engines, Link 16 Multifunctional Information Distribution Systems – Joint Tactical Radio Systems and Airborne Low Frequency Sonars.

DSCA said Lockheed Martin's rotary and mission systems business in Owego, New York, will act as the primary contractor for the proposed FMS deal. US government and contractor representatives would travel to Australia if the two countries implement the agreement to perform technical support work.

TRAINEE HELICOPTER PILOT SELECTION

APDR understands that all ADF helicopter pilots are commissioned officers. We asked a Defence spokesperson 'Can someone already in the ADF, who is not yet commissioned, apply to train as a helicopter pilot?'

They responded:

'Yes, however, if accepted for pilot training, trainees will first have to complete officer training at either the Royal Australian Naval College at HMAS Creswell for Navy or Royal Military College Duntroon (RMC) for Army. Navy accepts direct entry pilots.

'Army does not currently recruit direct entry pilots, therefore any applicant for Army pilot training must also meet the requirements for completing the full General Service Officer course at RMC.

'Allocations to each service are very limited, with any exceptions needing to be agreed by the respective Services.'

INITIAL AND ADVANCED FIXED WING FLYING TRAINING

Navy helicopter pilot trainees undertake the same training as future Air Force fixed wing pilots at 1 Flying Training School (FTS) (RAAF East Sale) and 2FTS (RAAF Pearce). They receive their wings upon graduation from 2FTS, before undertaking helicopter training in Nowra at 723 Squadron.

Army-only pilot trainees complete a shorter 23-week fixed wing course at 1FTS before they commence helicopter training at 723 Squadron. They receive their wings on completion of that course.

NAVY AND ARMY HELICOPTER PILOT TRAINING AT 723 SQUADRON HMAS ALBATROSS, NOWRA

With respect to initial rotary wing training; while there are common aspects for Navy and Army pilots at 723 Squadron, this is conducted on separate courses due to the different entry experience levels of Navy and Army trainees.

The Helicopter Aircrew Training Systems (HATS) at Nowra, where Initial Operating Capability was

announced in April 2019, features Thales EC135 Reality H full-motion flight simulators, part task trainers and classroom instruction, as well as 15 Airbus EC135 T2+ helicopters.

HATS can train up to 144 helicopter pilots, aircrew, aviation warfare officers, aircrewmen and sensor operators per year.

Defence said:

The Flight Deck Trainer facility at HMAS Albatross is primarily aimed at training and qualifying flight deck teams in procedures specific to ship-based aviation operations, such as marshalling and Helicopter In-Flight Refuelling (HIFR).

'Pilots operate to the static Flight Deck Trainer as

The Helicopter Aircrew Training Systems (HATS) at Nowra, where Initial Operating Capability was announced in April 2019, features Thales EC135 Reality H full-motion flight simulators, part task trainers and classroom instruction, as well as 15 Airbus EC135 T2+ helicopters.

Following successful completion of Pilot Intermediate training at RAAF Base Pearce and gaining their Wings, Navy officers move to 723 Squadron at HMAS Albatross to undertake Basic Pilot Rotary Training on the EC135 helicopter.

Pilots then consolidate their flying skills on the EC135 for up to 12 months before commencing Operational Flying Training on either the MH-60R or MRH90.

During this Basic Pilot Rotary Training at 723 Squadron Navy students will receive day and Night Vision Device (NVD) flight operations which include: low level terrain flight, ship-deck landings, hoisting, load lifting, confined area operations, maritime Hi-line transfers, helicopter in-flight refuelling, formation flight and extensive emergency and malfunction training.

APDR asked about the use of HMAS Albatross,

part of their training in all Navy helicopter types and will assist in the delivery of training for Flight Deck Teams at the trainer once fully qualified.'

Defence added that they had acquired the training ship MV Sycamore for helicopter landings on a vessel underway at sea, amongst a couple of other roles:

'Navy pilots utilise MV Sycamore for initial deck training and qualification as part of their course at 723 Squadron.'

Navy pilots then train to operate from RAN Air Capable Warships by day and night during conversion to operational aircraft types.

The separate Army Rotary Course Pilot, of approximately six months duration, also takes place at HMAS Albatross Nowra, straight after they complete their fixed wing course at RAAF East Sale, and develops many of the skills being taught to Navy pilots.



MH-60R helicopter Tiger 16 fires an AGM-114N Hellfire missile during the Anti-Submarine Warfare phase of Exercise Tigerfish off the coast of South East Australia. Credit: CoA



All flares being jettisoned from an MRH-90 Taipan at Brymaroo airfield, at the Army Aviation Training Centre, Oakey, Queensland. Credit: CoA / Jayme Saunders

During this course, Army trainees will receive approximately 87 live flying hours and 77 simulator hours in the EC135 helicopter and full mission flight simulator.

The course builds on the experience gained on the basic pilot initial flight training experience with the aim of providing the skills, knowledge, attitude and other attributes necessary for trainee Army pilots to commence operational type training.

Regarding the issue of whether Army pilots train on the Sycamore, Defence said:

'Army graduates do not practice at sea landings as part of their initial Helicopter Qualification Course. Army graduates who remain at 723 Squadron whilst awaiting their operational type transitions can conduct their initial Deck Landing Qualification on MV Sycamore.'

On completion of the Army Rotary Course Pilot at 733 Squadron Nowra, which provides helicopter qualification, Army pilots gain their wings and move on to the School of Army Aviation at Oakey, Queensland.

ARMY HELICOPTER PILOTS MOVE TO THE SCHOOL OF ARMY AVIATION, OAKEY

A Defence spokesperson for the Army's Aviation Command provided this statement on helicopter pilot training.

'The helicopter pilot training regime is fundamental to Army Aviation Command's ability to deliver aviation capability in support of Army's generation of land

power to the Joint Force now and in the future.

'The flying training institutions equip our young men and women with the knowledge and skills required to conduct a range of flying operations from support to the community in times of crisis to combat operations in theatres of conflict.

'Equally, it is the current cohort of helicopter pilot trainees progressing through the Tri-Service training establishments who will pilot our aircraft of tomorrow, such as the AH-64E Apache Guardian, and ensure we are Future Ready.'

When Army pilots transition to their main operational training activities are:

- Initial MRH Taipan and ARH Tiger operational type transition courses for Pilot and Aircrewman trainees;
- Qualified Flying Instructor training for MRH Taipan and ARH Tiger instructors; and
- All MRH Taipan and ARH Tiger refresher and transition training for previously qualified aircrew.

Army pilots can be allocated to CH-47F Chinook as their first operational type on completion of initial helicopter qualification course at 723 Squadron.

The School of Army Aviation at Oakey is responsible for all CH-47F Chinook aircrew training, but initial qualification training is conducted in the USA, with trainees attending the standard US Army Aircraft Qualification Course. All subsequent training is conducted at 5 Aviation Regiment Townsville. This is a more efficient way of conducting training than splitting the small CH-47F Chinook fleet across two locations.

Operationally, Army helicopter pilots are likely to

be deployed on LHDs at some stage. For amphibious and other operations, they normally start landing on the LHDs or other Navy vessels after a pilot qualifies on their operational types. This training is scheduled around the availability of LHDs, given the high demand on the ships. Flight simulators are used to assist some elements of deck landing training.

The next major training activity for selected Army helicopter pilots will be their operational conversion from flying Tigers to the Boeing AH-64E Apache Guardian. Australia is acquiring 29 of these advanced Apaches from 2025 to replace all 22 Tigers.

This has been a controversial decision because although the Tigers had a number of problems to be resolved when they were first acquired, which resulted in the hourly flying costs being way too high, there are several knowledgeable commentators who believe that they are now satisfactory for their role. They express the view that Australia is spending over an extra billion dollars for not a very significant gain in capability.

However, it was Defence's view that the Apache Guardian is the most lethal, most survivable and lowest risk option, meeting all of Defence's capability, through-life support, security, and certification requirements. They consider that by pursuing a proven and low-risk system offered by the Apache, Defence will avoid the ongoing cost and schedule risk typically associated with developmental platforms.

With the improvements in Tiger helicopter performance and operating costs, and given that these aircraft still have many flying hours left, questions have

been asked about the possibility of Army retaining both armed reconnaissance helicopters.

Army and Defence have made it clear that they will not accept this proposition.

Operating costs are a key consideration, given the other challenges to Army's budget. Airbus claim operating Army's Tigers should come in around \$A9,500/flying hour. Meanwhile the Royal United Services Institute, which is the world's oldest and the UK's leading defence and security think tank, estimate \$A27,000/flying hour. One piece of commentary seen by APDR stated that by late 2017 an Australian National Audit Office reported the cost per flight hour for the ARH Tiger averages about \$A26,000, but that covers training, engineering support and others elements of maintenance, which have been amalgamated.

Flying hour cost comparisons are always difficult because of a lack of consistent measurements, especially since the Apache will not be here for another four years. It has been claimed that Apache's projected operating cost per flying hour will be \$A10,567. It was a very brave person who made such a precise forecast without the necessary Australian experience data to back it up.

What are the attractions for Army to move from the

Tiger to the Apache?

Certainly, that Australia will be joining a large user community operating in our region including the armed forces of US, Singapore, Indonesia, South Korea, Japan, Taiwan and the UK. This can provide shared logistics, easy interoperability, and group learnings.

Apache's suite of mission systems is fully developed with advanced digital connectivity such as Link 16 tactical data network and advanced satellite communications. This gives the possibility of Apache not only linking into mission command networks, but also for itself to control a range of autonomous lethal unmanned aerial vehicles.

Are there any potential problems operating the Apache versus the Tiger? Apart from Apache having a gross weight of 8000kg compared with Tiger's 5000kg, the Apache's range is only 475km compared with Tiger's 796km, effectively restricting the Apache's operating radius to around 250 km when operating from a single base, with limited loitering time.

IN CONCLUSION

Overnight 13/14 October an RAN MH-60R Seahawk helicopter with three crew members on board conducted an emergency landing of their helicopter

into the waters of the Philippine Sea during a routine night flight. The aircraft was operating from HMAS Brisbane as part of a Regional Presence Deployment, in company with HMAS Warramunga,

The three RAN crewmembers were safe as HMAS Brisbane deployed sea boats and rescued the crew approximately 20 minutes later. A perceived deficiency of Seahawks is that they lack flotation devices and in situations like these after they ditch, they sink – unlike, say, the European NFH.

Commander of the Australian Fleet, Rear Admiral Mark Hammond, commended the crews of both ships involved for their quick response to the emergency:

'The successful rescue is credit to the devotion to duty and skill of the officers and sailors of HMAS Brisbane. Their immediate actions ensured the survival of the aircrew, validating the significant training undertaken in the event an emergency of this nature occurs.'

Both ships continued to search the area for any debris, which will aid in determining the cause of the incident. 'With the aircrew safe, investigating the circumstances that led to the helicopter ditching is the priority at the moment,' Hammond said. 'As a precaution, we have temporarily paused flying operations of the MH-60R Seahawk fleet.'

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FORGING AHEAD – SOUTH KOREA'S GROWING AIR POWER

At the ADEX 2021 defence exhibition, South Korea displayed some of its latest equipment, innovations, and concepts aimed at further strengthening the country's already formidable aerial capabilities. The event confirmed that Seoul is determined to also use locally developed technologies not only to help counter the growing military threats posed by North Korea but also to position itself as a regional power.

Companies such as Korea Aerospace Industries (KAI) and Korean Air took centre stage at the 2021 edition of the Seoul International Aerospace & Defense Exhibition (ADEX) held from 19-23 October, with both showcasing an array of aircraft models and unmanned aerial vehicles (UAVs) that are either currently in service with the Republic of Korea Air Force (RoKAF) or at the concept/development stage.

One of the most important was KAI's KF-21 Boramae (Young Hawk) multirole fighter aircraft, development of which began in 2015 under the Korean Fighter eXperimental (KF-X) program to fully replace the RoKAF's fleet of F-4E Phantom II and F-5E/F Tiger combat aircraft.

THE KF-21 BORAMAE

The first prototype of the '4.5-generation' fighter had been unveiled on 9 April 2021 in a ceremony held at KAI headquarters in the South Korean city of Sacheon, that was also attended by South Korean President Moon Jae-in and Indonesian Defence Minister Prabowo Subianto.

Jakarta is the only foreign partner in the approximately KRW8.8 trillion (US \$7.9 billion) KF-X development program, which is known as the Indonesian Fighter eXperimental (IF-X) program in the Southeast Asian country.

The maiden flight of the first KF-21 prototype is planned for 2022, with KAI set to complete work on five other prototypes – two of which are expected to be tandem-seat variants – that same year.

After completion of four years of flight tests, mass production of the KF-21 is expected to start in 2026 with the 'Block 1' aircraft, which will be equipped with limited air-to-ground and air-to-air weapons. From 2028 the 'Block 2' jets will be capable of performing full air-to-air and air-to-ground combat missions. The RoKAF is planning to acquire 40 examples of the fighter by 2028 and another 80 by 2032.



KF-21 Boramae (KAI photo)

Powered by two General Electric (GE) Aviation F414-GE-400K engines, it's expected to reach a top speed of about 1,400 mph (or about Mach 1.83), be capable of carrying up to 7,700 kg of payload, and have a range of about 2,900 km, and a maximum take-off weight of 25,580 kg, according to KAI.

It will be equipped with advanced sensors, avionics, and weapon systems, with three hardpoints under each wing for weapons and/or external fuel tanks and will also be capable of carrying four missiles under the fuselage, according to the company.

In its 2021-2025 Mid-Term Defense Plan, the Ministry of National Defense (MND) confirmed that the country will begin developing long-range air-to-surface and air-launched anti-ship guided missiles for integration with the KF-21.

