

A New Approach and Attitude to Electronic Warfare in Australia



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By Dr. Robbin F. Laird

In this report, the major presentations at the Williams Foundation seminar on the evolution of electronic warfare, notably from the standpoint of shaping an integrated force, are outlined and discussed. The seminar was held on August 23, 2017 in Canberra, Australia. Additional materials provided during interviews prior to or during the seminar are included as well as relevant background and analytical materials building out key themes introduced and discussed in the seminar.

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BY DR. ROBBIN F. LAIRD

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INTRODUCTION

The Williams Foundation has been a thought leader in bringing together the key players in the Australian military as well as allies to shape a way ahead for the integrated force.

Since March 2014, the Williams Foundation has conducted a series of Seminars that explored the opportunities and challenges afforded by the introduction of next generation combat capabilities.

Topics that have been explored prior to the latest seminar have included:

- Air Combat Operations – 2025 and Beyond
- Battlespace Awareness – The Joint Edge
- Integrating Innovative Airpower (held in Copenhagen)
- Training for an Integrated ADF: Live, Virtual and Constructive Design-Led Innovation
- New Thinking on Air-Land
- New Thinking on Air-Sea
- Integrated Force Design

On August 23, 2017, the Williams Foundation held a seminar on the future of electronic warfare.

With the introduction of the Growler, this has provided a natural hook into the broader discussion of the evolving payloads, which need to be part of an integrated 21st century combat force.

The seminar background and focus was described in the run up to the seminar as follows:

An increasingly sophisticated and rapidly evolving threat with ready access to advanced, commercially available off-the-shelf technology is transforming the operational context in which the Australia Defence Force must now survive and fight.



FIGURE 1 AIR MARSHAL (RETIRED) GEOFF BROWN, CHAIRMAN, THE WILLIAMS FOUNDATION

The next generation battlespace will be contested across multiple domains with control of the Electromagnetic Spectrum becoming just as important as control of the Air if the Joint Force is to operate with the freedom of manoeuvre necessary to ensure campaign success.

This Seminar seeks to build a common understanding of how the EA-18G Growler, in particular, will impact the Australian Defence Force at the strategic, operational and tactical levels, and how Airborne Electronic Attack is likely to shape future Australian Defence and Security policy.

It will provide a historical perspective on the development of the Royal Australian Air Force's Electronic Warfare capability dating back to World War 2, and describe how today's Air Force personnel are raising, training and sustaining the Growler Force in partnership with the United States Navy.

We will hear the perspectives of the Australian Army, Navy, and the Joint Commanders, as well as contributions from our senior coalition partners in the United States and the United Kingdom. The emphasis will be on gaining a better understanding of the key enablers and technologies, such as C4I, Electronic Warfare Battle Management, and training systems, which turn the manned and unmanned platforms into Joint Capability delivering sophisticated battlespace effects.

The Seminar will also serve as an opportunity to provide an industry perspective on Electronic Warfare and, in particular, the role they can play as a Fundamental Input to Capability. It will highlight the importance of disruptive technologies, speed to market, and the increasing emphasis on non-kinetic effects to gain operational advantage. Industry participants are invited to address topics including Electronic Warfare Battle Management, training, and the emerging technologies associated with networked, force level effects.

Above all, the seminar will emphasise the need for a new attitude to Electronic Warfare and, in particular, a need to embrace the arrival of the EA-18G Growler as a catalyst for change. In doing so, it provides an opportunity to make Electronic Warfare more accessible and understandable to the Joint Force, and develop the Information Age Warfighters necessary to deliver campaign success on future operations.

In effect, this Electronic Warfare (EW) seminar was a case study of the iron warfare piece of building an integrated force which can operate a variety of payloads in a diversity of conflict situations.

At first blush, the Growler and its integration was the focus of attention; but in reality, the seminar was much broader than that due to the focus of attention of the speakers and the interactions with the audience throughout the day.



FIGURE 2 GROUP CAPTAIN BRAZ

Second Line of Defense

The heart of the seminar was provided by a fascinating and wide ranging presentation by the RAAF and US Navy Growler participants.

The presentations highlighted the very flexible and innovative working relationship between the US Navy and the RAAF in delivering Growler to Australia.

This effort provides a model of how to deliver joint combat effects by an allied force.

But both highlighted, that Growler was in many ways a means to an end.

Group Captain Braz emphasized that the RAAF did not want stovepipe EW specialists but rather the delivery of EW or what we call Tron Warfare payloads in the battlespace.



FIGURE 3 CDR MIKE PAUL

And even though the Aussies are just now getting Growler, the US Navy is just now working beyond the land wars to sort out how Growler fits into the high intensity battlespace.

And it is clear that the US Navy has much to learn from Australia, a point driven home by the US Navy representative, CDR Mike Paul, Electronic Attack 'Wing, Pacific Fleet.

In an interview with Group Captain Graz last Spring in Amberley, he highlighted how he saw the Aussie approach.

We need to get the experience which Growler can deliver and share the knowledge.

The difficult thing with Growler is that it delivers non-kinetic effects, and sometimes they're difficult to measure. We're used to being able to deliver effects through other systems where the outcome is tangible and measurable.

For a Growler, if you're attacking a threat system or the people operating that threat system, then often it's difficult to truly assess how much you're affecting that system.

You can do trials and tests in certain scenarios, but it's never quite the same, and so you get a level of confidence about what immediate effect you can achieve, but it's the secondary and tertiary effects that we're often looking for that are sometimes harder to measure.

The difficult challenge will become knowing how degraded the network is and how reliable the information is at any given point.

If you create enough uncertainty in the operators, then you can achieve an effect even if it's not degraded.

<http://www.sldinfo.com/group-captain-braz-and-the-coming-of-the-growler-to-the-australian-defence-force/>

Lt. General (Retired) Davis, recently the Deputy Commandant of Aviation, built from the core perspective of these two Tron Warriors to emphasize that for the USMC, electronic warfare capabilities are something which the insertion force needed as a core capability, not a specialized asset to be flown in from time to time.

He highlighted the Marine Corps approach to enabling the MAGTF with integrated EW capabilities, ranging from Intrepid Tiger pods on aircraft, to the F-35B, to the payloads on Blackjack, and to the coming new UAV which will be payload configurable.

The seminar organizer, John Conway, highlighted during the seminar and in talks after the seminar, the centrality of building EW into the operational art for the evolving combat force.

It is about reshaping the payloads, which can be delivered by the integrated force across the spectrum of warfare.

The introduction of the Growler is an important jump start to Australian capabilities, but it comes into the force as the Aussies are working force integration hard.

This effort will inform how they use Growler and according to CDR Mike Paul will be very helpful as the US Navy transitions from a kill chain to a kill web focus.

In short, the seminar provided a case study of shaping a way ahead for broadening the capability, which the evolving 21st century combat force, can deliver.



FIGURE 4 LT. GENERAL (RETIRED) JON DAVIS

And as Lt. General (Retired) Davis put it with regard to the Williams Foundation contribution:

"Hats off to the Williams Foundation for what you do.

"You provide a venue where you can share your ideas, be challenged, and to do so in a joint community.

"And it is done in public so can inform a broader discussion."

Second Line of Defense

The next seminars will address the challenges of transitioning and shaping a combat force able to operate in and prevail in high tempo operations up to and including high intensity warfare.

AN HISTORICAL PERSPECTIVE ON RAAF AIRBORNE ELECTRONIC ATTACK

The seminar was begun with a very thoughtful overview on the history airborne electronic attack within the RAAF. This perspective was provided by Group Captain Andrew Gilbert, Director of the Air Power Development Centre, RAAF.

His presentation follows.

To lay the foundation for today's seminar, I have been asked to provide an historical perspective on the development of electronic attack in the RAAF. If I were to stick with that riding instruction, this would be quite a short presentation because, put simply the RAAF has no significant operational history with airborne electronic attack.

Let me be clear, I am not suggesting that the RAAF has not been interested in developing an electronic attack capability. The RAAF has had an enduring interest in electronic warfare (EW) predating the Second World War, and while the focus of our developments, modest as they may have been, were in the realms of electronic support and electronic protection, the RAAF was fully aware of the theory and possibilities of airborne electronic attack, as demonstrated by the acquisition of

Electronic Counter Measure (ECM) pods for our fighters, and our dabbling with anti-radiation missiles. The issue was no threat was sufficiently compelling to justify the investment expense or, more appropriately, the opportunity cost that would have been required to develop an electronic attack capability. This is now no longer the case.

The ability to control, exploit, and deny the electromagnetic spectrum, or the EMS, has become a defining feature of modern warfare, and is a capability that is vital to the success of a fifth-generation force. As regional military's continue their modernisation programs and we see the rise of increasingly tech-savvy non-state adversaries, the RAAF could no longer afford to ignore the requirement for air power to deny, degrade, and disrupt our potential adversary's ability to exploit the EMS. In this respect, the EA-18G Growler represents a vital new air power capability for the joint force.

But we have to be wary of assuming that the acquisition of 12 aircraft represents "Mission Accomplished" for airborne EW in the RAAF. Rather, we need to view the Growler as a missing piece of an ever-evolving EW puzzle.

The aim of my presentation today is to describe that puzzle in broad terms, and highlight how the evolution of airborne EW has been defined by an ongoing process of action-reaction; one in which developments in the ability exploit the EMS have driven advances in the ability to deny it. This process will continue. The key to future success lies in getting ahead of the curve, developing an attitude to EW that approaches the control and exploitation of the EMS in the joint force.

Electronic Warfare up to the End of the Second World War

The concept of EW, though not the term, dates back to the American Civil War, when Confederate cavalry regularly intercepted and misdirected Union message traffic, and cut Union telegraph wires.¹ The use of kinetic force to disrupt an adversary's use of the EMS was also widely used during the First World War. In fact, Australia's first foray into electronic attack took this form, when in November 1915 Thomas White of the

Australian Flying Corps' Mesopotamian Half-Flight flew behind enemy lines to destroy Turkish telegraph lines, landing next the target wires and destroying them with the aid of guncotton charges.² To call these types of operations electronic attack is to stretch the definition of the term, but I use these early examples to highlight the earliest manifestations of the action-reaction cycle in electronic warfare. When an adversary finds a way to exploit the EMS, a means was found to deny it.

EW, as we know it today, really emerged as a discreet role for air power during the Second World War. During the interwar period a number of advances in radar and communications technology in Europe, Asia and America, offered new possibilities for the exploitation of the EMS for use in surveillance, communications, and navigation. The British Chain Home radar system is undoubtedly the most famous example of the recognition of the EMS as an operational enabler. But other examples abound. The Germans, Japanese, Soviets and Americans also developed radio and radar technology, with varying degrees of success, in the lead up to the war.

As the operational impact of the exploitation of the EMS began to be observed on both sides of the Second World War, attempts to deny the spectrum quickly emerged. In 1940, British scientists developed a method of disrupting the German's use of Lorenz radio beams to guide Luftwaffe bombers onto their British targets. With the introduction of beam jammers in 1940 and 1941, the British were able to render the German Lorenz beam system largely ineffective. In March 1941 for example, of 89 beam bombing missions flown by the Luftwaffe, only 18 resulted in the aircraft receiving the bomb release signal.³ An excellent example of a successful early application of electronic attack in shaping the employment of air power.

Actual airborne electronic attack began to take form in the skies over Germany as specialised British bombers belonging to the RAF's Number 100 (Bomber Support) Group, including the RAAF's 462 Squadron Lancasters, began flying missions to specifically disrupt the German air defence network.⁴ Using window, thin strips of aluminium designed to spoof and deceive German radar, the British were able to reduce night bomber attrition rates by hiding the incoming raids, or diverting the German night fighters away from them as they chased false targets on their radar screens. 100 Group were also engaged in jamming Luftwaffe radio frequencies, and spoofing voice transmission, using Airborne Cigar aircraft accompanying bombing raids over Germany.⁵

These are just two examples of what was a dynamic and innovative process of action-reaction in the fight to exploit and deny the EMS during the Second World War. These experiences ushered in the era of electronic attack in the air domain. But the lessons learned were soon forgotten in the transition from a hot to the Cold War.

Electronic Warfare during the Cold War

The years immediately following the end of the Second World War provide excellent evidence of the action-reaction relationship between the developments in the ability to exploit the EMS and the corresponding investment in the ensuring the ability to deny the adversary's use of the spectrum.

With the Soviet Union as the only strategic threat to the West, and the assessment being that they lacked a credible electronic threat; interest in electronic attack capabilities went into decline. The RAF's 100 Group was disbanded in late 1945, and the US had removed the specialist EW operator from their operational B-29 squadrons. American experience in the Korean War would highlight the shortsightedness of these decisions.

The Ground-Controlled Intercept, or GCI, systems controlling the North Korean MiG-15s, and the radar-directed North Korean searchlights and AAA took their toll on the American B-29s. By mid-1951, the Americans had lost 25 of their 100 B-29s deployed into theatre.⁶ In response, the US reintroduced spot-Second Line of Defense

jamming capabilities on the B-29, in addition to a range of other initiatives aimed at denying North Korea's use of the EMS. These measures significantly reduced the loss rate, with only three B-29s being lost during the 4000 sorties conducted in the last seven months of the war.⁷

The experience in Korea reinvigorated interest in electronic attack, but in EW terms the Korean War was, for all intents and purposes, 'merely an extension of the Second World War'.⁸ The effectiveness of chaff and spot jamming had already been demonstrated in the skies over Europe. It was the advent of surface-to-air and air-to-air missile systems in the years that followed that provided the spark that re-ignited interest in the serious development of electronic attack in the Western world.



FIGURE 5 GROUP CAPTAIN GILBERT DURING HIS WILLIAMS FOUNDATION PRESENTATION

The growing sophistication of Integrated Air Defence Systems (IADS) posed a significant challenge to the operational effectiveness of Western air power from the early 1960s onwards. And experience in Vietnam and the Middle East played a critical role in shaping electronic attack into its modern form.

In Vietnam, the Soviet SA-2 surface to air missile system coupled with the GCI of the Vietnamese fighters presented American aircraft heading into North Vietnam with 'one of the most complex electromagnetic defence threats ever to be combatted by the USAF tactical forces'.⁹ The US response to the threat is informative because they approached the problem a number of different ways, and in so doing laid the foundation for the modern Western approach to electronic attack.

Specialised stand-off jammers, such as the EB-66 of the USAF and the EA-6A and Bs, of the USMC and USN arrived in theatre in 1965. In the same year, the USAF Wild Weasel capability emerged on the scene, combining technology, tactics, and the cross-pollination of personnel to create a formidable SAM suppression capability.

The Israelis observed and learned EW lessons from the US, but also drew on their own bitter experiences from the Yom Kippur War in 1973 and developed a truly masterful demonstration of operational EW during the 1982 Beqaa Valley campaign. Using Remote Piloted Aircraft to deceive Syrian air defences, jamming and chaff to deny Syrian Air Defence operators an air picture, long-range artillery and rockets to attack the SAM sites and anti-radiation missiles to take out early-warning and fire control radars, the Israeli Defence Force provided the gold standard of an innovative joint approach to denying the adversary use of the EMS.

While all these innovations were happening during the Cold War, Australia remained largely uninvolved in electronic attack, due primarily to the lack of a credible threat to justify the investment. There is no better illustration of the relative priority attached to such a capability than the RAAF experience of the F-111.

As many of you are aware, one of the main reasons why the F-111s did not deploy to the 1991 Gulf War was due to the inadequacy of the self-protection systems to meet the needs of the threat environment in theatre.¹⁰ Something that was addressed subsequently with Project Echidna and other related projects.¹¹ What is less well known, and more illustrative, is the integration trials of the AGM-88 High Speed Anti-Radiation Missile, also known as the HARM, onto the F-111 in the late 1980s. HARM was under consideration in Australia as a complement to the AGM-84 HARPOON anti-shiping missile. The broad concept of employment was for the HARM to destroy a ship's radars, rendering it defenceless while the HARPOON would be used to sink it. ARDU conducted trials of the HARM on the F-111 in the Southern Ocean in 1987 and 1988. Unfortunately, 'HARM was traded off in the Defence Committee for air-to-air missiles for the F/A-18 Hornets'.¹²

Each of these cases highlight that the consideration of electronic attack continued to be reactive to the threat posed by the adversary. US losses in Korea and Vietnam, and the heavy Israeli losses of the Yom Kippur War may have been further reduced had investment in electronic attack occurred in parallel with the development of capabilities designed to exploit the EMS. In the Australian context, the perceived absence of a credible electronic threat resulted in neglect of an electronic attack capability in the RAAF. The 1991 Gulf War changed this.

Electronic Warfare in the Modern Age

The Gulf War heralded a new era of air power. I won't digress into the debate about the decisiveness of air power that conflict spawned, that is a topic for a longer discussion in a different forum, but what we saw in 1991 was a new approach to the application of air power that continues to guide our operations today. Among the most notable features of the Gulf War air campaign was the systematic dismantling of Iraq's KARI Integrated Air Defence System through the integrated use of electronic attack, cruise missiles, and stealth aircraft.

The emergence of stealth aircraft onto the operational scene drew attention to another dimension of electronic warfare: the denial of an adversary's ability to exploit the EMS through signature management. This approach was not new, but the F-117's performance over Iraq in 1991 validated the science of low-observables. An 'all-aspect low observable' signature is now one of the defining features of fifth-generation fighter aircraft.

The 1999 Serbian shoot-down of an F-117 using an SA-3 Surface to Air Missile system, a system introduced into service in 1961, however, reinforced the fact that there is no permanent solution to the challenge of electronic warfare. Every action has a reaction, and the resulting adaptation, improvisation, and innovation by an adversary can create unexpected shocks that can undermine a perceived advantage upon which our operational concepts are developed. These may not necessarily take the form of cutting edge technology, as the Serbs demonstrated in 1999 and as we have seen from the non-state actors in our current conflicts, effective adaptation can be low-tech. We must remain wary of creeping complacency derived from a perceived technological edge.

And this is what we are seeing unfold in our region. The concept of the anti-access and area-denial, or A2/AD, that has attracted so much attention over the last few years is 'as old as warfare itself'.¹³ What are new and innovative are the technologies and the ways in which A2/AD strategies are being implemented by various states. In our own region, the EMS, both in its tradition manifestation and in the realm of cyber, will be one of the defining battlegrounds of any future conflict. Realisation of this fact has driven the realisation of an airborne electronic attack capability for the ADF.

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My mention of cyber within the context of EW is intentional, though perhaps slightly controversial. But I include it to highlight the continually evolving nature of the non-physical dimensions of modern operations. We cannot afford to be tribal and create stove-pipes around capability based on dogmatic perspectives of domains. Cyber and EW are linked and will continue to be inextricably linked into the future, and we must account this fact for as our attitude towards EW evolves.

The RAAF's introduction of the Growler, as I am sure we will hear from the speakers that follow me today, is an invaluable addition to Allied capability in this region and beyond. However, our potential adversaries will not remain static. They will continue to evolve their ability to exploit and deny the EMS to our detriment. Disruptive technologies such as artificial intelligence, quantum radars, Light Detection and Ranging (LIDAR), and wake detection technology will enable the exploitation of non-traditional areas of the EMS and require us to continue to adapt and evolve our own electronic capabilities so as to maintain advantage in the EMS. The introduction of the Growler is not the end of the journey in electronic attack, but the beginning.

CONCLUSION

Much has changed in the 102 years since Thomas White flew his Farman pusher behind enemy lines to destroy Turkish telegraph lines. Where before we needed to rely on kinetic action to deny our adversary their use of the EMS, we now fight for the spectrum in the spectrum, with explosives now complemented by ones and zeroes. What this highlights is that the technology and tactics will invariably change; they will advance, develop and evolve. As our reliance on the EMS continues to grow, we need to ensure that we stay ahead of the curve in anticipating change and adapting to the disruption that will inevitable occur in the battle for dominance in the EMS.

The challenge laid down in this seminar is to discuss how the introduction of the Growler can be seen as a catalyst for changing the RAAF's attitude towards electronic warfare. In my opinion, what the Growler has done has been to focus the RAAF on the missing piece long journey trying to solve the EW puzzle. We can now more clearly see and understand the full picture of what constitutes operations in the EMS look like. But what history has shown us is that the EW picture is dynamic, it evolves and changes.

To my mind, and to conclude, the RAAF needs to look beyond the Growler and continually bear in mind these three questions:

How do we ensure the RAAF remains ahead of the action-reaction cycle in electronic warfare?

How do we ensure we do not focus on the platforms and instead focus on the effects we need to generate?

How do we ensure our airmen remain innovative and not reactionary in providing an air power perspective on the battle to control and exploit the EMS as part of the joint force?

Endnotes

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13 Sam LaGone, 'CNO Richardson: Navy Shelving A2/AD Acronym', USNI News, 3 October 2016, viewed 17 August 2017, <<https://news.usni.org/2016/10/03/cno-richardson-navy-shelving-a2ad-acronym>>.

LEVERAGING GROWLER

Group Captain Braz on the RAAF and the Way Ahead on Electronic Warfare

At the heart of the Seminar and the discussion were the presentations by Group Captain Braz of the RAAF, a key figure in the introduction of the Growler into the RAAF, and CDR Mike Paul, Electronic Attack Wing, US Navy Pacific Fleet.

The two provided a significant look inside the standing up of the RAAF capability and the key role of the US Navy in this effort, and in turn the ability to stand up a joint capability.

The US Navy has provided an important lead in working the relationship with the RAAF in standing up this capability and in a rapid manner. In many ways, the Growler dynamic between the two forces provides a model of how capabilities can be generated rapidly in a coalition context to deal with an evolving threat environment.

For the RAAF, Growler represents a jump start to a 21st century EW effort, which includes Wedgetail and F-35. For the US Navy the cutting edge work which the RAAF is doing with regard to shaping a 21st century integrated force helps the US Navy to think through ways to break through stove piped thinking.

Group Captain Braz underscored that the RAAF was focused on taking EW from a niche capability within the ADF to working into a core competence within the integrated force.

"How we might drive this jet, and wider EW and cyber thinking, into the mainstream?

"Please note my use of the word drive. We need to take this thing and forcefully insert it into our daily business.

Second Line of Defense

"To let it drift or meander into some equilibrium would be a lost opportunity.

"It's time to be bold.

"The arrival of F-35 in the next year or so is one prime opportunity, and one that will need bold leadership to harness.

"The F-35 brings unprecedented EW capability, it can fight like no other fighter we have owned.

"Growler is an exceptional complementary capability and crossing personnel over between the teams will bring amazing results.