MUM-T CAPABILITIES

The KF-21 is not the only project where KAI is working together with an overseas company. In fact, Israel Aerospace Industries (IAI) signed a memorandum of understanding (MOU) with KAI during ADEX 2021 on a loitering munitions program designed to maximise the effectiveness of suppression and destruction of enemy air defence (SEAD & DEAD) missions.

The MoU was the second of its kind signed between IAI and KAI since March, with the South Korean company known to already be working on a manned-unmanned teaming (MUM-T) capability for some of its future helicopters, including the Surion Marine Attack Helicopter (MAH). This is to be developed for the Republic of Korea Marine Corps (RoKMC) – and the Light Armed Helicopter (LAH),

which under development for the Republic of Korea Army (RoKA).

In a video shown at the event, the company also revealed a concept known as 'LAH Manned-Unmanned Teaming' that would see multiple unmanned versions of the LAH operating together with a manned LAH.

ADDITIONAL ROLES FOR THE FA-50

In terms of aircraft already in service, the company also confirmed plans to enhance both the range and combat capabilities of its FA-50 Fighting Eagle, not only to bolster the capabilities of the RoKAF – which currently operates about 60 of them – but also to make

already integrated the FA-50 with Lockheed Martin's Sniper Advanced Targeting Pod (ATP) as well as with the GBU-12 Paveway II laser-guided bomb.

KAI also disclosed that a future unmanned version of the FA-50 is being considered to operate in conjunction with the KF-21 fighter as a loyal wingman.

After completion of four years of flight tests, mass production of the KF-21 is expected to start in 2026 with the 'Block 1' aircraft, which will be equipped with limited air-to-ground and air-to-air weapons.

NEW BASIC TRAINER CONCEPT

Also, KAI, which is also looking to meet the RoKAF's future training requirements, unveiled a concept model of a new electrically powered basic training aircraft known as Black Kite (Sorigae).

Expected to feature an electric propulsion system powering a total of four propellers mounted on the wings, the 4.7 m-high and 11.6 m-long platform – with a wingspan of 11.2 m – is meant as a replacement for RoKAF's KT-1 trainer.

the aircraft more competitive for the export market.

KAI revealed in an image shown at ADEX 2021 that the upgrade program, which is expected to begin in 2022, will involve fitting the light combat aircraft with a 300-gallon external fuel tank, a helmet-mounted display, an aerial refuelling capability, an AESA radar, and a glass cockpit with a large area display.

It will also include integrating the platform with targeting pods and new weapons systems, including mid-range air-to-surface missiles. The announcement came only a few months after KAI revealed that it had

UAV DEVELOPMENTS

Meanwhile, Korean Air displayed a number of military UAV models at the show, including vertical take-off and landing (VTOL), medium-altitude long-endurance (MALE), stealth, and hybrid UAVs.

One of them was the in-service KUS-FT tactical unmanned aerial system (UAS), which is used by the RoKA and RoKMC for intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) roles.

New systems were also showcased, including the KUS-VS VTOL UAV, which the company says takes advantage of independent thrusters for cruise and lift to enable both vertical take-offs and landings as well as "high cruising speeds". Other models shown were the KUS-VT tiltrotor UAV, the KUS-VH unmanned helicopter, and the KUS-FS MALE UAV.

South Korea is investing heavily in new UAV technologies, with the country's Agency for Defence

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exceptionally high levels of
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via rubber tracks and
independent suspension.
No debilitating vibration.
Arrive ready to fight.





FA-50 Fighting Eagle (KAI photo)

Improvements are also on the horizon for the RoKAF's transport capabilities, with DAPA announcing in April 2021 approval for the acquisition of additional foreign-made transport aircraft under a project set to begin in 2022 and be completed by 2026.

Development (ADD) announcing in May 2021 that it had completed development of a new 'sense-and-avoid' navigation technology aimed at enabling UAVs to autonomously elude threats and obstacles.

A few months later, in early September, the ADD said it had managed to secure core technologies to develop low-visibility, tailless UAVs, including aerial structure design technology as well as flight control algorithms that can help reduce a UAV's radar cross section.

These developments were unveiled just weeks after the MND in Seoul disclosed plans to procure 1,000 UAVs by 2027 for use by the South Korean armed forces.

HEIGHTENED TENSIONS WITH NORTH KOREA

The new platforms, systems and models showcased at ADEX 2021 reflect Seoul's push to make the country not only a top exporter of defence materiel but also less reliant on foreign military technologies and equipment, particularly as tensions between Seoul and Pyongyang continue.

In fact, in recent months, both countries have engaged in an arms race on the Korean Peninsula. Since late September 2021, North Korea has tested-launched several new missile systems, including a new short-range submarine-launched ballistic missile (SLBM), a surface-to-air missile, a 'hypersonic' missile, a new railway-based launch system for short-range ballistic missiles, as well as a new long-range cruise missile.

As for South Korea, the country test-launched for the first time a locally developed SLBM from an in-service submarine on 15 September and unveiled three other new missiles that same day, including a ground-launched supersonic cruise missile, a ground-launched ballistic missile, and the long-range air-to-surface missile for the KF-21.

Operating approximately 800 aircraft, including about 450 aerial combat assets, the RoKAF is one of the most formidable air arms in Asia and plays a vital role in the country's defence strategy against North Korea, especially in the areas of air defence, air transport, long-range precision strikes, and advanced intelligence, surveillance, and reconnaissance (ISR).

This is why Seoul has been keen on further developing and modernising the service's capabilities while at the same time bolstering co-operating and inter-operability with friendly air forces, particularly that of the United States.

F-35A deliveries to be completed in 2021

As part of efforts to improve the service's combat capabilities, deliveries of 40 F-35A Lightning II multirole fighter aircraft for the RoKAF are expected to be completed by the end of this year.

The fifth-generation aircraft are being acquired as part of a KRW7.3 trillion (US \$6.2 billion) deal approved in September 2014. At least 36 F-35As have been delivered so far, all of which are being operated by the service's 17th Fighter Wing at Cheongju. An order for 20 more of these aircraft is expected in 2022.

In case of a conflict the F-35s could give Seoul a strategic edge by penetrating Pyongyang's air defences, leaving it vulnerable to surgical air strikes.

Upgrading the KF-16 and F-15K fighters

At the same time, the service is modernising its fleet of KF-16 and F-15K multirole fighters, with the former being upgraded to the KF-16V Block 70/72 configuration under a US \$1.2 billion contract signed with Lockheed Martin in 2016. As part of the program 133 of the service's 140 KF-16C/D Block 52 multirole fighters are set to be modernised by 2026.

As for the RoKAF's 59 F-15K Slam Eagles, which are operated by the 11th Fighter Wing at Daegu in the southeast of the country, a 'Performance Upgrade Programme' is expected to begin in 2022. The type, which entered South Korean service in 2005, is expected to undergo an upgrade of its radar, avionics, and electronic warfare systems.

Military aviation expert Robin Polderman, who is author of the recently released book 'Modern South Korean Air Power | The Republic of Korea Air Force Today', said that while the RoKAF's F-35A fleet is regarded by many as an important deterrent against North Korean aggression, the service's larger fleet of F-15Ks – which can carry a variety of stand-off weapons, including the AGM-84 SLAM-ER and Taurus KEPD 350K cruise missile – seems to be as valuable to the RoKAF, at least for the time being.

"While launched over South Korean territory, for example, the Taurus can strike targets almost anywhere in North Korea, meaning that the F-15K is still the aircraft to use for destroying fortified or underground targets," said Polderman.

ADDITIONAL C4ISR REQUIREMENTS

As part of efforts to enhance the RoKAF's ISTAR capabilities, South Korea's Defense Acquisition Program Administration (DAPA) announced in June 2020 that the country's Defense Project Promotion

Committee had approved plans to acquire an undisclosed number of additional, foreign-made, airborne early warning and control (AEW&C) aircraft by 2027.

Although not mentioned by DAPA, it is understood that the RoKAF is seeking to add two Boeing E-737 AEW&C platforms to the four already in service under a project budgeted at KRW1.59 trillion that was set to start in 2021.

DAPA has said the planned procurement is meant to “minimise potential surveillance gaps amid growing security threats by neighbouring countries”, particularly as foreign military aircraft continue to enter South Korea’s Air Defense Identification Zone without notice.

A few months later, in October 2020, that same committee approved plans to upgrade both the identification friend-or-foe (IFF) and the Link 16 tactical datalink systems on the RoKAF’s four Boeing E-737 AEW&C aircraft as part of a KRW490 billion project set to be completed by 2025 with assistance from Boeing.

In November of that year the service disclosed that it had launched a new unit in charge of operating a number of aerial reconnaissance assets, including the four RQ-4 Block 30 Global Hawk high-altitude, long-endurance (HALE) UAVs acquired from the United States.

The service noted that the 39th Reconnaissance Wing, which is based at Jungwon Air Base, is in charge of conducting round-the-clock aerial surveillance and reconnaissance operations over the Korean Peninsula using several aircraft types, including the RF-16 (based at Jungwon), Hawker 800SIG (RC-800B/G) and Falcon 2000S (RC-2000) (based at Seongnam) reconnaissance and intelligence-gathering platforms as well as the Global Hawk UAVs (based at Sacheon).

The creation of this separate reconnaissance unit in charge of the RoKAF’s ISR and signals intelligence (SIGINT) aircraft is seen as a major boost for the defence capabilities required for the transfer of wartime operational control (OPCON) of South Korean forces from Washington to Seoul, commented Polderman.

That said, the RoKAF is planning to not only keep modernising but also further expand these capabilities. For instance, in April 2021 DAPA revealed Seoul’s plans to acquire new SIGINT platforms for the service under a project budgeted at about KRW870 billion that is set to be completed by 2026.

The new capabilities, which are to be acquired under the Paekdu (also known as Baekdu) program, are expected to replace the RoKAF’s four Hawker 800SIG aircraft, the first of which entered service in 2001.

In addition, the air arm is aiming to procure between four and eight ISTAR-capable aerial



KUH-1 Surion helicopter (KAI photo)

systems as part of a programme worth up to KRW2 trillion that was disclosed in the MND’s 2019–2023 Mid-Term Defense Plan.

“In order for Seoul to retaliate proportionally against Pyongyang in case of a conflict, accurate information is key, which is why the biggest priority for the RoKAF is to feed the country’s decision makers with accurate, real-time information regarding North Korea’s capabilities and intentions,” said Polderman.

This further explains the establishment of a separate reconnaissance wing as well as the launch of various development and acquisition programmes for both manned and unmanned ISTAR, imagery intelligence (IMINT), SIGINT and AEW aerial platforms, he added.

More transport aircraft required

Improvements are also on the horizon for the RoKAF’s transport capabilities, with DAPA announcing in April 2021 approval for the acquisition of additional foreign-made transport aircraft under a project set to begin in 2022 and be completed by 2026.

The RoKAF currently operates about nine Lockheed Martin C-130H/C-130H-30, four C-130J-30, four Airbus A330 MRTT, and 20 CN-235-100/220 aircraft in the transport role. At least three C-130Hs were recently upgraded and converted into MC-130K aircraft for special forces support.

PAC-3 AND CHEONGUNG SAM SYSTEMS

One of the RoKAF’s key roles is air defence, which includes protecting the country from the increasingly advanced missiles fielded and being developed by North Korea. This is another domain where Seoul is not relying solely on foreign defence equipment to strengthen and modernise its air-defence capabilities.

For instance, in its 2021-2025 Mid-Term Defense Plan the MND said that South Korea would locally

develop a long-range active electronically scanned-array (AESA) radar to replace the RoKAF’s AN/FPS-117 air-search radars.

Moreover, when DAPA announced in April 2021 approval for the acquisition of additional Patriot Advanced Capability-3 (PAC-3) missiles as well as the modification of the RoKAF’s PAC-2 launchers to enable them to mount the MIM-104F missile, the first batteries of the locally developed Cheongung Block-2 medium-range surface-to-air missile (M-SAM) system had already entered RoKAF service.

The new Cheongung Block-2 SAM system is designed to engage not only incoming enemy aircraft but also ballistic missile targets up to an altitude of about 20 km, with the upgraded missile believed to be capable of reaching a speed of Mach 5.

The Cheongung Block-2 is meant to supplement the RoKAF’s US Patriot Advanced Capability-3 (PAC-3) missile systems and contribute to the Korean Missile Defence System, increased defence exports, as well as the provision of core military capabilities for the prompt transfer of wartime OPCON to South Korea.

Slowly but steadily, the RoKAF is undergoing a transformation from a local to a regional force. “Seoul cannot afford to focus solely on North Korea, but it should also be wary of regional tensions. Today’s RoKAF focuses heavily on modern technology, and the days when this air arm had to make do with second-hand US equipment are behind us,” said Polderman.

With the planned introduction of new intelligence-gathering aircraft, the ongoing and planned upgrades for the F-15K, KF-16 and FA-50, as well as the introduction of the KF-21, the RoKAF will establish itself over the coming decade as one of, if not the most modern air forces in East Asia, and will serve as a credible conventional deterrent to war, added Polderman.

AIRPOWER TEAMING SYSTEM MOVING AHEAD

The most exciting Australian aerospace project currently underway is the Boeing-RAAF autonomous jet powered aircraft development known as Loyal Wingman. Unveiled in February 2019, the concept is that in future crewed aircraft such as the F-35 and Super Hornet will be accompanied on missions by groups of autonomous and remotely piloted drones that can carry out the dull, dirty and dangerous missions for which they are ideally suited.

This is the first time since the Second World War that Australia has developed a combat aircraft – and one of enormous potential, including on the export market to allied nations. Defence is quite guarded about full capabilities of the ATS for reasons of national security, saying:

“The Loyal Wingman program has completed physical flight tests, digital twin testing and operational analysis throughout 2021. The first flight

testing where the Loyal Wingman will perform teamed flight with other Loyal Wingman and Air Force crewed aircraft. Advanced and coordinated behaviours will be explored and tuned.”