"A good friend of mine from the US Navy planted this idea in my mind some months ago and it has significant merit.

"Setting up a Growler to F-35 exchange program won't be easy, it won't fit well into a transition plan and it will challenge some outdated mindsets, but it will be a brave move that will put innovation into overdrive.

"It's an example of the new thinking we need to reshape the way we fight air combat."

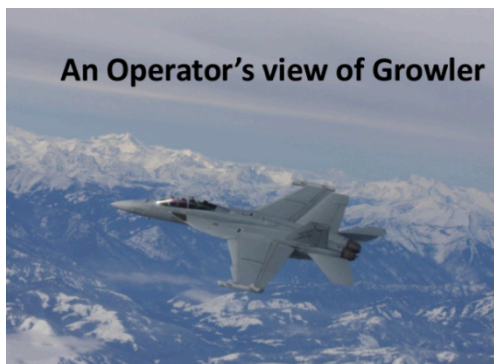


FIGURE 6 GROUP CAPTAIN BRAZ'S PRESENTATION AT THE WILLIAMS FOUNDATION SEMINAR

Group Captain Graz then dealt in the rest of his presentation on the challenges as he saw them in managing the way ahead.

First, there is the challenge of managing growth.

Growler is a low density, high demand asset. He underscored that a key challenge was shaping and managing a workforce that would insure that the EW capability is integrated within the Australian Defence Force (ADF) beyond the platform itself.

Second, Growler will operate under significant constraints in spectrum licensing and security.

Third, "Growler is part of the overall rethinking necessary with regard to targeting or rethinking with regard to payloads for the RAAF operating as part of an integrated 21st century combat force.

"Growler is a flexible system, manned by expert crew.

"It takes the initiative whenever possible but is by design a flexible sense and respond asset that is at its best when given significant latitude in targeting.

“Being overly tied to our kinetic and lethal effects targeting mindsets will not give you the Growler you need on the day.

“New thinking in terms of dynamic targeting, particularly of non-lethal effects, many of which may be temporary in nature, will be a key to success.

“Delegating these engagement authorities forward will be essential.”

Fourth, training to ensure that EW becomes part of the force, rather than a stove piped on call capability is a major challenge.

“We have invested heavily in training and rightly so; we are not there yet but the future is positive.

“Importantly, the rapidly evolving Electronic Warfare capabilities across the ADF need new ways of thinking to get the most from our family of systems.

“New training areas that test our ability to find, fix, track, target and engage adaptive threats are fundamental to our force.

“Of course, with the constraints already mentioned, live virtual and constructive environments are being enhanced and expanded to serve our needs.

“Ultimately fifth generation forces need fifth generation training.”

Fifth, the Group Captain emphasized the importance of what he called commonality both across the ADF and the allied forces using Growler.

“We have made changes to these jets (RAAF Growlers) based on Australian needs but they have changed the US Navy common baseline.

“Careful investment has given our Growlers targeting pods and Infra-red missiles.

“Not because it’s a fighter but because they help our active and passive kill chains.

“The US Navy is joining this path; it’s a team effort and our differences bring useful diversity to shape the growth of this aircraft.”

And the final challenge he addressed really flowed from how he saw the introduction of Growler as part of the broader evolution of the RAAF to support a payload revolution.

“Our thinking needs to cover payloads not just platforms and be driven by creative technical thinkers, connected with operators.”

Group Captain Braz ended on a very forceful note – don’t build a community of Growler operators; build a joint force within which EW is a core distributed competence.

“Our true challenge, as swimmers in the mainstream, is to acknowledge the currently niche players in EW, assist their real and important growth and to drag them into our swim lane; to roll their input and concepts into every plan, to seek to understand more and engage better.

“Our new thinking must be beyond labels like EW operators but that this expertise permeates our business as an assumed skill.

“So, as a strike fighter native, I am happy to wear an EW tag but I want it to be a temporary one.

Second Line of Defense

“The day where we are all suitably learned in EW that it no longer becomes a label is what we should strive for.

“That would signify success.

“That would have seen the mainstream embrace EW and cyber.

“So, my challenge to you is, regardless of your organisation, are you an operator in our age of EW?”

CDR Mike Paul on the Partnership with Australia and Shaping a Way Ahead

CDR Mike Paul, Electronic Attack Wing, US Pacific Fleet, highlighted the working relationship with the RAAF and the importance of integrating the Growler effect within the evolving kill web approach of the US Navy.

The US DoD's new EW Strategy tells us that Electronic Warfare underpins U.S. national military objectives through demonstration of electromagnetic spectrum (EMS) superiority. “A force multiplier for a range of military operations, EW maximizes lethality of precision strike weapons, assures mission command and increases mobility by protecting complex battle networks, weapon systems and forces. EW provides rapid situational awareness and produces chaos in adversary decision-making.”

The fact is that U.S. military operations are rarely conducted unilaterally and are increasingly reliant on contributions from our partners and allies. The Navy I think has done great work, ensuring EW development efforts are interoperable, and aligned with our allies (the Growler is a good example). The battlespace awareness you get with the passive sensing capabilities in the Growler is not free - by nature, our mission requires interoperable data sources and software formats.

In fact our Chief of Naval Operation's Maritime Strategy states that we must also expand opportunities for coalition EW training and education in the U.S. and abroad. We're tasked to build or enhance partner EW capabilities and capacity, and ensure partner and ally capabilities remain viable against emerging peer or near-peer threats.

Of the 4 Objectives in the DoD's EW Strategy, we like to say we achieved the “4th Objective” – to foster access, enhance interoperability and grow warfighting capacity – at least at the operational and tactical levels.

This is Operational partnering. It's easy to say “no,” or “you can't,” much more difficult to say yes. We had plenty of hurdles, some seeming impossible. I count significant “No's” that were turned into yes.

A significant part of the presentation detailed how the integration of the RAAF with the US Navy Growler force was achieved and in relatively compressed period of time.

This is a case study in many ways of the kind of integration, which the US and the core allies need to achieve to have the kind of force multiplier effect from an integrated coalition force.

This event is a great opportunity to mention some of the wins we've had in operationalizing our partnership in Airborne Electronic Attack (AEA).

We at Whidbey Island and leaders in NAVAIR removed years of cultural barriers limiting collaboration in a short amount of time.

That took people to lead and innovate. But that's what it took to begin to operationalize a strategic AEA partnership.

Our stated goal was to produce 100% fully capable & interoperable EA-18G wingmen, at all security levels.

At the peak of my Wing's support phase to 6 Squadron standup in March, we had Australian students and instructors alike in our replacement squadron, Australian officers operationally employed in 3 different squadrons – primarily in this part of the globe.

Multiple deployments to the PACOM AOR, multiple reps and sets of high end exercises, Australian aircrew were put in leadership roles in the squadrons in the air and on the ground.

Australian maintainers getting on the job training during pressurized Growler Tactics Instructor course sortie rates.

At one point we had roughly 45 Australians invading the Pacific Northwest of the US making lasting friendships... our neighbors... babies being born... We went "all in." We formed personal relationships that make the distance between Canberra and Pacific Northwest coast seem insignificant. Now look at what 6SQN did during their IOT&E for Growler. Amazing.

CDR Paul outlined that the non-kinetic payload was growing in importance both for adversaries and the US and allied forces, but that it was clearly different from a kinetic action.

EW is unlike kinetic air-to-ground payloads that simply require target coordinates, or an air-to-air missile that needs an appropriate target.

As CDR Mike Lisa, Commanding Officer of a "combined RAAF USN squadron" best stated, "it requires our sensors to call the signals the exact same thing, employ the exact same waveforms/payloads, and deliver at the exact same time with exact positioning."

This means that the secret ingredient within an effective EW contributor to the joint fight is a well-trained, effective and coordinated workforce.

That is, in order to get the right effect or impact there is a clear need for the EW team to be on the same page, to understand the signals they are reading, what they mean and to dial up the correct response to have the desired effect or impact.

It takes work to innovatively maximize our capabilities. For the US Navy, it has taken perseverance to innovate from a standoff EA-6B Jammer mindset, to a platform and community of experts focused on distributing battlespace awareness and attacking the enemy's kill web across all mission areas.

It all relies on a well-trained EMW workforce

- Growler-specific, Operational EW-Personnel Qualification Standards for our enlisted sailors
- A focus on efficient improvement of pre/post mission data analysis
- Air Wing Fallon validation of HAVOC tactics
- Advanced technologies + today's AEA suite
- World-class Information Warfare team providing efficiencies for VAQ (Electronic Attack Squadron).

Because of the nature of the blended capability one needs between technology and the work force, for EW to work within a coalition force, there needs to be tight integration.

This is why the way the US and Australia are working the issue is so crucial to mission success.

During his presentation, he presented a photo within which showed the team necessary to execute the EW mission. And he had this to say about the team and the challenge.

Second Line of Defense

On the right side of the lower picture is Petty Officer Amber Hart. She understands who does weapons-to-target pairing for non-kinetics – she does! She wears an Information Warfare pin. She's a warfighter and understands that modern, data-hungry aircraft are a mission-kill without her.

Our CAOCs are excellent at creating a Master Air Attack Plan and JDPI apportionment. The CFACC can tell you exactly what his JDPI servicing capacity is at H-hour of a conflict.

But if we do not put the "right" payloads on the "right" target, we become less lethal.

Simply put, having the same equipment is not enough.

Mission effectiveness requires that we think alike, train alike, and speak the same EW language.



FIGURE 7 THE ABOVE PHOTO WAS HIGHLIGHTED DURING CDR PAUL'S PRESENTATION.

Given the differences between kinetic and non-kinetic targeting, having tight integration of technology and training (TTPs) was crucial in shaping a 21st century EW Warfighting capability.

What's in the wingtips of that EA-18G, when operating the full capability, is unparalleled battlespace awareness distributed to the airborne force. And the Navy continues to invest in its passive sensing capabilities as our adversary systems become more complex.

And well integrated with 5th gen aircraft capability, and in about 4-5 years, next gen EA capabilities.

But EW boxes and aircraft are not what makes this work – it takes people and innovation with complicated EW technologies to realize the capability.

The Aussies are working Wedgetail with F-22s, and the US Navy is working Growlers with F-22s, and at the Red Flags they are now working F-35s, with F-22s, with Growlers, with the new EW capabilities on the Typhoon to shape ways to deliver integrated EW combat capabilities.

This is clearly a work in progress.

I had the opportunity to see it up close in Red Flag Alaska last year. 4th gen Canadian classic hornets, F-15Es, VAQ-135 Growlers (with Aussie crews), Raptors, Wedgetail. Everyone has gaps – physics has limits.

But our innovative JO's roll up their sleeves and mission plan, making EW/SEAD contracts with their counterparts – they're talking spectrum; sensors; gaps in capabilities; and contracts to ensure that non-kinetic effects are layered and distributed to increase lethality across the force.

It takes work to maximize innovatively our capabilities. For the US Navy, it took perseverance to innovate from a standoff EA-6B Jammer mindset, to a platform and community of experts focused on distributing battlespace awareness and attacking the enemy's kill web across all mission areas.

As CDR Paul summarized how he saw the way ahead: "An innovative, team-based collaborative culture that ingrains Information Warfare strengthens the VAQ community's enduring international partnership in EW."

Group Captain Braz and the Coming of the Growler to the Australian Defence Force

Interview conducted April 2017 at Amberley Airbase.

During my visit to Amberley Airbase in Australia, I had a chance to talk with the 82nd Wing Commander, Group Captain Braz on April 3, 2017.

The Wing had been reorganized to include both Super Hornets and Growlers as the RAAF prepares for the fifth generation air combat transition.

Group Captain Braz has been in the RAAF for thirty years; originally he was an F-111 operator and then transitioned to Super Hornet, which was the RAAF selection of the aircraft to transition from the legacy aircraft (F-111) to the fifth generation aircraft (F-35).

He was one of the pioneers in that transition (the first commander of 1 Squadron when the Super Hornet came into the force) and now is part of the next one (as the F-35 comes into the force). In addition to many other postings and duties, he served as the Growler transition team leader in the RAAF headquarters for two years as well.

Question: Let us start with the challenge of transition. The Super Hornet was an important stimulus to change in the RAAF going from the F-111 to the Super Hornet, going from the mechanical to the initial digital age.

How disruptive was that transition?

Group Captain Braz: The Super Hornet was acquired to reduce risk with regard to our air combat transition.

We were operating the F-111, and we were the sole orphan operator of the F-111, an aging airframe with declining relevance. We knew the F-35, the new generation was coming but with uncertain timelines. And we had an aging classic Hornet fleet, which was starting to show more signs of its age.



FIGURE 8 GROUP CAPTAIN GLEN BRAZ, OC OF THE 82ND WING.

We realized that there was an opportunity to acquire a bridging fighter, the Super Hornet. And by acquiring this aircraft we began to address the security challenges associated with a data rich aircraft and to change our security culture and engage in the new operational concepts that the Super Hornet enabled.

It had capabilities that we'd never had to deal with before or think about before. While they're not F-35s, they do generate inputs into rethinking about how to deal with the coming of the F-35.

The Super Hornet gave us that intellectual kick to think more broadly, and to adapt how we do things, and to not be wedded to historic approaches with regard to operating concepts.

Question: How many Growlers are coming to Australia?

Group Captain Braz: We've got four in Australia right now. By the end of the week, we should have seven, and we'll have all of them here by June. We will have 12 in all.

Question: The Growler is coming when much is in flux with the RAAF with the significant impact of tanker and Wedgetail, and the coming of the F-35 as well P-8 to the force.

How does the coming of the Growler intersect with the broader changes for the RAAF?

Group Captain Braz: From an ADF force-wide point of view, there is a huge amount of change. That's both a threat and an opportunity.

We've come to understand that we have to fight in the new information realm, and Growler allows you to do that more effectively.

Further, it changes how we are thinking about how we employ the existing capabilities with the new capabilities.

We're reshaping our technical and operational thinking to harness and to capture what Growler can offer in the operational space.

It's an opportunity while there is so much change to think wholesale about what we're doing and how we do it, and to integrate it from that very ground floor level with those new capabilities that air force is bringing to enable the joint fight and to support the joint fight.

Question: In effect, you are shaping a community of iron warriors who operate specific platforms, but who will shape a broader community of users beyond the platform specific uses.

How do you view this shift?

Group Captain Braz: That is a good way to look at the process of change.

We are looking at ways to get the operators of specific platforms to cross-learn from each other, particularly as we add Growler, evolve Wedgetail, add P-8 and add F-35.

We're also exporting our Growler experts into the wider joint environment, such as to our new Air Warfare Centre.

We used to have a very fighter-centric fighter combat instructor course.

Now this is changing under the influence of standing up the Air Warfare Centre and the Air Warfare Instructor Course.

Now we are focused on force integration.

We've integrated as best we could this year with the course that's running right now, including wherever possible the Growler folks who have been in country on and off this year already.

Two EA-18G Growler aircraft arrive at Avalon for the 2017 Australian International Airshow. Credit: Australian Ministry of Defence

We're tying in those other communities, the E-7, the ground-based air surveillance teams, the P-8 teams, the air mobility and tankers, because we see opportunity to shape a broader set of perspectives.

We are aiming to get the right integration mindset amongst the communities, which would enable us to take the team into new, and creative, innovative ways of operating.

We seek to bring technology more quickly on and off platforms. And we are doing so to find new ways to interact and to share information, and to create the web of options that will give us redundancy and resilience in our decision-making process.

Question: In effect, you are focusing on a 21st network of operators, rather than simply focusing on optimizing information flows.

And in that regard getting a small operator community onboard the Growler and then proliferating them in the crafting and evolution of a joint warfare community is what Growler for Australia is all about?

Group Captain Braz: That is a good way to look what we are about. We need to get the experience which Growler can deliver and share the knowledge.

The difficult thing with Growler is that it delivers non-kinetic effects, and sometimes they're difficult to measure. We're used to being able to deliver effects through other systems where the outcome is tangible and measurable.

For a Growler, if you're attacking a threat system or the people operating that threat system, then often it's difficult to truly assess how much you're affecting that system.

You can do trials and tests in certain scenarios, but it's never quite the same, and so you get a level of confidence about what immediate effect you can achieve, but it's the secondary and tertiary effects that we're often looking for that are sometimes harder to measure.

Second Line of Defense

The difficult challenge will become knowing how degraded the network is and how reliable the information is at any given point.

If you create enough uncertainty in the operators, then you can achieve an effect even if it's not degraded.

Question: Who are your initial customers in the ADF for the Growler produce?

Group Captain Braz: Clearly, the Joint Operations community, and special operations are key clients of interest. We are making sure that the Air Operations Center and the Joint Ops Command framework have appropriate access to Growler expertise.

Another joint customer is our Deployable Joint Force Headquarters, which is conveniently located here in Brisbane.

Question: Clearly, the Australian Army modernization approach is built around small engagement packages, which can have significant effect. Does not a Growler capability fight right into their mental furniture?

Group Captain Braz: It does. We know that a small force over a wide geographical area like Australia, we do need to be maximized in our lethality and our personal security, including force protection.

We need to make sure that we can have that relative advantage over our adversaries.

Growler gives us that opportunity to shape that role, not always being able to protect ourselves entirely from that attack from the potential adversary, but certainly to inflict similar pain upon them, and retain the relative advantage in decision superiority that gives our small force what it needs.

Question: What can be missed is how important cross learning is among the professional military working together as allies. I like to argue that if you want to make America great again, accelerate learning with allies.

This certainly applies to your area of work.

How would you describe your work as an Air Force officer with the US Navy?

Group Captain Braz: We couldn't have done this without a huge commitment from the U.S. Navy. There's simply no other way to describe that.

They have wanted us to be on this journey, and they have supported us wholeheartedly throughout it, both on what we do with the Growler training and the operational experience, the exchanges we've established, and how we prepare the team.

That's furthered by exchange opportunities. We have U.S. Navy Growler aircrew joining us here, but we've also used folks connected to intelligence organizations and data management organizations and used U.S. Navy expertise in those areas to bring us along and further on the journey.

It's no accident that when the Growler officially arrived in Australia at Avalon International Air Show a month or so ago, one of the four humans to step out of those two aircraft was a U.S. Navy aviator.

That was very deliberate, because we wanted both to recognize the amazing support we have had so far from the US Navy and the fact that we're in this together.

It's a partnership for the long term with cross learning on all sides.

HAVOC Works the Electronic Warfare Payload in the Digital Battlespace

(With Ed Timperlake)

During a July 2017 visit to the Naval Aviation Warfighting Center (NAWDC), we had a chance to talk with the leadership of N-10 or HAVOC as it is known at NAWDC.

N10: The US Navy's Airborne Electronic Attack Weapons School, call sign "HAVOC", stood up in 2011 to execute the NAWDC mission as it pertains to Electronic Warfare and the EA-18G Growler. HAVOC is comprised of highly qualified Growler Tactics Instructors, or GTIs, that form the "tactical engine" of the EA-18G community, developing the tactics that get the most out of EA-18G sensors and weapons. HAVOC's mission is also to train Growler Aircrew and Intelligence Officers on those tactics during the Growler Tactics Instructor Course.

The Growler Tactics Instructor Course is a rigorous 12 week syllabus of academic, simulator, and live fly events that earn graduates the Growler Tactics Instructor designation - the highest level of EA-18G tactical qualification that is recognized across Naval Aviation. The Growler brings the most advanced tactical Electronic Warfare capabilities to operational commanders creating a tactical advantage for friendly air, land, and maritime forces by delaying, degrading, denying, or deceiving enemy kill chains.

It is clear that the HAVOC leadership looks at their work as providing key tools for the current fight, including embedding Naval aircrews with ground maneuver elements in our current wars.

However they are also significantly laying the foundation for the con-ops evolution of many the tactics and training for combat employment of high intensity non-kinetic payloads in the digital battlespace.

Significantly in building to the future, they are working their "tron magic" across the joint and coalition force.

During our visit we interviewed LT Scot "Chu-Hi" Chuda, LCDR Stephen "Choda" Skoda, LT Steven Sanchetta and LCDR "Sharkey" McCormick.

The team has significant electronic warfare experience starting with Prowler and has worked with Growler for some time as well.

The first point made by the team was that the Growler is mission dependent.

They emphasized that their role varied by mission but they were seeing an expanded role for the non-kinetic capability.

They are expanding beyond a classic Suppression of Enemy Air Defense or SEAD role to look at other ways to contribute to a broader mission set.

One should look at Growler as providing a non-kinetic payload within the evolving digital battlefield because the non-kinetic payload business is itself expanding as threat change and technology evolves.

"How we integrate will always depend on the different assets available and the different missions."

The second point is that demand signal is going up with regard to the electronic magnetic spectrum threat.

"The electromagnetic spectrum is pervasive and everybody uses it and everybody tries to take advantage of it and we are the sole asset in the DOD that has that as our primary mission to affect the electromagnetic spectrum."

The third is that they work a lot with the joint force.

Second Line of Defense

For example, “we spend last third of our Growler Tactics Instructor (GTI) training course at the USAF Weapons School Integration (WSINT) course at Nellis. In fact, every Red Flag now has a Growler squadron participating.”

We asked about the current disposition of Growlers and we were told that there are more than 100 Growlers currently with 4 expeditionary squadrons to support the COCOMs.

The fourth point was about a ramping up of integration work for the high-end fight.

HAVOC participates two times a year in the USAF Weapons School WSINT course.

“The USAF brings all the platforms together. Everyone is an expert in their own platform when they start WSINT. But WSINT is about forcing integration into the mindset of participants. They provide a problem set where no single platform can do the job alone, they need to use other platforms to working together and need to synchronize to solve the problem and it's something we don't see anywhere else.”

There is a growing demand for electronic magnetic payloads in the digital battlespace is going up and the kind of integration being fostered will shape modernization as the combat fleet goes forward.

“Everybody is going to keep using electronics and advanced electromagnetic spectrum to their advantage in fighting and no one is going to forget about it.”

It has been a slow process of rolling out Growler capabilities and clearly there is a need looking forward to accelerate the modernization process to ensure dominance in this important warfighting area.

“We need to be pushing forward towards the next capability whether it be an aircraft or UAV or a system of systems bundled capability. As of right now we are 18 years into a 22-year upgrade project on current capabilities that looking forward to the future needs to happen more quickly to deal with this rapidly evolving warfighting area.”

We then addressed the need to modify how the USAF and the USN connect in order to more rapidly train and prepare for high tempo operations.