Even some of the physical characteristics of the system – such as the jet engine manufacturer – are being kept under wraps, though we do know that Boeing has just started work on the 5th airframe in Melbourne, with final assembly to

being designed to support rapid reconfigurability. We are working closely with our RAAF partner to implement a level of autonomy needed to support the missions. We have a number of payloads under development with multiple suppliers and partners.

“The payloads will include the continued development of intelligence, surveillance and reconnaissance sensors in addition to classified payloads that we are unable to share. The Boeing Airpower Teaming System could be configured to perform a range of missions that complement and extend existing aircraft. It is also an ideal aircraft to support force training requirements and can be used independently or in support of crewed aircraft.”

The company says that the aircraft prototypes have completed ground testing, which ensured the functionality of the aircraft’s hardware, software and systems, taxi testing at different speeds. The company will continue with the flight program, and conduct other testing to support early learning and discovery. They are clearly pleased with the announcement by the Australian Government in March to renew the contact for another three years of test flights.

Future parts of the program include provisions for testing with RAAF crewed aircraft. As part of the development program, Boeing will continue the manufacture of prototype aircraft alongside mission system and payload development. They say they are also rapidly progressing validation of Digital Twin modelling.

“Digital engineering is a fundamental pillar of our approach to the challenge of delivering this program’s advanced design and development, and the production of an affordable vehicle. It helps us create a digital twin of the entire system that encompasses the product, production system and the operating environment in which it will work. The digital twin is a really powerful tool to understand how the system can be developed to meet the key requirements, allowing us to rapidly design, develop and field current and future requirements.”



ANZAC frigate HMAS Arunta, returning after a five-month deployment to the Indo-Pacific.
Credit: CoA / Ernesto Sanchez

of Loyal Wingman was completed in February 2021.

“Physical flight tests have validated the digital engineering of the air vehicle and the data from the testing will feedback into the digital design model to further improve the design. The test program aligns with best practice for a new aircraft and will gradually test sub-systems such as landing gear retractions and extensions and take-off and landing behaviour in varying cross wind conditions.

“It’s early in the program but we intend to keep expanding the flight envelope so the ATS will have aerodynamic performance that is fighter-like. However, given the very clean aerodynamic design we fully expect to have a much greater range - in excess of 3700km - than a crewed jet of similar size and payload. The data so far closely aligns with the digital design model and we are very confident in the future progress of the flight envelope expansion program.

“Teaming testing will be a focus of future flight

take place at the company’s Toowoomba facility. Boeing says that experience in advanced robotics, composite materials and digital engineering enabled the Fishermans Bend site to take an innovative approach to the creation and production of the military development program.

Just the length of the aircraft tells you something: at 11.7 metres – compared with an F-16 at 15 metres – it is already a substantial beast. Equipped with an internal payload bay, which could carry anything from electronic jammers to guided missiles, the ATS also looks to be inherently stealthy. On the stated figures and depending on configuration it looks to have about three times the unrefuelled range of an F-35 and twice that of a Super Hornet, able to stay in the air for more than five hours. Asked about payloads and missions, Boeing said:

“The aircraft is a modular design with the payload capacity to perform a range of missions, and it is



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NEW RUSSIAN CHECKMATE FIGHTER A MAJOR SURPRISE

A demonstration of a completely new lightweight fighter from the Sukhoi design bureau at the MAKS'2021 air show took many by surprise - including Russia's President. Vladimir Putin inspected the exhibit inside a stand-alone pavilion labelled the "Checkmate/Turn the Chessboard" on July 20 without saying a word. Those who believe Putin is behind everything that happens in his country were puzzled and disillusioned.

Later in the same evening Yuri Slyusar, president of the United Aircraft Corporation (UAC), addressed the media, saying that the project is an industry initiative and has so far been wholly funded from the manufacturer's own resources. He confessed that UAC (Sukhoi is a member in this nation-wide merger) did not even have a specification from the Russian Air and Space Force, while expressing a hope that the service would endorse the project at some later stage.

MANY NAMES

The official site of the Russian President, www.kremlin.ru, refers to the exhibit as "Lightweight tactical single-engine aircraft from Sukhoi". This gave grounds for aviation enthusiasts to abbreviate it to LTS - but there is no trace of this acronym in any official documents made public.

"Checkmate" is how the manufacturer prefers to call the new project. Such a name cannot be adopted by the defence ministry. It is the MoD's privilege to give designations to military hardware. The military exercised their rights by naming the fifth-generation fighter in the heavyweight class from the same maker (previously known under the company's designation the T-50) as the Su-57.

Should the "Checkmate" program go forward and the lightweight fighter become operational, the type is likely to be given designation "Su-75". This is what Sukhoi suggested by painting "75" on the MAKS exhibit. The latter also bears registration "RF-00075" on the empennage.

The exhibit looks like a development prototype for ground testing, complete with a fully furnished pilot's cockpit. Slyusar confirmed this fact by saying that the exhibit "is more than a full-scale mock-up". The project had been initiated "over a year ago" and progressed quickly thanks to "extensive use of digital methods and super-computers to conduct virtual trials", he added.

Static testing will be complete in less than a year to enable a maiden flight in 2023. "The time factor is



'Checkmate' tentatively designated Su-75 (V. Karnozov photo)

very important. We seek ways to move the entry into service from 2027 to 2026, so that customers could start taking deliveries in 2026". This is very optimistic in view of how long the Su-57 and F-35 spent in development and refinement.

MARKET

The Su-57 first flew in 2010 and became operational ten years later. Why would Sukhoi go for another fifth-generation fighter when they already have one? Slyusar described the Su-57 as "the large, powerful, state-of-the-art multifunctional fighter with unmatched performance". Many experts would add that it is also costly to buy and maintain. Only a handful of foreign countries expressed interest in buying the type.

Alexander Mikheyev, head of Rosoboronexport, told journalists that five nations seek to procure an exportable version, the Su-57E introduced in 2019. "The aircraft does have an export potential despite the unfair competition in the form of sanctions", he added, meaning the Countering America's

Adversaries Through Economic Sanctions Act (CAATSA) introduced by the U.S. Congress and signed into law by then-president Trump.

Since the previous MAKS, on the eve of which Putin announced a launch order for 78 Su-57s for the Russian armed forces, "the interest from foreign customers has risen substantially", Mikheyev said. "So we are in a good mood. The interest in our new fighters will only grow as the Tactical Missile Corporation introduces new air launched munitions and puts them into serial production, especially those fitting in the internal weapons bays".

Asked about the Checkmate, Mikheyev answered: "We will be very glad to take up the task of selling this new airplane worldwide as soon after it acquires export clearance."

The business plan calls for at least 300 sales over the next 15 years, Slyusar added. "This is not a dream. Together with our colleagues at Rosoboronexport, we made a thorough assessment of the global market using a number of criteria. We find that the demand for such a plane is going to be

large provided we manage to bring the product to market quickly enough“.

COMMON POWER

The Checkmate project is meant to provide a solution for those who want an affordable next-generation fighter. In size, the new aircraft comes close to the MiG-23/27, the last Soviet single-engine supersonic jet, whose production terminated in the mid-1980s. It is markedly smaller than any of the Russian fighters available today.

Estimated length and wingspan are 17 and 12 meters compared to 19.4 and 14, respectively, for the Su-57. At 18 tons, the new Sukhoi is only a half of its predecessor in gross weight. With an area of 82 square meters, the Su-57's wing is much larger than that of the Checkmate.

At the same time, its outer sections (i.e. without the central fuselage and wing-fuselage extensions) seem similar, if not identical. Sweep angles for the leading and trailing edge of the trapezoid outer wings are 48 and 14 degrees, respectively.

The manufacturer hopes to leverage on the Su-57 experience, technology, software and hardware. “The technologies we have worked out on the prior program enable us to cut development time on a smaller combat airplane powered by not two but a single engine of the same thrust”, Slyusar said.

The manufacturer does not specify what the engine type is. A clue came from it saying that the MAKS exhibit features “an existing motor in the class of thrust between 14.5 and 16 tonnes”. That certainly sounds like the AL-41F-1 (develops 15 tons of thrust at full afterburner) in use on the Su-57 or its derivative AL-41F-1S (14.5 tonnes) on the Su-35, with a rider that the RF-00075 exposed a refined nozzle to lower infrared signature.

In future, the Checkmate may receive the more advanced “Item 30” now in development for an improved Su-57. Experimental engines have been undergoing flight trials since 2017. The “Item 30” has similar weight and dimensions to the AL-41F-1, promising more thrust (18 tonnes) and less specific fuel consumption.

The common engine is among a few items that the Checkmate and the Su-57 share. Another is a wide-angle head-up display. The device seen in the RF-00075 cockpit is similar, yet not identical to the ShKS-5. The cockpit itself is different in having a single large MFD similar in style to the F-35, instead of two 15-inch colour multifunctional displays in the Su-35 and Su-57. The electro-optical system on the Checkmate seems to be a derivative of the UOMZ 101KS on the Su-57, with the OLS-50M forward looking device in front of the cockpit's visor.



‘Checkmate’ rear view (V. Karnozov photo)

DIFFERENT AERODYNAMICS

A striking difference between the two fighters lies in aerodynamics. The heavier one features a classic aerodynamic layout with a few innovations. The aircraft has a wide blended wing body fuselage with two widely spaced engines. All moving horizontal and vertical stabilisers work in conjunction with the forward aerodynamic surfaces known as “adjustable leading-edge vortex controllers” (LEVCONs), a characteristic feature of the Su-57.

The Checkmate has none of those. Rather, it relies on the flying wing concept (no elevators or canards). Trajectory control is through the use of a V-shaped tail formed by two large “ruddervators” (not fins). Each is placed on its own pedestal, enlarged by a small air intake on the inner side. “Ruddervators” were seen previously on the YF-23. They rotated in the opposite direction for pitch control, and in the same direction for yaw.

For additional forces in pitch, the plane has two deflectable surfaces at the rear, powered by vortices coming from the massive wing-fuselage extensions. Because of the unusual control surfaces at the back, the Checkmate falls in between a classic aerodynamic layout and flying wing. Like all other recent Sukhoi fighters, the Checkmate incorporates thrust vectoring for shorter takeoff, improved controllability at high angles of attack and spin recovery. For the “flying wing”, vectored thrust is also important to keep the aircraft stable when it transits from subsonic to supersonic flight and back, and also help balance it within a wider range of centre of gravity (CoG) positions.

The angular ventral air intake wraps up the plane's

lower nose section and features a diverterless supersonic inlet. This is a popular engineering solution, previously seen on the F-35 and the J-20, but not the Su-57.

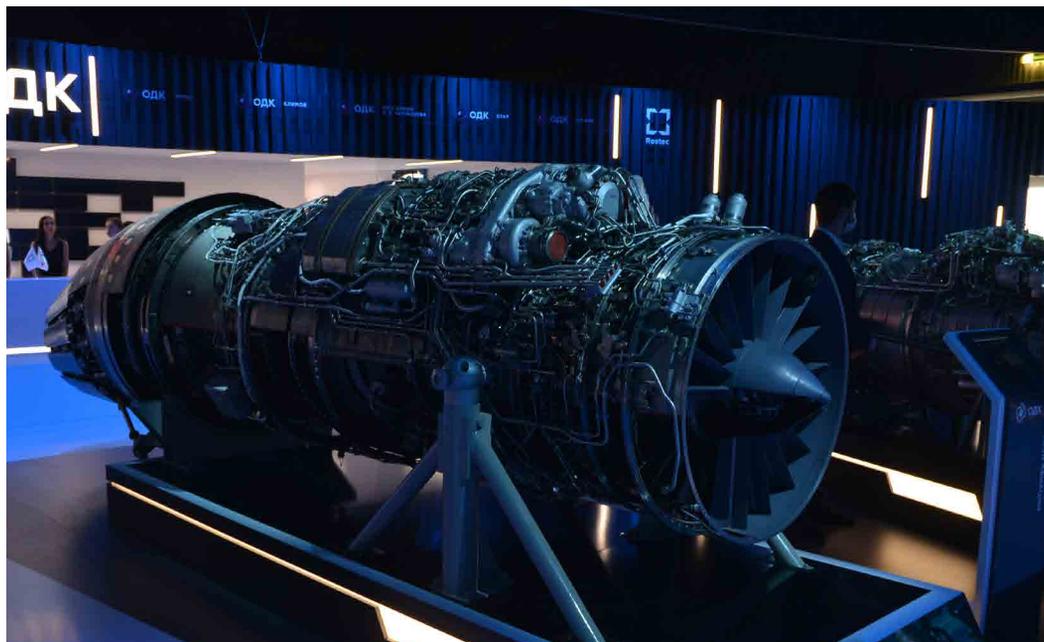
All these differences point at the fact that the Checkmate is not a scaled down Su-57 derivative, but rather a completely new aircraft design with its own advantages and disadvantages. Thanks to the more complex air intake design, the heavier aircraft can accelerate to Mach number 2.45 versus 1.82 for the lighter one, and attain an altitude of 20 vs 16+ km. The maximum g-load factor is 10-11 against 8.

This means a well-trained pilot in the Su-57 can outmanoeuvre a similarly skilled opponent in the Checkmate during a dogfight. Range without additional fuel tanks is 4300 against 2800-2900 km (combat radius is given at “about fifteen hundred kilometres”), maximum combat payload 16 against 7.4 tons. All that data renders the Su-57 a faster, more manoeuvrable, longer-legged and heavier-armed combat jet.

WEAPONS

In its turn, the smaller and lighter Checkmate may attract more overseas customers since it costs less while offering sufficient flight performance and a number of features attributable to fifth-generation fighters, such as super-cruise and low observability. In part, the latter is achieved through internal weapons carriage. There is a large central bay in the lower section of the fuselage, a convenient place from the viewpoint of CoG positioning.