The team pointed out that it took three months to prepare for the joint training, as security and communication barriers made the process much harder than it would need to be to get the quick on the fly integration for the 21st century digital battlefield.

Put in blunt terms, the enterprise rules and security rules in place for today's “Slo Mo” war clearly are not adequate to preparing for higher tempo ops where the force needs to integrate on the fly to deal with the contested battlespace.

The team next discussed the need to get better integration earlier in the process of introducing new equipment or modernized equipment into the force.

“It is not so much teaching the air crews how to use a particular piece of equipment; it is about learning how to integrate into the fight and to get best value from any upgrade or new piece of equipment. We need to focus more attention on that part of the equation.”

As an aside we saw the same technology and combat learning dynamic embedded in the US Navy P-8/Triton community at Navy Jax.

Finally, we discussed a topic which we also discussed with the Hawkeye instructors as well.

Working integration of the digital battlespace among Growler, F-35 and Hawkeye would enhance the TTPs, which could be developed to more rapidly evolve capabilities in the digital battlespace.

"There are many of us around here who think that the concept of the E2D the F35 and the Growler integrating would accelerate our transition to where warfare is going with regard to the contested battlespace.

"There are many of us around here who think that would be an outstanding idea that we should really push for and should be a focus of testing and evaluation.

"But there will be people around as well who will say but how does that lead to me dropping bombs?"

SHAPING AN INTEGRATED FORCE WITH DISTRIBUTED EW CAPABILITIES

Air Commodore Chipman on Electronic Warfare Within the Evolving Integrated Force

Air Commodore Chipman, the Director General of Capability Planning in the RAAF spoke to the question of force design to ensure that EW was an effect built into the force.

In this sense, he picked up on themes, which he discussed at the last Williams Seminar, which was specifically focused on force structure design.

"We need to have broad enough of a perspective so that we can drive programs towards joint outcomes.

"For example, it will be crucial to bring E-7, with F-35 and air warfare destroyers into a common decision making space so that we can realize built in capabilities for integrated air and missile defense."

He continued this approach in his discussion at the latest Williams Seminar.

I met with him the week before the seminar at his office in Russell.



Figure 9 Air Commodore Chipman on a panel at the Williams Foundation Seminar on Electronic Warfare, August 23, 2017

He would focus upon the effects or more generally designing the force to get the kind of information and decision-making dominance you need to achieve against a reactive 21st century peer competitor.

"I am going to focus on the backend capabilities which we are not invested in enough at the moment, rather than dedicated EW platforms.

Second Line of Defense

"We are doing pretty well at buying platforms, which allow us to observe in the EW area, and we are buying platforms, which can act within that space.

"But we can not orient ourselves effectively enough and make the kind of decisions in a timely manner which we will need to be able to do.

"So applying the OODA loop, we are doing reasonably in the Observe and Act area but not enough in the Orientate and Decide part of the OODA loop.

"How do I manage to leverage my intelligence data base and networking forward to locate and identify the proper threat so I can orient my EW capabilities and then how do I make decisions to deny, degrade, deceive or destroy that threat?"

In that discussion, he underscored a core point about the contribution of the Williams Foundation Conferences .

"I probably would not have had the thought I just expressed to you if I was not going to make this presentation.

"It takes you out of your day job and forces you to think at a different level, which is critical if we are going to shape the kind of force which we need to develop and deploy."

At the conference, Air Commodore Chipman entitled his presentation "Electronic Warfare – C4I Enablers," which allowed him to discuss what he called the backend of the EW Warfighting capability.

In effect, what he outlined throughout his remarks were the building blocks crucial to enhance the ability to deny EW success to the adversary as you tried to maximize your own ability to prevail in the electro magnetic spectrum.

Again, it was not about a single point of entry specialized EW platform; it was about the force being able to shape an approach and to evolve an approach that minimizes vulnerabilities and maximizes capabilities to exploit EW vulnerabilities of an adversary.

He started by discussing a radar range equation, which exemplifies the importance of force design, and shaping an approach.

My understanding of electronic warfare started to improve when I was taught this equation – what a great place to start. In a very basic sense, this equation tells us that the range at which radar first detects a target increases with the amount of power transmitted, the antenna's performance, the radar's operating wavelength and the targets radar cross section. Detection range also decreases with the minimum power required to discriminate a target return from competing clutter and noise.

This equation can help explain why long-range surveillance radars operate at lower frequencies, why integrating force elements can deliver superior detection performance. It explains how basic noise jamming decreases sensor performance. It explains why the United States has invested so heavily in stealth technology over the last 30 years, and why China and Russia are now doing the same.

From this perspective, he then discussed low observability as a key force design issue in the current period.

It's important to understand that stealth does not make an aircraft invisible; it just makes it extremely difficult to detect, track and engage. It is also important to understand that stealth does not just apply to the aircraft's radar signature. Modern stealth aircraft utilise low observable technology across the entire electromagnetic spectrum to reduce radio frequency, infrared, electro-optical, visual and acoustic signature.

I make this point to address a common fallacy; that somehow low-observable technology is being made redundant by the proliferation of counter-stealth technologies in our region. There is no doubt low observable technology will be subject to the same counter and counter-counter cycle as other forms of electronic warfare, but there is also no doubt that low observable technology combined with specialist operational tactics makes stealth aircraft far easier to hide in the electromagnetic spectrum using on-board or off-board jammers than conventional aircraft. They are more survivable and better equipped to penetrate contested airspace in order to achieve an operational objective. Stealth is not just viable, it's becoming increasingly vital.

For Air Commodore Chipman, the force design issue, which is crucial here is signature management.

Clearly, the F-35 is part of the low signature focus which the RAAF is pursuing, but there is a broader issue – how do you reduce your overall radar signature profile and enhance the adversaries vulnerabilities in the same domain?

Signature management is certainly not unique to the air domain. Our Army is now consciously minimising their electronic signature during Brigade manoeuvre exercises. And our submariners have long been masters in masking their signature, and making very deliberate vulnerability assessments before exposing themselves to the risk of detection. As the battle for supremacy of the electromagnetic spectrum intensifies, we will all need to rise to their level of skill and expertise.

This includes signature management at the force level. The networks used to achieve force integration must be secure, resilient and persistent – but they should also be designed and operated cognisant of their electromagnetic signature. We will need to make compromises that balance the operational advantages of joint force integration through networking, and the imperative to minimise our vulnerability through effective signature management. And we'll continue to employ force level electronic attack in its historical supporting role, to mask a force that is no longer able to hide below an adversary's detection threshold.

He then went on to describe way ahead in terms of Boyd's OODA loop as he suggested he would in the remarks in our discussion prior to the conference.

Boyd himself identified the orient phase as quote "the most important part of the OODA loop since it shapes the way we observe, the way we decide, the way we act". I'm at risk of over-simplifying this stage by suggesting the task is to take observed data and generate meaning. This involves accurately identifying and locating specific emitters in the electromagnetic spectrum. In this way, we create a tactical operating picture, which provides essential situational awareness across the joint force.

Identification is heuristic – we observe specific characteristics of a signal in the environment and compare those characteristics with a database of previously observed signals in order to establish the identity of that emitter. We improve the accuracy of identification by correlating different characteristics the threat system's emissions collected by different sensors.

Locating emitters in the environment is largely achieved through triangulation. This is one of the great advantages of networking: if a single signal is received by two geographically separated receivers, the task of accurately locating the source of that signal becomes relatively simple. However, both receivers must interpret the signal the same way and cooperate constructively to identify and locate it, otherwise they create ambiguity and confusion.

This is why intelligence mission data is so important. It is the heuristic frame of reference we use to orientate ourselves in the electromagnetic spectrum. Developing joint force concepts for emitter identification and geolocation will require all contributing systems operate to a compatible frame of reference.

Second Line of Defense

And if it's not immediately obvious, let me emphasise this point: we need a compatible frame of reference to be interoperable with our primary security partners as well.

To add to this complexity, the frame of reference is not static. We must be capable of resolving ambiguous signals in the environment, and we must be capable of interpreting new observations that have not been previously associated with a specific threat system.

That requires two feedback loops:

One that operates at the tactical and operational level to cue Electronic Attack resources and rapidly disseminate new information to the joint force.

This is the domain of Electronic Warfare Support.

The second feedback loop operates at the strategic level – signals intelligence - which ensures our intelligence mission data is constantly updated.

This is why EW is part of the broader information network and warfare domain.

For it is about enhancing information available to the warfighter at the key point of attack or defense and augmenting your ability to attack the critical choke points affect force performance of an adversary.

This requires a more sophisticated understanding of how information should be managed across the joint force. Recognition of this requirement led in part to the establishment of the Chief of Joint Capabilities, with a dedicated Information Warfare Division responsible for joint intelligence and electronic warfare.

The goal is to have a more lethal and survivable force and one able to operate and prevail in the electromagnetic spectrum.

We must create a test and training environment that stimulates the exacting demands of electronic warfare, both at the individual and collective training level. Historically, this has only been possible through the use of actual adversary systems – threat emulators provide reasonable training, but they can not provide the high fidelity test and training environment required to develop and validate electronic warfare strategies and tactics.

The rapid development of adversary capabilities and the difficulty associated with acquiring actual threat systems will drive the need for more effective threat emulation. And it will reinforce the need for a coherent Live, Virtual and Constructive test and training environment.

We must prepare forces to operate in future contested environments where the cycle of counter and counter-counter technology is far more rapid than we've experienced historically. Mastering this volatile, uncertain, complex and ambiguous environment will require a new way of thinking for those of us accustomed to air superiority and a dominance of the electromagnetic spectrum. We must now come to terms with competing for both.

Our workforce challenges are pervasive: creating the workforce establishment, recruiting appropriately skilled personnel to fill those positions and then developing professional mastery all take time. I am constantly reminded by DGPERS that from the time a new workforce need is identified, it takes on average seven years to establish, recruit and train an individual to competently perform that role. It's difficult to think that far forward, and it is difficult to be that patient.

We are experiencing the consequences of under-investment in our classified war-fighting networks and information systems. These challenges are not insurmountable, but they increase the complexity and risk of integrating new systems into a coherent joint electronic warfare capability.

Finally, we are already encountering the demands of protecting highly classified data and systems. This will soon become routine, but we currently lack the policy settings and organisational capacity to administer these programs with confidence. It will place demands throughout the organisation. For example, the requirement for a positive vetted top secret security clearance has increased by an order of magnitude in Air Force over the last ten years, and this will do doubt continue to increase across the Australian Defence Organisation and industry.

These are examples of the enabling capabilities that are so critical to the realisation of a 5th generation Air Force. Plan Jericho was created to draw attention to the importance of enabling capabilities and deliver the organisational capacity and incentive to remediate them. Air Force's investment in this program has created confidence that we're up to the challenge.

It is encouraging to see joint force integration also being incentivised by the Joint Force Authority – and the increasing influence of our Chief of Joint Capabilities. It will be through Air Force's commitment to the centre, that we will deliver integrated 5th generation air and space power for the future joint force.

Lt. General (Retired) Davis Focuses on Distributed Electronic Warfare Capabilities

As Group Captain Braz put the objective of Growler introduction within the ADF:

“New thinking in terms of dynamic targeting, particularly of non-lethal effects, many of which may be temporary in nature, will be a key to success.

“Delegating these engagement authorities forward will be essential.”

Lt. General (Retired) Jon Davis, the former Deputy Commandant of Aviation, echoed these sentiments within his presentation to the Williams Foundation seminar.

He described the USMC transition from a core aircraft delivering an EW effect to building out the MAGTF to include ubiquitous access to non-kinetic EW warfare capabilities.

The core approach going forward is very clear.

“MAGTF EW transitions the Marine Corps from a focus on low density/high-demand EW platforms, to a distributed, platform-agnostic strategy – where every platform contributes/ functions as a sensor, shooter and sharer – to include EW.

“Under MAGTF EW the Marine Corps is leveraging emerging technologies and integrating multiple platforms, payloads, nodes, and capabilities to provide commanders with an organic and persistent air and ground EW capability.”

Davis underscored that with the changing nature of warfare and how the Marines operate, shaping a distributed strategy was a necessity, not an option.

“We operate on ships, from ships to shore and ashore.

“We cannot simply have an on call EW asset.

Second Line of Defense

"We can confront the threat requiring an EW capability anywhere we operate."

He described the sun setting of the unique EW aircraft, the Prowler, in favor of a sequential role out of distributed capability to the MAGTF.

He focused initially on Intrepid Tiger which is an EW pod being incorporated the Marine Corps legacy air.

It is on the Harrier and UH-1Y currently but will be added to other aircraft in the force.

"It's made over 20 deployments now.

"It's an open architecture system.

"It does electronic surveillance; it does electronic attack.

"We have a new one called Intrepid Tiger Block 2X which is being built to do radar jamming.

"It's about 305 pounds for the Harriers and Hornets.

"It's going to go next on V-22 then on C-130 and then on the CH-53 helo.

"We had about 120 we've built so far, we have 268 in the program of record."

It's completely an open architecture.

"And we have invited manufacturers if they have a card that can fit into the system to propose putting it into the pod.

"If you have a card that fits in that slot and you can do so, bring it and you can plug it in, but do not ask us to change the box for us to take your card.

"You have to adapt your card to fix my box."

The Marines are deploying the F-35 at the same time, which is a core capability for the USMC in delivering non-kinetic effects throughout the distributed force as well.

"The F-35 is part of our electronic warfare strategy for the United States Marine Corps. Indeed, it is a key part of our strategy."

He then described an exercise involving the F-35.

"We were doing a drill, and the F-35 does a great job at a lot of things.

"It does a very good job in terms of electronic warfare as well.

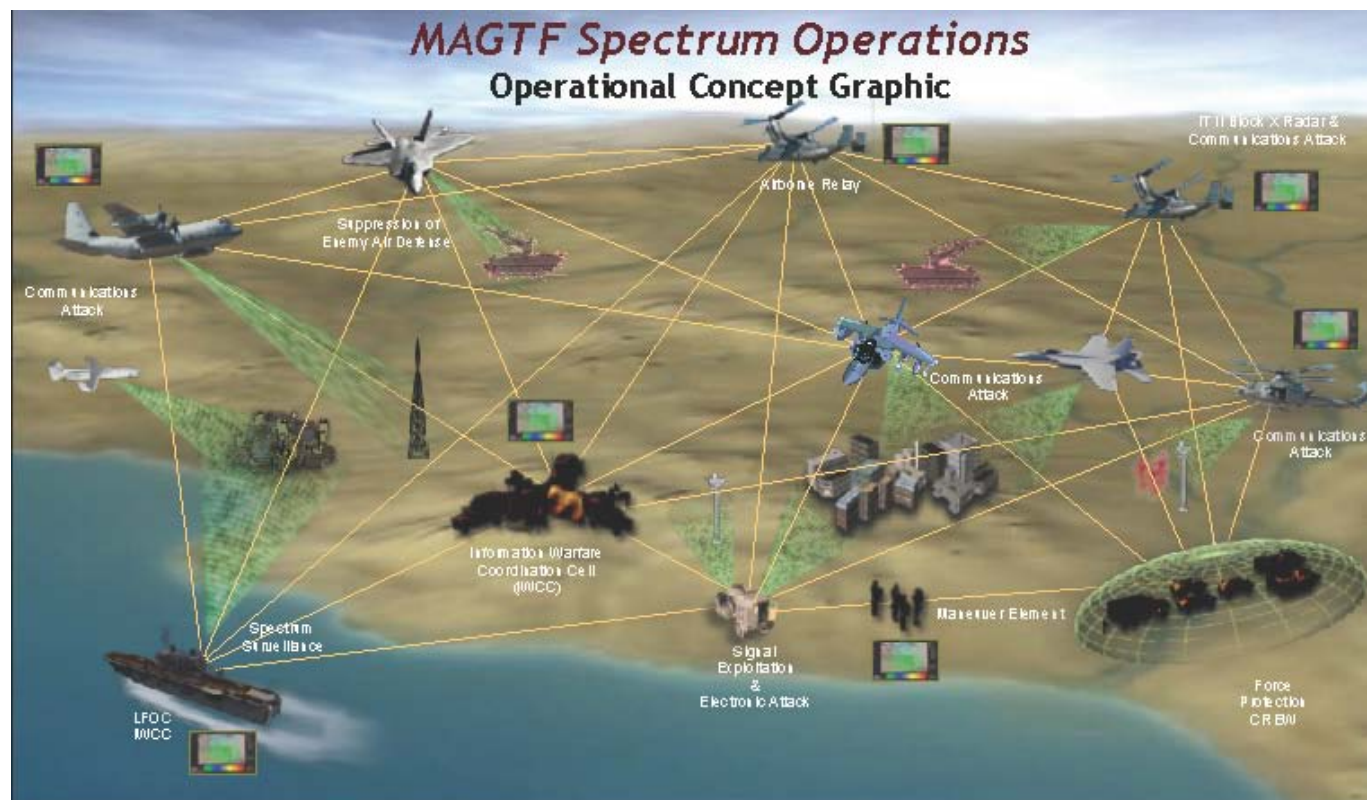
"Bottom line, I was out there, I saw four ship of F-35s, and the scenario was a double digit SAM threat, it was 1,000 foot overcast, we had four Bs out there, we had a forward air controller on the ground, and these guys had launched off the ship and they were overhead, and they were going to go take out ground vehicles and suppress and shutdown the SAM.

"We brought in all of our senior one and two star generals. In short period of time, the F-35s got rid of the SAMs.

"They were operating more like a pack of dogs than ever seen in 36 years of flying strike airplanes including being the CO of the Weapons School.

"It was a work of art.

"The infantry officer came at the end came up says, "Hey, that was fantastic, but I think that's not very realistic."



"MAGTF EW transitions the Marine Corps from a focus on low density/high-demand EW platforms, to a distributed, platform-agnostic strategy – where every platform contributes/ functions as a sensor, shooter and sharer – to include EW.

Under MAGTF EW the Marine Corps is leveraging emerging technologies and integrating multiple platforms, payloads, nodes, and capabilities to provide commanders with an organic and persistent air and ground EW capability."

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"We need to capture it on live streaming video see we can see a confirmation of those targets."

"I commented: Well it's overcast, they're not going to be streaming video, and you're probably not going to have a Reaper out there, right? It's going to get shot down."

"He goes, "We need more time so we can review the video feeds."

"I said, we have to remove the admirals and the generals out of the kill chain.

"If the pilots have got the right RoE, let them loose.

"If you inject too many decision makers from on high, you're going to get Soldiers, Sailors and Airmen killed."

Davis added: "We're going to grow the F-35; We're going to be very aggressive about growing capabilities in the F-35. It's good at what it does right now; it'll be a hell of a lot better in the future."

He then went on to describe other roll-outs of evolving EW capability for the MAGTF.
Second Line of Defense

The Blackjack UAV, which has a modular payload structure, has an EW payload inside as well and is currently working with the USS America amphibious group.

The goal is clear: "There will never be a Marine infantry unit or a group on the ground that will not have access to electronic warfare capability.

"The guys on ground can go up and e-connect.

"Almost like they're going to a server in the sky and pulling the information for them, he or she can basically pull the capability down from the air asset."

The next platform, which will provide an EW delivery capability to the MAGTF will be the Group 5 UAV, the Marines are working on right now.

This will be a VTOL UAV and will have an open architecture with modular payloads.

And clearly one of those payloads will be an EW one. And by having a VTOL asset this can provide MAGTF support throughout its operational cycle, whether on the ship, coming off the ship or operating ashore.

He concluded by reminding the audience of the philosophy of the Marine Corps as the big green killing machine. It was not about the fair fight; it was about speed and combat success against a determined enemy.

He quoted the most famous Australian general officer from World War I, General Sir John Monash to provide perspective on how the Marines looked at the inclusion of EW as a ubiquitous asset for the MAGTF.

"The true role of infantry was not to extend itself upon heroic physical effort, not to wither away under merciless machine gun fire, not to impale itself upon hostile bayonets, but on the contrary, to advance under the maximum possible array of mechanical resources, in the form of guns, ...tanks, mortars and aircraft; to advance with as little impediment as possible; to be relieved as far as possible of the obligation to fight their way forward."

During the panel discussion after the presentations by Group Captain Braz and CDR Mike Paul, a question was asked about the challenge of working with the US Navy and its approach leveraging Growler and the USAF's approach to leveraging fifth generation aircraft in shaping a way ahead.

The answers were quite noteworthy.

Group Captain Braz viewed the RAAF as in an interesting bridging function between the USN and USAF and playing a potentially useful and significant role in shaping integrated capability across the RAAF, the USN, and USAF as well.

"The diversity that we bring is very useful in shaping the combined team of US Navy and US Air Force capabilities."

Lt. General (Retired) Davis from the floor added his thoughts on how integration is proceeding in the US.

He sees the schools, MAWTS-1, Nellis and Fallon as key elements in shaping an integrated force. He mentioned that a Marine is for the first time teaching at Nellis and a USAF pilot is training at MAWTS-1 and will be an instructor there as well.

"The more we learn from each other, the better we will be."

And then CDR Paul added that it remains to be seen how the US Navy will employ the F-35 but that cross learning from the USMC and the USAF will be crucial in this process.

Visiting the Prowler: USMC Electronic Warfare Capabilities in Transition

Todd Miller

February 22, 2017

The unmistakable Grumman EA-6B Prowler comes into view on the horizon and streaks low across the hills of southern Virginia.

“Dog 31” of the VMAQ-3 Moon Dogs is on a routine low level training mission. The flight ensures pilot and electronic countermeasures officers (ECMOs) realize the minimum designated 15 hours of monthly flight time to maintain proficiency.

Additional time is spent training in simulators to address specific threat environments.

The Prowler wings by and banks into the late afternoon sun.

It is a visual metaphor, as sundown for the Prowler fleet is drawing near.

The Prowlers remain one of the premier electronic warfare (EW) aircraft in the services and are planned to cease operations in 2019.

Prowler squadron VMAQT-1 the Banshees were decommissioned in 2016, and the current Marine Aviation plan has the remaining squadrons following one per year; in 2017 the VMAQ-4 Seahawks, in 2018 the VMAQ-3 Moon Dogs, and the last Prowler squadron, the VMAQ-2 Death Jesters will be decommissioned in 2019.

The 18 currently remaining EA-6Bs are based at MCAS Cherry Point, NC and split among the 3 active squadrons as needs (deployments) require.

During this staged sundown, pilots and ECMOs are given options to transition to other aircraft, incoming EW platforms, or pursue new occupational specialties.

In many respects the Prowler “sundown” is not a typical “retirement” where a platform with diminished capacity slowly fades away.