Each right- and left- hand sections of the large wing-fuselage extension also comes with a bay. On an air-sweep mission, the Checkmate carries five air-to-air missiles internally. This compares to



AL-41F-1S engine (V. Karnozov photo)

eight RVV-AE (R-77, RVV-MD) medium-range radar-guided missiles inside the two fuselage bays and two short-range heat-seeking R-73/74s in the wing-fuselage extensions for the Su-57.

When armed for a strike, the Su-57 can carry up to eight KAB-500 guided bombs internally. The larger inner volume is indeed an advantage. However, there are many tactical situations, where an interceptor or a strike aircraft does not need many air-launched munitions to complete an assigned mission.

A Checkmate pilot can still get a “good job!” from friendly troops by scoring direct hits on allocated targets with three KAB-500s. The airplane can carry that many in the central bay, along with a pair of R-73/74 AAMs in the side bays for self-defence. The internal carriage of ammunition and other design solutions for lower observability allow the fifth-generation fighters to perform combat missions over the battlefield with higher lethality and few losses compared to previous generation warplanes.

The RA-00075 was not alone on display in the “Checkmate/Turn the Chessboard” pavilion. Beside it, there were three other items representing munitions: the Kh-58, R-74 and RVV-AE. Remarkably, the latter missile was a new version (“180”, R-77M) with “stubby” aerodynamic surfaces at the rear instead of the lattice fins on the early production examples.

The Checkmate multimedia presentation added the following guided weapons to the list: the Kh-31PD, Kh-38MLE/MTE, Kh-38UE, Kh-58MK, Kh-58SHKE, Grom-E2, as well as the KAB-250/500 controlled-trajectory bombs. The presentation also

mentioned a 30-mm “gun assembly” but it remains to be seen whether it is built-in or podded. There were also 100/250/500 kg free fall bombs, and the S-8 and S-13 families of unguided rockets. Since some of these can only be carried on outer hard points, the Checkmate delivery package will contain under wing pylons for weapons. If so, the airplane will be able to use a wide variety of Soviet legacy aviation munitions and pods.

COST CONSIDERATIONS

Sergei Chemezov, head of Rostec corporation that controls UAC and Sukhoi, promised to sell serial Checkmates at US \$25-\$30 million each. This is the lowest price ever charged for a fifth-generation fighter. Mr Chemezov has had huge experience of weapons sales so there should be no miscalculation. Perhaps the main reason for Chemezov to glue that price sticker onto the new airplane was to lure more clients in.

In turn, Slyusar insisted that the affordability comes not only with the low sticker price, but also maintenance costs. “It is not enough to buy an airplane you also need to operate it in an affordable way”. He estimated that heavy and line maintenance, spares, expendables and fuel account for some 70% of combat aircraft lifecycle costs saying:

“Single engine airplanes are less expensive to operate. Besides, we offer our customers the Matryeshka integrated logistics support system on a modern data base. This tool will help type operators to reduce expenses in many areas related to ground support - including minimisation of the personnel and

managing a system of spare part warehouses – while keeping the fleet readiness high. Our goal is to offer a minimal cost per flight hour”.

There will be a factory standard package of friend-or-foe interrogator, communications equipment and active phased array radar (AESA) capable of tracking 30 targets simultaneously and guiding six missiles. For those who want it cheaper, UAC offers help in selection of on-board systems for installation on customized aircraft, the process made simple through “open architecture” and “module assembly” policies.

The idea to come up with a new fighter design was prompted by economic considerations. It should be a multirole one, able to perform air-to-air combat, ground strike, anti-ship and reconnaissance missions. Compared to existing types in the class, the new one would differ in having a higher thrust-to-weight ratio and larger internal bays for weapons carriage. It would be able to get airborne in some 400 meters, using vectored thrust for shorter take-off as on the Su-57.

“There are many ageing single engine warplanes in service, and some modern types from a bunch of foreign manufacturers but there is no a fifth-generation fighter type among them that would be affordable to buy and maintain for the large majority of countries that may want such aircraft”, Slyusar said. UAC made the decision to go forward with Checkmate “after we have seen the market for a lightweight fighter and understood we can develop it quickly by using the existing technologies”.

Russia’s minister for industry and trade Denis Manturov reminded us that the Soviet Union mass-produced many single engine fighters, such as the MiG-21 and MiG-23/27. Russia gave up this market but wants to re-enter it with the Checkmate. Among competitors he mentioned the F-35 Lightning II, JAS-39 Gripen and JF-17 (JF-17), while stressing that the latter Sino-Pac design relies on the Russian-made Klimov RD-93 engine. The minister believes Checkmate development can be completed quickly through a wide use of technology and hardware. “Our goal is to create a product that will offer high performance at lower cost”.

Primarily, the Checkmate is intended for export, but the Russian army may also order a quantity. Yuri Borisov, a deputy head of the Russian prime minister’s department, who supervises the military-technical complex, mentioned India, Vietnam and “African countries” among potential clients. At the same time, he believes Checkmate development can be partially funded from the Russian budget through allocations on the next edition of the State Armament Program, covering for the period from 2024 to 2033.

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Australian Army Signaller Christopher Driscoll and Signaller Richard Davis from the 1st Combat Signals Regiment shows United States Marine Corps Lance Corporal Rodrigo Morales from Marine Rotational Force - Darwin a Medium Satellite Communications (SATCOM) Terminal during preparations for Exercise Koolendong 2021 at Robertson Barracks, Northern Territory. Credit: CoA / Rodrigo Villablanca

KYM BERGMANN // CANBERRA

AUSTRALIA'S MILITARY SATELLITE PROGRAM TAKING SHAPE

With bids closing at noon on January 10 there is excitement in Australian industry for a program vital in developing a sovereign satellite capability. Bids are expected from five consortia, all with extensive local industry involvement. They are: Airbus; Boeing; Lockheed Martin; Optus; and Northrop Grumman. Others cannot be ruled out, but if so, they are keeping a very low profile.

Defence's preference is to engage a single prime contractor to enter into both an Acquisition Contract and a Support Contract to deliver, upgrade and sustain the Joint Project 9102 capability over its fifteen year life of type based on a whole of life value for money proposition.

As the duration of the Project is likely to be in the order of 25 years, Defence says it will be seeking to engage a long-term industry partner

who has a strong track record in delivering complex space and/or SATCOM related programs. The Joint Project 9102 Request for Tender is seeking a highly integrated end-to-end system across the space, ground and control segments to deliver a seamless capability to end-users. A single prime mitigates the risk of schedule disaggregation between these segments and reduces technical integration risk.

Although it is Defence's preference, a single prime is not an essential requirement. Defence will

consider splitting acquisition and support work between related companies.

Defence summarised the approach to local industry, saying it includes the following Australian Industry Capability (AIC) requirements, consistent with Defence expectations to maximize opportunities for Australian Industry participation:

- Software support for the SATCOM Management System;
- Investment in the enduring skills and professional

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development of an Australian workforce in the space domain;

- Certification of SATCOM user terminals;
- Satellite Operations Centre facilities and infrastructure design, development and delivery; and
- ICT security accreditation of SATCOM systems.

Defence also considers there are potential opportunities for Australian industry involvement in software development, systems integration, satellite system operations and through life support, and participation in the supply chain through manufacture and supply of sub-systems and components.

To meet the requirement, four satellites in the 3-6 tonne category will be needed in geostationary orbit about 38,000km above the planet. Two of them will be to cover Australia and parts of the Pacific and Indian Oceans, respectively. A further two will be configured to support mobile operations and those in our broader areas of interest.

Any ADF assets even more distant will still be possible to reach through the use of allied systems – the US and NATO in particular – and also commercial networks, the best known being Iridium. A multitude of low and medium earth orbiting satellites are already whizzing around – or will soon be doing so – promising a wealth of private sector internet connectivity that can carry voice and data.

For prudent risk management it would seem sensible to launch the satellites one at a time – or even in pairs – rather than bundle them up into a single mission. The launch continues to be the most spectacular but also one of the riskiest parts of a satellite program, though technology is becoming more reliable. At this relatively early stage the choice of launch systems seems to be coming down to the European Arianespace and Elon Musk's SpaceX Heavy – though with several years to go before that choice needs to be made, other entrants might emerge as the sector is experiencing huge growth.

With the tender evaluation expected to take most of 2022 and following selection of a preferred bidder there will be the usual offer definition activities - meaning that a contract might not be signed until the following year. Satellites of this size and complexity take about three years to build and test, so allowing for reasonable delays a launch could be expected no earlier than 2028 – and perhaps after that.

The logic of JP 9102 – which might cost way in excess of \$5 billion – is strategic self-reliance. For the last 20 years the ADF has been very well served by a payload on the Optus C1 satellite that covers our immediate area. However for operations further

away we are dependent on systems such as the US Wideband Global Satcom (WGS) network that we paid \$1 billion back in 2006 to access.

In the event of a crisis, it is possible that Australian use of WGS will suffer if the US – as expected – gives priority to their forces. Many other regional nations such as Indonesia, South Korea, Japan, and probably secretive Singapore have their own military communications satellites. Thailand has two known satellites, though these are said to be for earth observation. Why Australia has lagged behind this trend for so long is a puzzle, though not all countries have the same access to US systems as we do.

AIRBUS

Airbus is basing its offer on designing and building the UK's Skynet secure communications satellite network. It claims, not unreasonably, that the latest in the series the 6A – manufacturing of which started a few weeks ago – will be the most advanced such platform in the western world when it's launched in 2025, with more known capacity than any other platform. All integration and testing is taking place in the UK at the direction of the customer, the Ministry of Defence, which currently has five satellites operated and supported by Airbus.

The company believes that the level of capability in Skynet 6A, including things such as anti-jam capability, is representative of what JP 9102 seeks to provide – particularly as Airbus has the ability to finetune individual solutions to meet current needs. The company has taken an evolutionary approach to satellite technology, with 6A not only being a derivative of 5A but which also incorporates knowledge gained from its considerable experience in the commercial sector, being a world leader in telecommunications systems.

The satellites for Australia will be designed exactly to the needs of the ADF. To help develop sovereign capability the company has formed Team Maier, which is a mechanism for engaging with Australian industry to transfer technology, encourage innovation and ultimately to build an export base. Team Maier is a long-term undertaking not only to manufacture satellites but also to provide long term support for the network.

BOEING

Boeing Defence Australia has a team including Leidos Australia, Viasat, the Indigenous Defence and Infrastructure Consortium (IDIC), Clearbox and Saber, amongst others. Regarding the technical solution, the companies says that it must be resilient and flexible – pointing out that the future threat

environment might be quite different from the one being faced today.

As well as the satellites themselves – obviously the vital big ticket items – is the ground element and control software that stitches everything together for a complete solution to meet ADF needs. This includes all the antennas and modems required to make everything work. Boeing says that between themselves and their local partners they can provide a complete turnkey solution, rather than just selling satellites.

Turning to those, Boeing has been the incumbent contractor for WGS since 2001, has ten of those satellites in orbit and is in the process of designing and building the 11th in the constellation. The company says that this next one provides a step change in being able to deliver high-capacity services – and the technology will be available to Australia, as well as that developed for Boeing's numerous commercial programs. The ADF has access to WGS via JP 2008.

The company emphasises their experience with Ultra High Frequency (UHF) solutions, some of which are being used by the ADF – especially when mobility is required – and the current terminals will be fully compatible with the JP 9102 solution. Boeing Defence Australia also emphasises their broader ADF communications experience through activities such as the modernisation of the Defence High Frequency Communications System and also Project Currawong, which is part of JP 2072.

LOCKHEED MARTIN

The company is a very experienced designer of military communications satellites and says it is ready to deliver a sovereign military satellite communications system to the ADF. That system will leverage Lockheed Martin's long heritage in the development and delivery of some of the world's most resilient satellite communications networks, including Mobile User Objective System (MUOS) for the USN and the Advanced Extremely High Frequency (AEHF) network for the US Space Force.

The company says that for the ADF, satellite communications are a vital capability, especially as it transforms into a force centred around advanced platforms with high bandwidth requirements utilised to support networked operations at greater distances. In short, the use of space has become a largely essential pre-requisite for many types of ADF contingency, especially those at the higher end of the war-fighting spectrum.

Lockheed Martin says that it is putting together a large Australian industry team for the bid.

OPTUS

As mentioned, Optus has been involved as a provider of satellite communications technology to the ADF for more than 20 years. Nick Leake, Head of Satellite and Space Systems at Optus, confirmed that his company is the prime contractor for the bid with partners Raytheon Australia and Thales Australia.

He said that Optus has a longstanding, collaborative partnership with Defence with more than two decades of experience working with the ADF delivering whole of life satellite services on the Optus C1 satellite – which provides critical mission capabilities for Defence's operations and, at the time of launch, was the world's largest hybrid Military-Commercial spacecraft, and ongoing operational sustainment.

Optus says that Team AUSSAT offer more than 35 years' experience in space and an unrivalled history of owning and operating satellites in Australia, by Australians, for Australians. Team AUSSAT is comprised of businesses that, for decades, are all known for their exceptional pedigrees when it comes to building and delivering world-class

Defence capabilities. Nick Leake added:

"We have an unwavering commitment to deliver a sovereign solution and collectively members of Team AUSSAT have been responsible for key accomplishments across the space operations and systems management industry. This includes a proven global space surveillance capability at the Harold E. Holt Naval Communications Station; Satellite connectivity solutions to a range of State and Commonwealth Government Departments and Agencies as well as commercial and civilian customers; Proven cyber security capability that protects systems for the ADF, air traffic management and transport systems.