Today’s Prowler is the most capable variant ever. The aircraft features the improved capabilities (ICAP) III package and will receive Block 7 ICAP III upgrades to improve EW performance and operability through to the end of service life.

The aircraft are effective and future deployments are planned.

Over 46 years of service Prowlers (USN since 1971 & USMC since 1977) have been involved in scores of critical Navy, Air Force, Marine and Coalition operations. Since 9/11 Prowlers have been deployed near continuously.

Recently, the aircraft have provided extensive service (including deployment to Incirlik Air Base in Turkey) over Syria and Iraq to support the coalition in the fight against ISIS. In these theaters, the aircraft jam cell phones and other remote signals that trigger IEDs as well radars that may be tracking coalition air assets.

Second Line of Defense

While the aircraft can utilize anti-radiation missiles to strike enemy radar assets, their secondary role in this region is more likely to include intelligence gathering within the electronic spectrum.

By 2020, the USMC will have adopted a revolutionary change in how they address electronic warfare.

Rather than replace the Prowler with a dedicated platform, the USMC has adopted a distributed strategy, where “every platform is a sensor, shooter and sharer.”

This new paradigm brings together both electronic warfare and cyber capability with the Marine Air-Ground Task Force (MAGTF) in a structure called the (MAGTF EW).

USMC Captain Sarah Burns explains, "Under MAGTF EW the Marine Corps is leveraging emerging technologies and integrating multiple aviation platforms [unmanned, fixed-wing, tilt-rotor, and rotary-wing assets]; payloads; ground-based EW nodes; and cyber capabilities to provide commanders with an organic and persistent EW capability - for every MAGTF - large and small..."

Within the MAGTF EW each USMC aviation platform will have the capability to carry its own pods packed with sensors / jammer payloads (such as the Intrepid Tiger II).

2nd Lt. Samuel Stephenson indicates:

“This integration of manned and unmanned airborne and ground EW capabilities will provide the MAGTF commander with greater flexibility and control of the electromagnetic spectrum and, in many cases, giving the commander a capability where previously they had none.

"MAGTF EW assets will be modular, scalable and networked, utilizing an open architecture that is rapidly adaptable and remotely re-programmable at the tactical level to support future Marine Corps warfighting requirements."

The US Navy EA-18G Growler will continue the Prowlers dedicated EW mission.

The USMC F-35B & C (replacing the AV-8B, F/A-18A-D and EA-6B) will provide the tactical aviation requirements of the USMC while offering a very robust EW capability. Combined, the two aircraft (EA-18G & F-35B/C) will bring immense EW capability to the Joint Force.

As Stephenson indicates, “These aircraft, combined with the assets available in the MAGTF EW, will ensure the Marine Corps will be able to quickly innovate and adapt to the changing EW mission set and the battlefield of tomorrow.”

During this time of dynamic change within the USMC, the Prowlers remain at the ready and heavily utilized.

The aircraft train out of MCAS Cherry Point and participate globally within exercises of USAF, USN and coalition forces.

The Prowler community and aviation enthusiasts have a few remaining years to celebrate the service and enjoy the flight of the Prowler.

They can do so knowing this cat is black, and will be on the prow until the final hour.

Second Line of Defense thanks Maj. Nathan Baker, Operations Officer for Marine Aircraft Group 14, 2nd MAW, 1st Lt. John Roberts, and 2nd Lt. Samuel Stephenson Public Affairs Officers 2nd MAW, and Capt. Sarah Burns, Public Affairs Officer, Office of Marine Corps Communication, Pentagon.

EA-6B Prowlers in "Final Four" Flight: The Marines Look to a New Approach to Electronic Warfare

Published March 6, 2016

Four EA-6B Prowlers assigned to 2nd Marine Aircraft Wing's Prowler Squadrons (VMAQT-1, VMAQ-2, 3, and 4) conduct a "Final Four" division flight near Cherry Point, N.C., March. 1, 2016.

The 4 Prowlers flew together one last time before the official retirement of Marine Tactical Electronic Warfare Training Squadron 1 at the end of the Fiscal Year 2016.

MARINE CORPS AIR STATION CHERRY POINT, N.C. - Four EA-6B Prowlers belonging to each Prowler squadron aboard Marine Corps Air Station Cherry Point conducted a "Final Four" division flight aboard the air station March 1, 2016.

The squadrons have a very high operational tempo, so it is rare to see all four squadrons home at the same time. In an effort to highlight this platforms legacy, the "Final Four" flight came to fruition.

As technology changes and new innovations emerge, the Marine Corps acknowledges and remembers the accomplishments of this platform and what it has done for the nation during its time in service, and what it will continue to do over the next four years.

Marine Air-Ground Task Force Electronic Warfare is what the Marine Corps will transition to as the Prowler is replaced.

MAGTF EW is a more distributed strategy where every platform contributes and functions as a sensor, shooter and sharer.

This includes an EW node that moves relevant tactical information throughout the electromagnetic spectrum and across the battlefield faster than ever before.

Under MAGTF EW, the Marine Corps is leveraging emerging technologies and integrating multiple aviation platforms including, unmanned, fixed wing, and rotary wing assets, payloads, ground-based EW nodes, and cyber capabilities to provide commanders with an organic and persistent EW capability for every MAGTF.



Figure 10 Three EA-6B Prowlers belonging to each Prowler squadron aboard Marine Corps Air Station Cherry Point conducted a "Final Four" division flight aboard the air station March 1, 2016. The "Final Four" flight is the last time the Prowler squadrons will be flying together before the official retirement of Marine Tactical Electronic Warfare Training Squadron 1 at the end of Fiscal Year 16 and the eventual transition to "MAGTF EW". MAGTF EW is a more distributed strategy where every platform contributes to the EW mission, enabling relevant tactical information to move throughout the electromagnetic spectrum and across the battlefield faster than ever before. (U.S. Marine Corps photo by Cpl. N.W. Huertas/Released)

The “Final Four” flight is the last time the Prowler squadrons will be flying together before the official retirement of Marine Tactical Electronic Warfare Training Squadron 1 at the end of Fiscal Year 16 and the eventual transition to MAGTF EW.

VMAQT-1 traces its lineage back to Korea when it was known as Marine Composite Squadron 1, flying electronic counter-measure missions for UN aircraft.

Throughout the years, it has re-designated many times and alongside the other Prowler squadrons, flew combat missions in support of every conflict ranging from Vietnam to operations in Iran, the former Yugoslavia, Operations Iraqi/Enduring Freedom and everything in between.

It wasn’t until the summer of 2013 that VMAQT-1 assumed fleet replacement squadron responsibilities and was officially named VMAQT-1. Today, VMAQT-1 trains Prowler pilots, electronic countermeasure officers and maintainers, readying the men and women it trains to join the other three squadrons as they continue to conduct missions in support of joint and strategic objectives.

This integration of manned and unmanned airborne and ground EW capabilities will provide the MAGTF commander with greater flexibility and control of the electromagnetic spectrum and in many cases, will give the commander a capability where previously they had none.

MAGTF EW assets will be modular, scalable, and networked, utilizing an open architecture that is rapidly adaptable and remotely re-programmable at the tactical level to support future Marine Corps warfighting requirements.

As these legacy aircraft conduct their last flyover together, aboard MCAS Cherry Point, 2nd Marine Aircraft Wing respects the incredible support provided by the Marines of the Prowler squadrons over the years and looks forward to what the future will bring.

https://www.dvidshub.net/news/190748/prowler-final-four-division-flight#.Vtwd1cf_s7k

Earlier, we conducted interviews at 2nd Marine Air Wing and Yuma, each of which discussed the transition.

The Prowler is due to be retired in 2019 and will be replaced by a wide-ranging focus on EW throughout the MAGTF.

One asset that will play a role will clearly be the F-35, which is in Ed Timperlake’s words, a “tron warfare aircraft.”

And Major Summa, the XO of the Green Knights, who is taking over as the Warlords CO highlighted how the F-35 affected the EW approach:

Question: Obviously your pilots need to be trained to combine the air-to-air and CAS capabilities and to use the new organic tools sets as well?

Major Summa: It does.

Now we’re going to have a pilot that’s versed in doing CAS, if he needs to use the electromagnetic spectrum or exploit it to accomplish his mission, he’ll be educated and have the equipment to do so.

If he needs to use it in the air-to-air arena to exploit it, to accomplish his mission, he’ll have the training and the equipment needed to use it as well.

In the current situation, I would deploy a Prowler to work with my legacy fighters.

The Prowler would have to be sortied and would operate only for a period of time and in a specific operational area.

With the low observability of the F-35 combined with the organic EW capability of the aircraft, the aircraft expands my capabilities for both air-to-air and CAS.

Clearly, unmanned aircraft or remotely piloted vehicles will be added to the mix as well.

Currently, the USMC Blackjacks carry payloads to contribute to EW and over time the UAV element will enhance its role as well.

The Next Phase in the Evolution of USMC UAS Capabilities: An Interview with Colonel Barranco

Interview Conducted June 2017

In my recent interview with Lt. General (Retired) Trautman, the former Deputy Commandant of Aviation highlighted how he saw the way ahead for unmanned air systems in the MAGTF:

The current Deputy Commandant for Aviation has been very prescient in laying out a requirement for a program called MUX (MAGTF Unmanned eXpeditionary UAS) which the current aviation plan says will be ready for initial operations in the 2025 time frame.

That platform, whatever it becomes, should have the capability to take off and land from the sea base, to take off and land from an expeditionary operating location ashore and deliver long range relatively high speed service to the fleet so that you can use that range and speed to your advantage.

It should also come in with adequate power and non-proprietary "hooks" so that future users can employ whatever payloads make the best sense for the force as it evolves.

This is a very exciting time for the development of unmanned systems in support of the amphibious task force and the Marine Corps.

<http://www.sldinfo.com/the-role-of-unmanned-aerial-systems-in-the-remaking-of-the-amphibious-task-force-the-perspective-of-lt-general-retired-trautman/>

I had a chance to follow up on these thoughts with the current senior Marine involved in working the evolving UAS issues, namely, Col. J.B. "Buss" Barranco.

Col. Barranco is an experienced Marine Corps aviator with significant combat experience. He has been an instructor at MAWTS, and has had eight deployments. He was the escort flight leader for the Afghan operation for the Marines in 2001, and then was involved in the 2003 invasion of Iraq and then back to Iraq in 2005 and 2007 as well. He worked the H-1 transition task force for Lt. General Trautman when he was DCA in 2008. He then deployed to Afghanistan again in 2010, 2011, and 2012.

When the Col. discusses platforms he does so from the standpoint of what they bring to the Marine Corps and how they integrated into the evolving capabilities of the MEU or MAGTF.

Question: Clearly, you are looking at unmanned air systems from the standpoint of how they work to enhance USMC capabilities.

Second Line of Defense

How do you view the evolution to date?

Col. Barranco: "I think we've done a pretty good job of trying to fully integrate our unmanned into our manned aviation in the aircraft wings. And we are in the process of going back to sea after a long period of being focused on the land wars. We want to get back to sea.

"We want expeditionary.

"We want VTOL.

"Although Reaper is a tremendous capability is is limited to runways, and runways are going to be targeted by peer competitors. And we want to be independent of the need to use allied runways as well. Sovereignty needs to be exercised independent of absolutely needing to use allied airfields.