"Optus has invested over \$22 billion into our Australian telecommunications network and, along with our partners, we employ over 12,000 Australians today. Combined with decades of experience, Team AUSSAT's sovereign solution will leverage the full technical capabilities of leading technology providers from across the world to provide a solution that will meet the needs of the ADF now and into the future.

"The solution will also allow us to continue to grow

Australian skills in a high-tech sector, strengthen existing partnerships with local universities and further build SME partnerships under a joint strategy that is going to benefit Australians and position our nation as a global leader in space.

NORTHROP GRUMMAN

Northrop Grumman Australia has been relatively quiet to date but indicates that it will be making some industry announcements soon. The company is already involved in Australia through JP 2008 Phase 5B. Northrop Grumman and its partners ViaSat and Optus will deliver a satellite ground station at Wagga Wagga and a wideband SATCOM network management system that supports home station and deployed forces.

The company says the ground station and network management system will be integrated into the WGS constellation of highly capable, secure military communications satellites. It provides a network management capability aligned with and functionally similar to the one developed for the United States that successfully manages and monitors the WGS system.



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KYM BERGMANN // CANBERRA

FORMER PRIME MINISTER MALCOLM TURNBULL SPEAKS WITH APDR EDITOR KYM BERGMANN



2 May 2018: Prime Minister of Australia, the Hon. Malcolm Turnbull, MP and Chief of Navy, Rear Admiral Tim Barrett, AO, CSC, RAN, on the wharf at Fleet Base East, Garden Island, Sydney during the visit to Australia by the President of the French Republic, His Excellency Mr Emmanuel Macron.

Kym: During your speech to the National Press Club you mentioned that in 2018 you asked the Department of Defence whether nuclear powered submarines would be appropriate for Australia. Did they give you a one word answer or did it have a bit of substance?

Malcolm: The response from Defence was quite detailed – as is usually the case for them. The main point they made is that all other countries that operate nuclear powered submarines have large domestic nuclear power industries, many of which have been in existence for decades – and Australia does not. Supporting nuclear powered submarines is quite complex when you factor in the extreme safety standards that are needed for regular checks and inspections of their entire propulsion system,

another country they would not, of course, be a sovereign capability.

Kym: OK – the government has referred to strategic circumstances changing. But the last time I looked, the South China Sea is the same distance as it was from Australia 10 million years ago due to the slow speed of plate tectonics...

Malcolm: Plate tectonics are the only thing slower than Australia's submarine program!

Kym: And even though the size of the Chinese navy is increasing dramatically, this is exactly in line with projections that were made back in 2018 and even earlier than that. I'm inviting you to speculate – what do you think might have changed?

Malcolm: It seems that for whatever reason Morrison just lost interest in continuing with the French. It's appalling that a decision of this magnitude appears to have been taken with so little research – and in such a duplicitous way. Australia's international trustworthiness has been trashed.

France has a major presence in the Pacific and

Plate tectonics are the only thing slower than Australia's submarine program!

not just the radioactive core. You can't take the risk of leaks of radiation.

They also made the point that all the countries – the US; UK; Russia; China and India – are nuclear weapon states. Other countries that are considering nuclear propulsion, such as Brazil, have large supporting industries.

So a shift to nuclear propulsion would take 15 years or more to acquire the skills and infrastructure to support and maintain nuclear power submarines. If the maintenance and support of such vessels was outsourced to

is a long-term regional player. Morrison has single handedly wrecked our relationship with them by pretending all was well with the submarine program while simultaneously working to get rid of them.

Even if there were legitimate concerns about how things were progressing, it should have been sorted out with the inclusion of the French.. It would have been possible to say to Macron something like "we are going to pause the Attack class for 18 months while we investigate other options – but don't worry, French companies will be paid whatever they are owed, and we will

keep you informed”.

The French might not have liked it, but that would have been a far better way to proceed than the unmitigated disaster we now have on our hands which will result in an additional delay of at least a decade before Australia receives nuclear submarines around 2040 – if then.

Kym: I have picked up a bit of scepticism even in government ranks about the nuclear idea, but some people already have a scapegoat – you. I’ve heard it said that if you hadn’t picked the French in the first place we wouldn’t be in this mess.

Malcolm: I inherited a competitive evaluation process that was extremely detailed and complex. As a lawyer I understood the need for the process to be rigorously conducted with the utmost probity. Prior to setting up the CEP, Abbott had been planning to engage the Japanese to build submarines for us in Japan.

I can assure you that the proposal from France’s Naval Group was assessed as being superior to the other two, by far. I have to be careful about what I say, but there was a clear preference for the French – and that decision was also supported by some of our US advisors such as former US Secretary for the Navy Dr Don Winter and the advisory board he chaired whose members included three retired US Navy admirals with extensive experience in submarine construction and operation.

The French Barracuda design had the advantage of being based on a nuclear submarine, which left open the possibility of building, say, three conventional boats out of twelve and then switching back to nuclear at some stage if that became a necessity. This would have had major savings in things like training if all submarines had the same hull, combat system and electronics but different propulsion.

Kym: At the time many of us assumed that this must have been at the back of your mind in selecting the French.

Malcolm: At the back of my mind – yes. It wasn’t part of the evaluation, but it was something that we were aware of. Nuclear propulsion has many advantages, such as the ability to get out of trouble very quickly. A conventional submarine might be able to manage a burst of 20 knots and eventually you have to come to the surface and snort to run the diesel engines. Nuclear power gives you the ability to travel a lot faster than that and for much longer.



2 May 2018: President of the French Republic, His Excellency Mr Emmanuel Macron delivers a speech aboard Amphibious Ship HMAS Canberra during a three day visit to Australia.

On the other hand conventional submarines are quieter and better suited for shallow waters in the archipelagic waters around Australia’s north – which is where we operate in the vast majority of cases. So the idea of starting with conventional submarines and having the ability to transition to nuclear seemed an attractive option.

We were on track to have the first Attack class in the water in the early 2030s. That has now all been thrown away and replaced with – nothing.

Kym: It would seem sensible to first study the idea of nuclear of nuclear propulsion before making the announcement rather than the other way around.

Malcolm: It’s an extraordinary decision that has also destroyed the sovereign submarine building capability that was central to all of this. The idea was that Australia would be independent and have a permanent submarine construction schedule. That has all been thrown away.

As I said at the Press Club, the idea that a submarine nuclear reactor is like a battery that you plug into a power tool from Bunnings is ridiculous. It seems highly likely that if we buy from either the

US or Britain the first ones will be built in their yards and then there will be little incentive to move that work to Australia.

Kym: If, when you were Prime Minister, the Air Force came to you with a suggestion that Australia needed to build our own long range aircraft to bomb Moscow I guess you would ask them to have a rethink.

Malcolm: That’s probably correct.

Kym: But the RAN somehow convinces everyone that they need something that is at the very extreme of the range and endurance that you can get from a conventional submarine. But there are plenty of choke points to the north of Australia far closer than the South China Sea – and also technology is changing rapidly.

Malcolm: You have touched on something that I’ve been thinking about a lot but haven’t yet had the chance to put into writing – and that is the development of Autonomous Underwater Vehicles. A huge amount of work is going on in that area, including by Australian companies. As an aside,

I'm involved with Advanced Navigation – a local company that has developed inertial navigation systems based on a digital fibre optic gyroscope. They are receiving a lot of interest and investment, including from the US.

This technology means that in the future you could have large numbers of battery powered AUVs able to travel huge distances and navigate autonomously. They could be programmed to come to the surface at various places and raise an antenna to gather electronic information and then quickly transmit that to a satellite. Or they could undertake their mission in complete radio silence. They can wait on the seabed for months on end. The development of AUVs, underwater drones, will revolutionise the world of submarines especially in terms of surveillance.

The main reason why submarines are so complex and expensive is because they have a lot of people in them who have to live and work underwater for weeks at a time. If you can replace humans with electronic systems then the equation looks quite different. If you happen to lose one or two it doesn't really matter because there are no people on them. They can be designed to fry their own hard drives or physically self destruct if captured or tampered with.

Kym: Do you see any way out of the submarine mess? I can think of two. The first is for the RAN to radically rethink their range and endurance requirements. The second is to bring the French back into the equation.

Malcolm: Its going to be very difficult. The French have been so insulted by Morrison and treated so badly that I'm not sure about their attitude.

People seem to have forgotten that France and Australia had formed a strategic partnership around submarines that was in both our interests. Macron actually announced his country's Indo-Pacific strategy in 2018 at the Garden Island naval base in Sydney. This was hugely significant and committed France to this region in a way that the UK never could. France has two million citizens in the Indo Pacific. France is our close neighbour in New Caledonia and French Polynesia. France is here to stay.

With the UK, would anyone be surprised if in a few years from now someone asked "why are we sending our warships all the way out there?" Boris Johnson's enthusiasm for our region may not outlast his government.

I struggle to understand how the US has gone along with AUKUS given the damage it has done to relations with France. If you look at the recent Biden-Macron statement it is as close to a public

stabbed in the back.

You might have noticed that after my Press Club speech, no one objected to my assessment. Even News Limited journalists like Greg Sheridan and Cameron Stewart thought that basically I was correct. Greg's only reservation about my critique was that I had exaggerated the diplomatic consequences of Morrison's duplicity. Well, I am in a better position to judge than most people.

You can't find many commentators who support this move after they have looked at the details.

Kym: I guess it would be like if Australia announced we were going to put a man on the moon.

Malcolm: Hooray – until people start looking at actual details like cost and schedule.

Kym: I'm surprised that more research hasn't been done by the government on the matter of using Highly Enriched Uranium as the fuel, which is nuclear weapons grade material.

Malcolm: I think this is going to be a huge problem that hasn't been thought through at all regarding nuclear proliferation – and that alone might be enough to stop the acquisition. Already Indonesia and Malaysia have expressed concern about the precedent this sets and what it might mean for a regional arms race.

Because Australia doesn't have a nuclear industry – and because we seem to have ruled out French technology which uses Low Enriched Uranium – we are going to be fully dependent on the US. What does that say about sovereign capability?

Can you imagine the situation when Iran says it wants to enrich uranium to weapons grade standards and says this is for the purpose of naval nuclear propulsion. How does the US argue Australia can be trusted with weapons grade naval reactors but nobody else? How does the US mount an argument that Iran should use low enriched uranium for its naval nuclear propulsion when it has decided to equip Australia with highly enriched uranium reactors?

And this is why so many people concerned with nuclear non proliferation, including the IAEA, have objected to the plan.



Royal Navy Astute class nuclear submarine
(U.K. MoD Crown Copyright 2021 / Jay Allen)

apology from Washington as you are ever likely to see. It emphasised the importance of open consultations between strategic partners – which is the opposite of what occurred in the lead up to the AUKUS announcement.

Kym: The Attack class was already a trilateral program with a US combat system and US weapons. Why not build on that?

Malcolm: Exactly. The way this should have been handled was through a process of discussion and dialog – not some sort of secret back room deal. The French have every reason to feel

CAE congratulates the Royal Australian Air Force on celebrating its Centenary during 2021 and 100 years of service to Australia.

CAE is proud to have supported the training of RAAF aircrew for many years. From platforms such as the B707 and C-130H long since retired to current platforms including the C-130J, KC-30A, Hawk Mk127, P-8A and others, CAE has been an industry partner playing a small role in preparing and training the men and women serving in the RAAF.

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WHAT HAPPENED TO A REGIONALLY SUPERIOR CONVENTIONAL SUBMARINE?

That was quick. Just a few days ago Australia was in the process of spending \$50 billion – in 2016 dollars – on the most advanced conventional submarine in the region, if not the world. We know this because that is what everyone from the Prime Minister down – and including Defence and Foreign Affairs Ministers, Admirals and Departmental Secretaries – have been insisting was the case since 2016.



GROTON, Conn. (Sept. 19, 2021) The Los Angeles-class submarine USS Montpelier (SSN 765) transits the Thames River toward Naval Submarine Base New London in Groton, Conn. (U.S. Navy photo by Chief Mass Communication Specialist Joshua Karsten)

Now Prime Minister Morrison tells us that the submarines are lemons and would have been obsolete as soon as they hit the water. Where is the RAN – and all their highly paid US advisors – in all of this? Like any prime contractor, Naval Group has been working at the direction of Defence, not the other way around. Surely if \$3 billion and five years of effort has been spent on an obsolete product people need to be held to account.

Similarly with the schedule, everyone had continued to insist that the program was on track with steel to be cut for the first boat in 2023 and delivered a decade later. That also has changed in just a few days, with the Prime Minister saying that the initial boat would not have been launched until 2038 – which means that the first of class Attack,

following extensive sea trials, would probably not have been accepted into service for another two years after that. This would have set a world record for the least efficient submarine enterprise ever. Who has been covering up this shambles?

The Joint Communique issued by the Defence and Foreign Affairs Ministers of Australia and France issued on August 21 said in part:

“Both sides committed to deepen defence industry cooperation and enhance their capability edge in the region. Ministers underlined the importance of the Future Submarine program. They agreed to strengthen military scientific research cooperation through a strategic partnership between the Defence Science and Technology Group and the Directorate General for Armaments.”

This was a mere 25 days before the AUKUS announcement. The document is available in full here: <https://www.foreignminister.gov.au/minister/marise-payne/media-release/inaugural-australia-france-22-ministerial-consultations>

Something similar has happened with our broader relationship with France. We have gone from trusted allies and long-term partners with mutual interests in the Asia-Pacific to now having the respective heads of government exchanging insults and making accusations against each other. To read the analysis of the conservative Australian media and listen to some Defence insiders, the vitriol – in some cases pure hatred – is such that one wonders why they have been silent the last five years. If the French are so bad and untrustworthy, why did we sign a contract with them in the first place?

Referring again to the communique referred to above:

“Ministers reaffirmed the shared values, interests and principles that underpin the bilateral relationship, as reflected in the Joint Statement of Enhanced Strategic Partnership between Australia and France, and the Vision Statement on the Australia-France Relationship. They agreed to publish a report on the Australia-France initiative (AFiniti) to highlight the depth and breadth of cooperative activities.”

WHO HAS BEEN LYING?

Clearly there is a lot to try and understand in all of this and the complete story might never be known. Without being in possession of the full facts it is difficult to make firm judgements – but we can make some guesses. Prime Minister Morrison has given several accounts of the dinner with President Macron in June during which he says he told his counterpart that the submarine contract would be terminated. Macron asserts that no such thing was said and that France was oblivious to the dramatic switch that was about to occur.

These two different versions are compatible and do not indicate that either Morrison or

Macron have been lying. It all gets down to the exact words that were used and in what context. It happens all the time and neither individual is deliberately stating a falsehood. Person A: "You didn't show up on Friday"; Person B: "You said next Friday, not this Friday."

Perhaps a message of the enormous consequences of cancelling a strategic partnership worth tens of billions of dollars between two nations should not have been delivered casually during a friendly dinner, perhaps with a few glasses of alcohol involved. Whatever message the Australian Prime Minister thought he was delivering, the French President heard something different. We know this from the now infamous leaked "is it good news or bad news" text from Macron a couple of days before everything went public on September 16.

WHY NOT A 4-WAY ALLIANCE?

One of the great mysteries is why there was no attempt to structure a relationship between France, Australia, the US and the UK. All four countries are already connected via various security arrangements, not the least of which being NATO for the three northern hemisphere countries. The Attack class submarine is already a tri-nation undertaking with a US nuclear submarine combat system, the AN/BYG-1 from Lockheed Martin and US weapons, principally the Mk 48 heavyweight torpedo in a French hull for an Australian customer.

One of the paperwork chores when the project was first established was to put in place the necessary security protocols and procedures so that French, Australian and US personnel could share Top Secret data. A number of them have been co-located in the Attack class design centre in Cherbourg. Adding the UK to the mix would have been administratively simple. Such a group might have been able to conclude that the best solution was to fast track the Australian version of a nuclear-powered Barracuda – which already exists – perhaps with the first of class built in France.

NAVAL REACTORS

As we have previously written, there is a quite a bit of misinformation about naval nuclear reactors, particularly the assertion that US and UK systems are far superior because they never need to be refuelled. This might be true, but they still need to be thoroughly inspected regularly, itself an intrusive process that is inherently risky because the material – highly enriched bomb grade Uranium 235 - is completely toxic to humans if it leaks out. Each Virginia or Astute class submarine is powered by about 300kg of the stuff – enough to make a dozen

or so nuclear weapons. There is still a very long way to go in legal and regulatory matters if Australia is ever to receive such technology.

French reactors use commercial grade Low Enriched Uranium and need to be refuelled every ten years. Various Australians, including the Prime Minister and Defence Minister, have said this is a no-no because refuelling them is a complex and dangerous process – and that if it had to be done in France this would be an unacceptable risk to national sovereignty. This might be true, but it seems at least worth exploring in a bit more detail. The French have developed a highly automated process that can be completed in three weeks – some sources say a few days – and it would be interesting to see if that technology could be transferred to Australia.

The bottom line is that refuelling a reactor with LEU is not that much more dangerous than the regular safety inspections that are needed for one using HEU.

UNTRUE OFFICIAL STATEMENTS

There are some other untruths being uttered about the supposed superiority in all regards of nuclear-powered submarines over conventional ones. This is a clumsy retrospective attempt to make the diesel-electric Attack class look unacceptably bad. In an opinion piece published in the Australian Financial Review on October 26, Defence Minister Dutton wrote:

"Compared to their conventional counterparts these submarines are superior in terms of stealth, speed, manoeuvrability, endurance and survivability. Nuclear-powered submarines can carry a greater number of advanced weapons and deploy underwater vehicles. There's also significant interoperability advantages in working with the UK and US."

He is wrong on several counts:

1. Stealth. Nuclear submarines are not stealthier. This is factually incorrect. At all speeds, particularly slow and stationary, nuclear submarines are noisier, mainly because of the need to cool their reactor;
2. Manoeuvrability. Nuclear submarines are not more manoeuvrable. They are large and not particularly agile – certainly not compared with a Collins class or smaller vessels;
3. Endurance. The endurance of a submarine is limited by the amount of food that can be carried for the crew and the amount of time that people can be confined underwater in a large metal tube without going insane. A nuclear submarine certainly has the capacity to carry a lot more

supplies than a conventional one, but human mental frailty means that missions of more than 70 days for either type are unlikely.

4. Interoperability. The reason why Collins currently and the future Attack class use the AN/BYG-1 combat system and Mk 48 torpedoes is to maximise commonality with the US. This commonality therefore already exists. There is no commonality with UK submarines, which have their own combat system and weapons.
5. Nuclear submarines can deploy uninhabited vessels - but so can conventional submarines. There is no difference.

The Minister is new to the portfolio and next time might wish to have his article fact checked by experts before submitting it for publication.

INDISCRETION RATES AND MORE FALSE INFORMATION

As if the piece in the AFR isn't bad enough when it comes to misleading the public, a lot has been said about the supposed weakness of conventional submarines because of their indiscretion rate. This is a consequence of their need to come near the surface to put up the snort mast, which sucks in huge quantities of air when the diesel engines are running to charge the battery pack.

A lot of work has been done on developing stealth masts that are undetectable by radar and EO systems. Secondly, there is a great deal of junk floating around on the sea surface that has signatures similar to those given off by submarines. Thirdly, skilled submariners move their vessels at the same speed and direction as the waves so that there is no tell-tale wake. Finally, the diesels only need to be run for a short time and have an acoustic signature very similar if not identical to thousands of merchant vessels and fishing boats chugging around all the time.

Conventional submarines can be made stealthier by the use of Air Independent Propulsion and lithium ion batteries. The RAN – and especially the highly paid US advisors referred to earlier – have shown no interest in either. France and Naval Group cannot be blamed for that. These are entirely Australian decisions – and backward ones at that.

Another thing that no one is pointing out is that nuclear submarines also come to the surface. That is why they have numerous masts, including periscopes and radar / ESM systems. These wonderful pieces of technology only work when they are poked up into the air to see what is going on. Submarines have an attack periscope because the captain likes to verify a target before blowing it out of the water in case it's a hospital ship or a friendly

SUBMARINES

GROTON, Conn. (Aug. 26, 2021) Sailors stand topside aboard the Los Angeles-class attack submarine *USS San Juan (SSN 751)* as it returns to its homeport following a seven-month deployment (U.S. Navy photo by Mass Communication Specialist 2nd Class Tristan B. Lotz)



vessel. Imagine the embarrassment of sinking one's own flagship by mistake.

When a nuclear submarine comes to the surface to put up its masts, it is just as vulnerable to detection as a conventional one. It has the option of staying underwater the entire time, but if it does that why bother with all those fancy masts in the first place?

Nuclear submarines have the advantage that they can run at high speed underwater for extended periods of time, but even this needs to be qualified. Because of the noise caused by hydrodynamic flow, the faster a submarine travels the less its sonars can detect anything in the area because of the vast rush of water over its own arrays. This means that there must be a compromise between high speed and situational awareness – you can have one or the other, but not both.

DEFENCE'S SELF-DEFEATING INFORMATION BLACKOUT

In words dear to the heart of APDR, French Ambassador Jean-Pierre Thebault told the National Press Club on November 3 that he felt the Department of Defence had concealed positive information about the Attack class program to make it easier to cancel it. He said:

"We have questioned the Australian government several times over the years about the false and misleading allegations which have been regularly made – with scarce official response. We were told: such things are normal in Australia, go away – and have to be managed by Defence.

"But in light of subsequent events, the question arises: why was it not possible earlier to state the basic truth about the program?"

The Ambassador is referring to clear statements during Senate Estimates and earlier hearings

involving senior Defence officials who stated repeatedly that the Attack class program was on time and on budget.

"Why was the smear campaign not stopped? In retrospect and knowing what we know today – and I thank the press – about the relentless conduct of an alternative plan, some had an interest in sabotaging public support for the Attack class program."

The handling by Defence of information about the Attack class has indeed been abysmal, hiding behind the cloak of national security to say nothing about it publicly. But things have gone much further, with the French and Naval Group saying that they have been blocked by the Department from having any contact with the Australian media.

If true, this is a disgrace and should have resulted in the Naval Group CEO writing the following letter:

Dear Minister,
It has come to my attention that your officials are attempting to prevent communication between Naval Group and the media. If correct, such actions are in breach of the Trade Practices Act, which makes it unlawful for a government to stop a company going about its usual lawful commercial activities. We have the right – within the bounds of military and commercial sensitive information – to communicate in general terms about our activities.

By attempting to muzzle us, the Department is not protecting matters of national security – it is seeking to hide its own deficiencies.

We will continue with our usual marketing activities and if Defence would like to have a representative present at all briefings to make sure that nothing untoward happens, it is welcome to do so – at its own cost.

Finally, if you have been a party to the suppression of unclassified positive information

about the project you might also be personally liable for the consequences of your actions.

Yours sincerely,

POSSIBLE LEGAL CONSEQUENCES

If the cancelled Attack class contract ends up in court – as well as it might – Naval Group could have a huge financial claim against Defence for trashing the company's international reputation and thereby costing it billions of dollars in foregone revenue. Lawyers would be salivating at the prospect of running a case if there is written proof that Defence has been blocking the release of unclassified, positive information about the performance of the company.

Make no mistake – the international arms trade is huge and competition is fierce. Without doubt, the many competitors of Naval Group will be capitalising on the Australian decision and will be gleefully repeating the words of various Ministers who have been seeking to damage the company for several weeks.

Perhaps this is why Defence officials have been far more circumspect, saying that the cancellation has nothing to do with contractual performance and everything to do with changed international circumstances. However, these words cannot undo the damage caused by years of suppressing any good news.

THE WAY AHEAD

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HMAS Rankin sails in company with Indian Navy Ship Kadmaat during AUSINDEX 21. Credit: CoA / Yury Ramsey



GEOFF SLOCOMBE // VICTORIA

SUBMARINE PROPULSION

Australia has two major submarine construction projects to get underway in the next few years – Collins Class Life of Type Extension (Collins Class LOTE) and the nuclear-powered submarines announced on Thursday 16 September 2021. Both projects have an enormous number of options which could be considered, some easier to select than others. This article will focus on submarine propulsion power sources and the choices to be made.

The performance advantages of the nuclear submarines over conventional (typically diesel-electric) submarines are considerable. Nuclear propulsion, being completely independent of the air, does not need to surface frequently, as is necessary for conventional submarines.

The huge amount of power generated by the reactor helps nuclear submarines to operate at high speed for long periods of time and the current generations of nuclear submarines do not need to be refueled during their 30-year lifespans. It is obvious that nuclear propulsion will be a non-starter

for the Collins Class LOTE but will come into its own with construction of a predicted eight nuclear powered submarines.

The debate on lithium-ion versus lead-acid storage batteries will command a lot of attention before final orders are placed for the LOTE. Defence will have to be receptive to very persuasive arguments before changing from lead-acid to lithium-ion batteries for the first of these with work scheduled to commence in 2026.

There is no real doubt that diesel electric generators will continue to be used at snorkel

depth below the surface, both for electric motor propulsion and recharging of storage batteries, whether lithium-ion or lead-acid technology.

A Defence spokesperson told APDR that:

'Lead-acid battery technology has remained a dependable form of energy storage in submarines, as demonstrated in recent times by their effective use in Australia's existing Collins fleet of submarines.

'Lithium-ion batteries are a new technology with respect to application in submarines and have not yet been proven fully at sea. Defence will continue to make informed decisions on technology including

the risks associated, noting the opportunity to introduce new technologies will be available as they become sufficiently mature. This includes dedicated science and technology work to assess the future suitability of a range of battery technologies, led by Defence Science and Technology and in cooperation with industry, including PMB Defence.'

Another option is fuel cell electricity generation. A fuel cell is an electrochemical cell that converts the chemical energy of a fuel (often hydrogen) and an oxidising agent (often oxygen from the air) into electricity through a pair of redox reactions. These are in use on German-designed Type 212 and 214 classes of submarine. Stirling air independent engines are used on Swedish submarines and have been previously used by Japan, though it is believed that they are being phased out. They are internal combustion engines using the submarine's own diesel fuel combined with liquid oxygen that is stored in tanks outside the pressure hull.

COLLINS CLASS LOTE

Under current Royal Australian Navy doctrine, the Submarine Service has the following responsibilities:

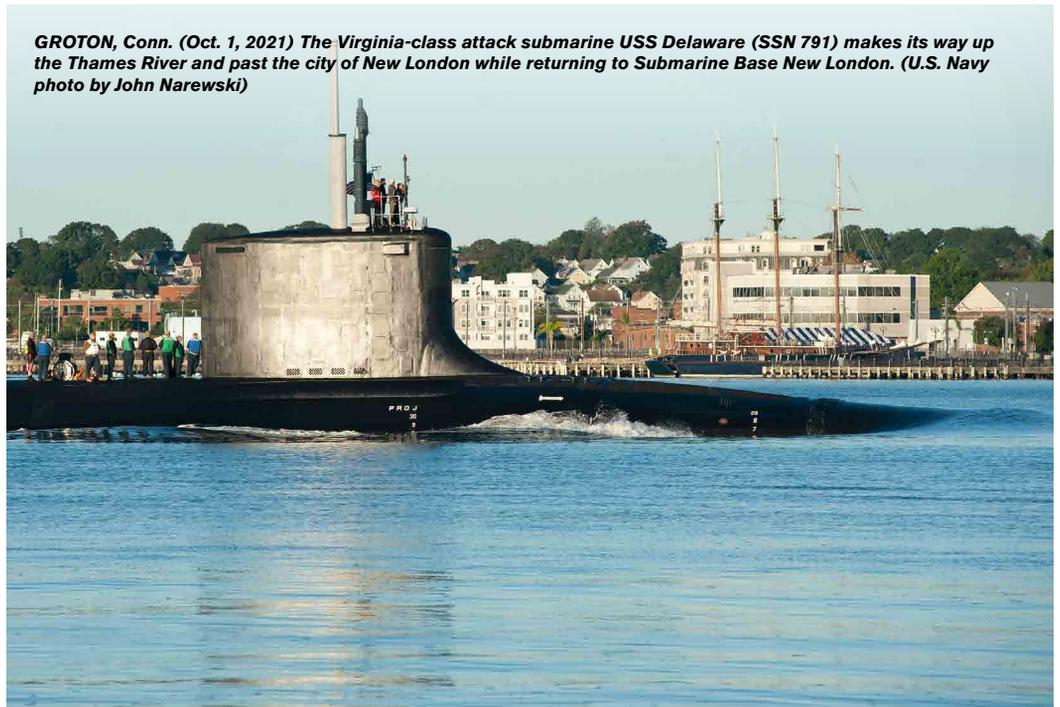
- intelligence collection and surveillance
- maritime strike and interdiction
- barrier operations
- advanced force operations
- layered defence
- interdiction of shipping
- containment by distraction; and
- support to operations on land

The characteristics and range of Collins Class submarines have been tailored specifically for its defence and two-ocean surveillance role in the Royal Australian Navy. Designed to be as quiet as advanced technology can achieve, Collins Class submarines have been developed from five generations of submarines designed and built by the Swedish Navy.

One of the first submarines to be totally designed by computers, these submarines boast a vast range of features. They include a high-performance hull form, highly automated controls, low indiscretion rates, high shock resistance and an efficient weapons handling and discharge system.

The submarine moves silently on electric power supplied by banks of new-technology batteries. The batteries are charged by three on-board diesel generator sets.

Minister for Defence Peter Dutton said the Government's investment in the LOTE would ensure Australia maintained a strong and agile submarine capability for decades:



GROTON, Conn. (Oct. 1, 2021) The Virginia-class attack submarine USS Delaware (SSN 791) makes its way up the Thames River and past the city of New London while returning to Submarine Base New London. (U.S. Navy photo by John Narewski)

Every two years from 2026 until 2036, a Collins Class submarine will be brought in for its Life-of-Type Extension so Australia always has at least five in the water at any time.

'The Collins Class submarine to this day remains one of the most capable conventional submarines in the world,' Minister Dutton said. The planned Life-of-Type Extension, through the replacement of key systems, will help deliver Defence's strategic objectives.'

Planning to extend the service life of Collins Class to avoid a capability gap commenced in 2011. Defence and industry are continuing to progress work on schedule to achieve implementation in the first boat that will need an extension - HMAS Farncomb - commencing in mid-2026.

That program will update key equipment on the submarine, including the propulsion systems, diesel motors, generators, power conversion and distribution systems, along with a range of hull assessments and upgrades.

The LOTE will extend the operational life of each submarine by 10 years.

A Defence spokesperson told APDR that:

'The Collins class LOTE core work package is planned for implementation during a standard two-year full cycle docking. Collins LOTE is not expected to require more hull cuts than currently undertaken during full cycle docking activities.'

ASC will lead design and implementation

activities, and the Department continues to support ASC in its ongoing engagement with other companies, including Saab Kockums, to progress the project.

'Central to the success of the full-cycle docking and life-of-type extension program is the commitment of ASC's workforce, which includes Australia's leading submarine platform engineers, trades and professionals' said ASC's Managing Director and Chief Executive Officer Mr Stuart Whiley. 'Upgrading the Navy's six Collins Class submarines through the program and provide Australia with a world class submarine capability into the 2030s and beyond.'

Every two years from 2026 until 2036, a Collins Class submarine will be brought in for its Life-of-Type Extension so Australia always has at least five in the water at any time.

SUBMARINE NUCLEAR POWER PROPULSION

The huge amount of power generated by the nuclear reactor helps these submarines to operate at high speed for the long periods of time and the current generations of nuclear submarines do not need to be refuelled throughout their 30-year

SUBMARINES

The Japan Maritime Self-Defense Force submarine JS Soryu (SS-501) is pulled alongside the submarine tender USS Frank Cable (AS 40) for a touch-and-go exercise. (U.S. Navy photo by Mass Communication Specialist 3rd Class Randall W.



The naval reactor's thermal efficiency is less than land-based nuclear power plants, with percentages often just in the teens. They use highly enriched uranium and modern plants use recycled pressurised water to avoid the noise of pumps running.

lifespans – though they do require regular safety checks and maintenance. They enable submarines to undertake patrols of more than 70 days, with the length of missions being limited only to how much food can be carried and the endurance of the crew.

The nuclear submarine works on the same principle and construction design as a conventional submarine. Naval power plants are quite similar to land-based nuclear power reactors. They produce heat through a nuclear reaction that is used to boil the water that then turns the turbine.

Naval nuclear power reactors have a few different properties from the land-based ones, due to space considerations, these reactors are small (a hundred or so megawatts compared to quite a few gigawatts on land) and they have a higher output power density. Nuclear powered submarines can also have large batteries that allow the submarine to run at minimum reactor power for several days in near perfect quiet.

The naval reactor's thermal efficiency is less than land-based nuclear power plants, with percentages often just in the teens. They use highly enriched uranium and modern plants use

recycled pressurised water to avoid the noise of pumps running.

The AUKUS partnership of Australia, the United Kingdom and the United States will almost certainly mean that the new submarines will have their PWR3 pressurised water reactor systems provided by Rolls-Royce Marine Power Operations at Derby, UK.

Nuclear submarines using highly enriched uranium have long core lives so they don't need refuelling. The reactor itself is contained in a safe, compact pressure vessel due to the need of the flexible power output and space constraints.

But what happens when a submarine's nuclear reactor has to be closed down while the crew do system fault-finding and repairs? An Emergency Diesel Generator, or two in larger submarines, is usually located in an Auxiliary Machinery Space. This can be run if there is insufficient charge left in the batteries to provide power until the problem is rectified. Since they are combustion engines and need air, the submarine has to come to periscope depth and use its snorkel mast.

The number of storage batteries aboard nuclear-powered submarines is very small by diesel-electric submarine standards, so it's imperative the diesel generator be brought up quickly. This diesel generator is small, and is used only to keep batteries charged and support basic electrical loads while the crew troubleshoots the fault in the nuclear reactor.

Swedish Gotland-class submarine, HMS Uppland (Saab Kockums photo)





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BEIJING'S STRATEGIC ENCIRCLEMENT OF AUSTRALIA

No country has come close to China's long-term growth rate, which has averaged a remarkable 9.5% over the last 40 years. This sustained high level of economic activity has enabled a parallel expansion in defence spending. While NATO countries are struggling to hit 2% growth targets, China's defence budget increased by 7% in 2021.

Chinese and Russian warships transit simulated mined sea area during the naval exercise Joint Sea-2021 on the morning of October 15. (eng.chinamil.com.cn/Photo by Sun Jingang)



Rising military capability has encouraged national assertiveness, and a ratcheting up of military pressure against Taiwan. Several military airfields have been built on the mainland opposite the island, facilitating a dramatic rise in military aircraft incursions into Taiwanese airspace. Observers interpret this growing military momentum as a prelude to actual combat, perhaps during the present decade - even within the next six years. For an invasion to be credible, naval dominance will be paramount, and this explains the push behind Beijing's remarkable shipbuilding program.

China's shipbuilding numbers have always been impressive, dwarfing even the US efforts of World War II. In 2019, China built more ships in a year of peace than the US did between 1941 and 1945. Reportedly across 2014-18, China launched more submarines, warships, amphibious vessels, and auxiliaries than the number of ships currently serving in the individual navies of Germany, India, Spain, and

the United Kingdom.

By 2025, the PLA(Navy) is predicted to comprise 400 battle force ships, compared to the planned US fleet of 355. This huge naval build-up coincides with China reinforcing its claims to the 3.3 million square-kilometre South China Sea. The attraction is twofold. Firstly, the area has abundant resources, such as hydrocarbons, oil, gas, and fisheries, and secondly, Beijing seeks to protect its trade routes for the essential imports sustaining rapid industrialisation. Accordingly, China is building artificial islands and military facilities in the Spratly and Paracel chains to respond to threats and exploit intelligence gathering, surveillance system surprise, and cyber warfare.

China's projection of maritime capability hints at 'strategic-reach' ambitions going beyond reunification of Taiwan and the militarisation of the South China Sea. More likely Beijing aims to become a regional Asia-Pacific hegemonic power via exploitation of both hard-power threats and soft-power inducements to

reassert itself as a new 'Middle Kingdom'. The 'China Dream' aims to close the page on what it views as a century of humiliation and to ensure that into the future its periphery is secure through a ring of vassal states serving Beijing's eco-strategic interests.

This is just a first step, however, with China's naval superiority acting to secure 'far seas protection' of its growing overseas assets. From the hard power perspective, the process began with the 2017 opening of Beijing's first overseas military facility in Djibouti on the shores of the troubled Red Sea and the building of a potentially military port at Gwadar, Pakistan, facing the Arabian Sea. Exercise of soft power, by contrast, is more focused on acquiring overseas economic assets and nurturing diplomatic influence. The process has been catalysed through the 2013 launching of Beijing's US \$4 trillion Belt and Road Initiative (BRI).

The BRI targets the building of roads, railways, ports, and other eco-strategic infrastructure. Chinese state-owned companies now control about 76 ports in 35 countries - including Darwin. A 2020 Washington CSIS Think Tank Report identified 46 African ports where China has financial, construction and operational involvement. This reincarnation of the Silk Road Economic Belt is written into China's Constitution and aims to touch 60% of the world's population through offering major investments financed through long-term loans.

In Asia, for instance, China is pushing Thailand to agree construction of the 100km Kra canal, on the scale of Panama, linking the South China Sea with the Bay of Bengal, and thus bypassing the crowded Strait of Malacca. For the West, the Kra project exemplifies the common danger of the BRI acting as a vehicle for Beijing's potential acquisition of overseas infrastructural assets, contributing to a broadening and deepening of China's strategic influence.

Chinese asset acquisition invariably occurs through 'debt traps.' For instance, Sri Lanka's inability to repay a \$6 billion debt to China led to it taking a controlling 70% stake and a 99-year-lease in the Hambantota port, as a means of repaying the burden. Similarly,

Beijing has built a new port at Kyaukpyu, Myanmar, and taken a 70% controlling stake after Myanmar defaulted on its repayments.

China now has the potential for a naval base on the Indian Ocean side of the Malacca Strait chokepoint, projecting power across the Bay of Bengal. The recent loss of office by Maldives' former President Yameen, a close friend of Beijing, spotlights how this Indian Ocean territory can repay Chinese loans for a major airstrip and an ambitious China-Maldives Friendship Bridge. Significantly, the Maldives is also home to an abandoned British naval facility, ripe for Chinese redevelopment.

China's BRI transition from soft into hard power is aimed at weakening the West's traditional 'Three Island Chain' potential blockade, encompassing what Beijing claims are around 250 US military installations ringing the Chinese mainland. Several of these are in Australia, representing the West's principal geo-strategic buttress to China's Grand Strategy of Pacific domination.

If China encroaches into the Pacific, Canberra's traditional sphere of interest, the Continent will face the beginnings of a 'reverse' Chinese containment strategy. The process began years ago, with PLA delegations visiting 24 Pacific islands between 2006 and 2019, more than 60% involving PLA(Navy) ships. This emerging threat has begun to focus the minds of Canberra's policymakers, as the danger of conflict increases.

Earlier in 2021, US Secretary of State, Antony Blinken, singled out China's "blatant economic coercion of Australia" as an example of the urgent threats that democratic nations around the world face from increasingly assertive authoritarian regimes. Using similar bellicose language, Mike Pezzullo, Australia's Home Affairs Department Secretary, warned that liberal democracies must brace themselves for war. Mr Pezzullo did not offer a specific reason for his remark, but tensions with China, particularly Taiwan, are almost certainly a factor. The *Global Times*, the Chinese Communist Party's journalistic mouthpiece, responded by threatening that China would launch "ballistic missiles" against Australia if it makes "any incursion" towards Taiwan.

The catastrophic decline in Sino-Australia relations has led to a 40% hike in Canberra's defence spending over the next decade, with an enormous US \$200 billion allocated to improving long-range strike capabilities. The US will assume the role of a 'strategic partner' and likely support Australia's plan to build a sovereign guided weapons capability in a US \$735 million project to address local supply chain vulnerability in the event of a regional conflict.

Additionally, Prime Minister Morrison has announced



a US \$550 million upgrade of military training bases, which would be used in any conflict with China. The most important of them, Pine Gap in central Australia, acts as a geospatial operations and intelligence hub. On top of its role in America's global drone surveillance and targeting programmes, Pine Gap is also a vital piece of the US' nuclear warfighting apparatus, the capabilities and destructive capacity of which have been dramatically expanded in recent years.

Australia also plays host to a fully equipped US Marine Air-Ground Task Force stationed in Darwin. There are planned upgrades of shooting ranges and airstrips and new training facilities for both Australian troops and US marines. More than 2,000 US Marines have already travelled to Northern Australia to participate in annual joint training activities.

There are additional testy politico-economic dimensions to the souring of Canberra-Beijing relations. China is no longer supine in the face of international criticism and was irked by the Federal Government's 2020 call for an international inquiry into the origins of the coronavirus pandemic, its criticism of Beijing's ill-treatment of the Uighurs and its restrictions on democracy in Hong Kong. This then spiralled into a series of tit-for-tat spying accusations, including claims of Chinese interference on Australian university campuses and counterclaims that the universities were discriminating against Chinese students.

However, behind the political rhetoric lies the economic leverage that China can exert. Trade disputes have proliferated, including Beijing's decision to halt or severely restrict Australian exports, such as

coal, beef, wine, barley, timber, grapes, and seafood. By some measure, China is Australia's biggest trading partner, accounting for almost 33% of its exports. In particular, the mining of iron ore is hugely dependent on China's big internal demand for steel production.

Thus, weaning itself off addiction to Chinese markets will not be painless, especially since Beijing is not averse to retaliatory economic pressure. Nevertheless, Canberra went ahead and blocked a Chinese commercial takeover in the state of Victoria, as part of China's global BRI programme and is additionally considering whether the Chinese-owned Landbridge Group should be forced to give up its 99-year lease of Port Darwin, on national security grounds.

Australia's closest neighbour, New Zealand, is also heavily dependent on Chinese demand, accounting for around 30% of its exports, but in contrast to Canberra's robust response to Chinese 'wolf' eco-diplomacy, Wellington's reaction has been muted. Indeed, there are signs that New Zealand is even willing to increase diplomatic cooperation with China. The Foreign Affairs Minister, Nanaia Mahuta, has stated that the government was 'uncomfortable' with the Five Eyes Alliance expanding its remit beyond intelligence-sharing - and New Zealand was also the only Five Eyes' member not to sign a joint statement condemning Beijing's new security laws in Hong Kong.

Canberra, of course, recognises that the importance of such strategic partnerships extends beyond Australia, not least because its national security is necessarily dependent on regional security. It thus watches with growing alarm China's efforts to spread

its influence into Australia's 'backyard', even extending to Antarctica.

Here, Beijing has recently announced plans to build a large all-year-round airport 17 miles from its Zhongshan ice research station, located in East Antarctica within the 42% of the continent claimed by Australia. The project will compete with Canberra's plans to construct a 1.6-mile paved airstrip for its Davis research station, allowing access to RAAF C-17 aircraft. While both countries seek to justify their respective investments on research grounds, there is no doubt that the reported presence of sizable energy and mineral resources acts as a decisive pull factor.

While China's growing presence in Antarctica is of grave concern, the principal fear is that China's long-term plan is to establish a strategic foothold in the Pacific islands from which it could threaten Australia. President Xi has already sought to engage numerous islands to participate in a Pacific maritime 'Silk Road'.

As elsewhere, the first step will be to entice small Pacific Island states to take on unaffordable loans as part of China's debt trap strategy of acquiring strategically important maritime infrastructure. Beijing's loans do not come cheap, and Australia's Lowry Institute cautions that such indebtedness gives China significant leverage over Pacific nations to convert loans into equity in infrastructure.

For example, witness Papua New Guinea's (PNG) experience in the telecommunications sector where Chinese firms continue to make large promises of new fibre optic connections, 4G towers, and data centres, even though PNG owes China's Exim Bank US \$526 million on existing projects. The island government is now concerned about repayment and frustrated that many of China's investments have operationally failed.

To thwart the intentions of state-controlled Chinese telco giant Huawei, Australia's Prime Minister Turnbull in April 2018 promised PNG that funding would be available for a new undersea internet cable. Yet the promises continue, with Beijing offering to build a US \$30 billion city, including a large port, on PNG's impoverished South Coast, less than 50 miles from Australian territory across the strategically important Torres Strait. Chinese investment in PNG has risen dramatically over recent years, especially in infrastructure projects. By 2017, China had reportedly invested more than US \$3.6 billion solely in building essential roads.

Elsewhere, in 2013, 64% of Tonga's foreign debt was owed to China, amounting to 43% of the Pacific island's annual GDP. Tonga has reportedly warned to

the idea of writing off this burden by allowing Beijing to establish a naval base on the island. Vanuatu is similarly indebted to Beijing, owing around US \$1.7 billion. In 2019, China was reportedly seeking a permanent military presence on the island.

Lending weight to this report, Vanuatu's Chinese-built US \$85 million Luganville wharf seems more suited to navy vessels than cruise ships. Vanuatu's location is particularly strategic as it lies within the



Sailors assigned to the 39th Chinese naval escort taskforce connect a fuel probe from the comprehensive supply ship Taihu (Hull 889) to their ship during a replenishment-at-sea operation in waters of the South China Sea on October 1, 2021. (eng.chinamil.com.cn/ Photo by Zhao Yang)

sea lines of communication between the US and Australia. China also has advanced plans to build a US \$100 million wharf in Samoa, close to the capital city Apia, but these were thwarted when Samoa's long-serving pro-China Prime Minister was ousted. The wharf would have been capable of berthing 12 large vessels, fuelling fears of a Chinese military Pacific base potentially bigger than any in Australasia. China's investments in Samoa are already sizable, representing more than 40% of its national debt, with China increasingly pressuring the country to pay back the money.

While Fiji's indebtedness to China is only 10% - small compared to Tonga and Samoa - for years it has been the beneficiary of PLA military equipment donations. Fiji is pursuing a 'Look North' policy, and the ensuing warmer relations with China has encouraged the latter to invest US \$1 billion in around 300 investment projects, including the usual infrastructural targets of roads, dams, and bridges, as well as goldmining.

On the Eastern edge of Micronesia, Beijing is reportedly interested in refurbishing and expanding Kiribati's remote and rundown 6,000-foot WWII airstrip. Under the guise of economic development

and climate change adaption, the airstrip's geostrategic significance is obvious, given sensitive US military installations in Hawaii located 1,800 miles across the Pacific.

South of Kiribati lies New Caledonia, and it too is looking vulnerable to Chinese influence. If a recent referendum on breaking ties with France had been successful, New Caledonia would have inevitably invited interest from China, as the territory owns around

25% of the world's nickel reserves, presently generating about US \$1.1 billion of sales to China. New Caledonia's independence would have dealt a serious blow to Macron's vision enunciated during his 2018 visit to the territory.

He proposed a 'Paris-Delhi-Canberra axis, representing joint objectives to address Chinese challenges in the Indo-Pacific region. In a later Pacific visit in 2021, President Macron visited French Polynesia, and announced that France would support South Pacific nations in launching a local coastguard network to counter China's predatory paramilitary fishing vessels. Moreover, in discussions with Japan's Prime Minister, Yoshihide Suga, a joint statement was issued that the two nations would work more closely on defence for a 'free

Pacific' to arrest China's expansionism.

While sparsely populated, the broad swathe of states in Oceania control immense marine resources and represent a potentially decisive bloc of votes in bodies, like the UN, that China has sought to influence to isolate Taiwan. Pressure can move both ways, however. Taipei has warned the Solomon Islands that its efforts to forge closer links with China will replace four decades of a stable diplomatic allegiance with "flashy infrastructure" sourced through destabilising debt and causing permanent damage to local ecosystems.

Canberra has recently signed a Security Treaty with the Solomon Islands and has also fought off Chinese competition to sign a 2019 MoU for the redevelopment the Fijian Black Rock Military Training Centre in Suva. Similar security partnership understandings have also been negotiated with Tuvalu and Nauru, and Kiribati is in talks. Additionally, Australia has opened new Embassies in the Marshall Islands and French Polynesia.

Such responses to China's funding of local infrastructure and dual-use projects are to be applauded. However, while Australian military and diplomatic agreements are important elements in the security mix, there is a supplementary need to fill the socio-economic development policy vacuum by forging a framework of tangible investment support packages designed to 'win the hearts and minds' of the Pacific Island peoples.



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NEWS FROM ACROSS THE TASMAN

RNZAF C-130(NZ) Hercules. Credit: NZDF



RNZAF AIRCRAFT FLEET BY 2025

Hercules becomes Super

Five Lockheed C-130H Hercules aircraft, originally purchased in the 1960s, have experienced a number of upgrades and are currently in service, being designated C-130(NZ).

These Hercules provide strategic airlift (inter-theatre) and tactical airlift (intra-theatre) as well as participating in international training exercises. Tasks are flown in support of combat, peace-keeping and humanitarian relief operations. The agility of these Hercules means they can be seen operating in the cold of Antarctica one week and the heat of the tropics the next.

On 5 June 2020 the Government announced that a fleet of five C-130J-30 Super Hercules would replace the current fleet of Hercules.

The aircraft and a full mission flight simulator are being acquired through the United States' Foreign Military Sales process. Deliveries are scheduled to commence in 2024, with all five aircraft in country by mid-2025.

Passengers, Freight and Medevac

RNZAF operates two Boeing 757-2K2 aircraft in passenger and freight roles. These aircraft provide strategic airlift to carry personnel and equipment globally in support of operations and deployments.

Modifications commencing in 2007 saw the aircraft fitted with an upper deck cargo door to facilitate an 11-pallet cargo capability, internal air stairs, upgraded engines and flight deck enhancements including full compliance with current global air navigation specifications and standards.

The next phase of the Future Air Mobility Capability project is underway and is expected to deliver Boeing 757-2K2 replacements by around 2028.

No progress has been reported publicly as yet, but the project team will have noted that many Boeing 757 passenger aircraft are being replaced by Airbus 321neo (new engine option) jetliners.

Son to Father – Orion (mythical hunter) to Poseidon (sea god)

The RNZAF has a total of six P-3K2 aircraft five of which date from 1966. All six aircraft have been

upgraded several times and are now designated the P-3K2.

The P-3K2 provides airborne surveillance and reconnaissance of New Zealand's areas of economic interest, exclusive economic zone, the South Pacific, and the Southern Ocean including Antarctica in support of the Commission for the Conservation of Antarctic Marine Living Resources.

The Air Force's future Boeing P-8A Poseidons, starting to arrive in 2023, will operate in the anti-submarine warfare, anti-surface warfare, and shipping interdiction roles. They will be armed with torpedoes, anti-ship missiles, and other weapons, can drop and monitor sonobuoys, and can operate in conjunction with other assets.

Rotary Wing

The RNZAF has five state-of-the-art AgustaWestland A109 Light Utility Helicopters (A109LUH). They are a lightweight, twin-engine aircraft with a modern glass cockpit and a retractable wheeled undercarriage.

The A109LUH is part of the Defence Force helicopter training system that includes a virtual interactive procedural trainer and a top-of-the-line full flight simulator provides the Defence Force with a comprehensive and cost-effective means of training aircrew prior to operational conversion onto the NH90 or Seasprite helicopters.

In addition to its training role, the A109LUH is utilised in various operational tasks, including counter-terrorism, disaster relief, and personnel transport. It is available to be employed in support of various government departments in a light utility role.

The NH90 is an advanced medium utility helicopter, capable of undertaking a wide variety of roles. The NH90 can carry up to nine stretchers plus medical staff, or palletised cargo; it can also lift the NZ Army's Light Operational Vehicle.

The RNZAF now has eight NH90 helicopters in its fleet, which have been used for disaster relief operations throughout NZ and in the South Pacific. The NH90 has the capability to support ground operations, conduct search and rescue missions, counter-drug operations, and counter-terrorism responses. It is utilised by many national organisations such as the NZ Police, Customs, Maritime NZ, Civil Defence, MFAT, and DOC.



RNZAF Orion P-3K2. Credit: NZDF

In May 2012, then Defence Minister Jonathan Coleman announced that Cabinet had given Defence officials approval to negotiate with Kaman Corporation for the 11 helicopters and flight simulator from the cancelled Australian SH-2G Super Seasprite project. A decision to purchase ten of the helicopters for \$NZ242 million was announced on 19 April 2013. Eight of the aircraft entered service with the RNZAF to replace the existing five Seasprites, and the remaining two are used as a source of spare parts.

The New Zealand Ministry of Defence accepted the first of the helicopters in the United States on 1 December 2014, and deliveries were completed by the end of 2015. They will be replaced with eight re-manufactured SH-2G(I) models, allowing the Navy to embark up to three helicopters from ships at once instead of two. The 'I' model also replaces the AGM-65 Maverick with the AGM-119 Penguin anti-ship missile.

They are flown by Royal New Zealand Navy aircrew and maintained by Royal New Zealand Air Force maintainers.

Fixed Wing Training

Eleven T-6C Texan II aircraft are used to train New Zealand Defence Force pilots during the Pilot 'Wings' Course, and pilot instructors during the Flying Instructor Course.

Pilot Training aims to deliver 15–20 qualified pilots and 8–10 flying instructors annually. Two fixed base flight simulators and 12 avionics desktop trainers are used throughout pilot and instructor training.

Following completion of Wings Course, pilots will move onto either multi-engine conversion training (fixed-wing aircraft) or rotary-wing conversion training (helicopters).

The T-6C aircraft are purpose-built for military training and have the latest technology including;

ejection seats, collision-avoidance and ground proximity warning systems, a pressurised cockpit and an on-board oxygen generating system to provide supplementary oxygen for each pilot.

They are expected to remain in service until the mid-2040s.

The Super King Air KA350 is a light twin engine fixed wing, nine passenger, commuter aircraft. The NZDF has four KA350s in its fleet, introduced as part of the Air Crew Training Capability (ACTC) project.

The KA350 has been modified for the NZDF to allow three configurations:

- Transport for nine passengers
- Air Warfare training
- Sensor suite training

The ACTC project also introduced ground-based training systems for both pilots and air warfare officers. The air warfare officer training is conducted using airborne consoles and a mission management system installed in the KA350 cabin.

Pilot training can be conducted in any of the three configurations. There are two ship-sets of consoles allowing Air Warfare Officer training to be conducted on two KA350 aircraft concurrently.

The sensor suite, permanently fitted to two KA350s, consists of an Electro-Optic and Infra-Red camera and a single array multi-mode surveillance radar. The sensor suite is utilised for sensor operator training.



RNZAF Boeing 757K2. Credit: NZDF



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