"These are the drawbacks of land-based systems."

Question: How then are you looking to build that VTOL capability?

Col. Barranco: "We are looking to build airborne early warning capability, and air to air capability into MUX, something that you don't find in Reaper.

"We want an expeditionary, shipboard capability.

"We are building a digital interoperable network and we want the MUX to be a node in that digital network.

"We want air to ground capability but we also want air-to-air capability as well. By being able to operate shipboard, we can free up our manned aircraft in some cases for other missions. We'd also like to have a cargo capability to avoid having to use trucks on the road when we wish to avoid that.

"The Osprey has raised the bar with regard to range and speed.

"We need range and speed that's comparable to the Osprey in the new UAS, the MUX. MUX will be a key element in our execution of distributed operations.

"We will operate our forces further from the ship and the assembly area and need to operate with smaller distributed forces that are network prior to any massing of our forces.

"The MUX will need to fit into that template.

"Classic helicopters are not going to get it done in terms of range and speed to deliver a distributed strike force.

"The MUX by being VTOL will be heavier and give up some time on station.

"We need to operate it shipboard and have it protected against corrosion, which will add to the weight.

"But because it is expeditionary, able to take off virtually anywhere, we can give up that slight loss of time on station and range of current UASs."

Question: How does your current experience with Blackjack fit into your learning curve with regard UASs?

Col. Barranco: "Blackjacks currently operate from LPDs and are deployed with our MEUs.

"We have our second MEU using the Blackjack afloat underway right now.

"We have also done a land based combat deployment as well in Afghanistan.

"Our first MEU using the Blackjack, the 22nd, was a sea-based deployment with Blackjack supported combat ops in Libyas as well.

"It is more difficult to operate at sea.

"It's not just our operators, our UAS operators, who are gaining experience at sea, but it's everyone else who's getting experience within part of a MEU MAGTF ACE at sea and learning how to use the system.

"And of course the NAVY is learning as well and this joint learning could well inform a joint acquisition of the MUX as well.

"We are deploying Blackjack in advance of MSD or the material support date.

"We always lean forward and try to get equipment into the hands of the warfighter as rapidly as possible.

"This means that the reliability rates will be lower initially but as we approach MSD then they adjust upwards.

"There are clear limitations on a Group 3 system like Blackjack, for example, it is a line of sight system.

"But we have a number of payloads for the Blackjack which give us operational flexibility, and Blackjack is evolving and will remain in the force even after we add MUX."

Question: There is a challenge clearly with how to handle data onboard current Navy amphibious task force ships.

How will you deal with this?

Col. Barranco: "There is no question that the LPDs and LHAs are going to have to see significant expansion of their ability to manage data.

"The coming of the F-35 alone would require that but as well augment UAS capabilities this demand will grow."

Question: So in effect as you are designing MUX you are building on the Blackjack experience and shaping inputs into Navy ship design as the LPD-17 morphs into LXR, for example?

Col. Barranco: "That is a good way to put it.

"The evolution of the ACE, including UASs, is driving significant change in how we need to design our ships to manage the MEU afloat and work with the MAGTF ashore.

"Marine Corps Aviation is focused on integration; not just inside the air wing, but on the MAGTF and its evolution.

"And that is how we look at the evolution of UASs in the force."

In short, the current operation of Blackjacks at sea and on land is a key part of the learning curve with regard to the operation of the systems and their integration within evolving Marine Corps operations.

As is Marine Corps practice, the Blackjack is in the force in advance of fully being able to support the force.

Second Line of Defense

For the Marines it is about getting capability to the force and letting the war fighter use that capability as that capability evolves and becomes fully operational.

And the Blackjacks is part of the new Air Combat Element for the Marine Corps is impacting on the ship design for the LHR which will be modeled on an enhanced San Antonio Class ship and on the America class LHAs.

A key part of this effort is the need to expand significantly the capability to handle much larger volumes of data generated by F-35s and UASs to the ship as well. In this regard, it is the Navy-Marine Corps team, which is learning from Blackjack deployments, not just the Marine Corps.

The Marines are working to add a new more robust UAS capability to the force by the mid 2020s.

And they are hoping that the US Navy will buy in as well, and allies who are building up their amphibious fleets might well be candidates for the new platform as well.

The Marines are looking for a platform, which can fly with the Osprey, which means range and speed, are essential. It may well be a tiltrotor platform although other platform variants might be feasible as well.

This Group 5 UAS will have an open architecture system allowing complete software upgradeability to keep abreast of threats.

The RAAF speaks of the need to build in software transient advantage and this is clearly what the Marines are looking for in their new UAS system as envisaged.

They are looking for the new platform to have a number of plug and play capabilities.

They want it to be an armed UAS with a variety of weapons which can be configured to the mission.

With the core focus on shaping a digital interoperable MAGTF, they look to the UAS to be a key node in the network afloat and ashore.

They are looking at the new UAS as a partner with the F-35, Osprey and CH-53K, where the UAS could be as well a cargo carrier as well, dependent on the operation and the mission.

As the Marine Aviation Plan 2016 put it about one of these requirements:

“UAS are a planned critical component of the MAGTF EW concept. As such, EW expertise normally resident within the VMAQ community began to transition to the VMU community in 2015. Airborne electronic attack (AEA) capabilities post-2019 will be provided by EW payloads such as the Intrepid Tiger II EW Pod, UAS EW payloads, and the EW capabilities inherent to F-35.”

The new UAS will be STOVL as that fits both the shipboard and well as no fixed airfield requirement.

The MAGTF will rely on the F-35 and related systems for forceable entry, so that the UAS as envisaged will operate largely in a non-contested air environment, although arming the UAS will be crucial for its self defense in gray operating situations.

The Marine Corps Aviation Plan put forward the following as how to characterize the way ahead for UASs:

“In the 2016-2029 timeframe, the family of unmanned aircraft systems (FoUAS) provides support to any sized MAGTF for influence of the electromagnetic spectrum, battlespace awareness, offensive air support, target acquisition, force protection, and digital communication backbone. Marine Corps UAS employment will

continue to enhance and extend the lethal and non-lethal capabilities of MAGTF and joint force commanders, facilitating advancements in observation, understanding, and influence on the battlefield."

"The FoUAS will play a key role in all USMC missions across the range of military operations to include forward presence, security cooperation, counterterrorism, crisis response, forcible entry, prolonged operations, and counterinsurgency."

<https://marinecorpsconceptsandprograms.com/sites/default/files/files/Marine%20Aviation%20Plan%202016%20FINAL.pdf>

The new UAS, labeled as MUX, would leverage the operational experience of the Blackjack and combine with Blackjack in shaping a way ahead.

Given the payload flexibility of the Blackjack, this system could well complement the new MUX as well.

KEY AUSTRALIAN BUILDING BLOCKS FOR SHAPING AN DISTRIBUTED EW CAPABILITY FOR THE INTEGRATED FORCE

Australia is leveraging three key air platforms in shaping its way ahead with regard to the air delivered component for electronic warfare, namely, the Growler, the F-35 and the Wedgetail. In addition, the work in progress of better integrating the navy with the air force as well as the army opens up other key opportunities for shaping new capabilities for the integrated force.

Clearly, one core example of this is working integration between the air components such as Wedgetail with the radars on the new air warfare destroyer.

Some of these elements are discussed in this section and are based on interviews done during this visit to Australia.





In other words, with regard to airborne electronic warfare, the RAAF is looking to leverage multiple platforms and build a foundation for evolving integrated capabilities for the future. It is about inclusion of EW within the integrated and evolving force design.

Wedgetail and Its Evolution

During my visit to Australia in April 2017, I had a chance to continue my discussions with Group Captain Stuart Bellingham, Officer Commanding Number 42 Wing, about the Wedgetail and its continuing evolution.

The Wedgetail has demonstrated in the Middle East and in high end warfare exercises that it is a very good fit for the shift to a fifth generation enabled air combat force.

Most recently, I heard from USAF and RAF personnel involved in the first Red Flag this year, how impressive they found the aircraft.

As one senior RAF pilot put it: "I would never fly with an AWACS if had a choice. I would only fly with Wedgetail."

Obviously, Number 2 Squadron and Number 42 Wing have made an impact on air combat thinking.

In this year's Red Flag 17-1, the F-35 and F-22 flew with RAF Typhoons and USAF F-15s along with the Sentinel UK aircraft and the Aussie Wedgetail, along with other assets as well.

But the exercise was notable in terms of the first appearance in Red Flag 17-1 an exercise in which one combat participant noted: "In this exercise, the F-35 reshaped how we are thinking about the use of our entire air combat force.

"The question was not what the F-35 could do for the rest of us; it was what can we contribute to the F-35 led air combat force?"

The Wedgetail certainly found its place in answering that question and in providing unique quarterback functionality to the force and to support functions from an ISR and C2 role as well.

Not only did the Wedgetail show up, but the Officer Commanding 42 Wing played a key role in the exercise as well.

According to an article published in Australian Aviation on February 14, 2017:

GPCAPT Bellingham was the first non-US participant to be Director of the CAOC, leading 250 American, British and Australian personnel. This was the first time a coalition nation has performed this role in such an exercise.

"We are integrated with these capabilities from start to finish, from planning missions, through to debriefing the missions," GPCAPT Bellingham said.

"Australia has air battlespace managers from No. 2 Squadron and No. 41 Wing who are controlling the Red Flag airspace, and getting first-hand experience how these capabilities can be employed."

"We're getting real insight into understanding the capabilities and what Australia's future is going to look like."

<http://australianaviation.com.au/2017/02/exercise-red-flag-2017-concludes/>

Question: I think Red Flag 17-1 is a good example of how we collectively are shaping a way ahead.

In effect, we are seeing the training of a network of operators who can shape high intensity air operations under the impact of fifth generation warfighting concepts.

The technology is crucial; the platforms are important; but it is the training towards where we need to go that is crucial, rather than simply training to the past.

Is that not where your experience with Wedgetail and working with allies comes in?

Group Captain Bellingham: That is a good way to set up the discussion.

I think the strength of everything we're doing at the moment only comes from a strong cooperation with our allies. Obviously, we're a tiny force, and our relevance and real strength becomes fully apparent when we tie our capabilities with those of our allies.

At Red Flag 17-1, we saw the US, the UK and Australia blending advanced assets together to make the entire force more lethal and survivable in the high end threat environment.

Question: The F-35 plays a key role in shaping the battlespace and target identification for other air assets.

What is the Wedgetail's role in that context?

Group Captain Bellingham: As we evolve the capabilities of Wedgetail, we see key roles it can play as a quarterback in a high-end fight.

And as we upgrade the software and hardware capabilities, it is only by interacting with the other assets in that air combat environment that we can truly evolve new ways of doing things.

It's not just we've updated the software and now we've got a great radar. That's a continuous process, and every time we go to these exercises and go, "You know, that was kind of neat. How do we make that repeatable, and how do we embed that in our doctrine and TTPs?"

Our true strength comes from multiple nations working together and blending their capabilities for the fight, because it is simply very difficult for any one nation to fund and deploy all the high-end capabilities we need.

Our Wedgetail contribution can be seen in this light.

Question: Let us return to the concept of shaping a network of operators for 21st century high-end operations.

How do we best get this done?

Group Captain Bellingham: It is about deploying your new assets, and learning how to use them in an interactive context.

Second Line of Defense

For us, it is starting with Wedgetail, and then moving to Growler, and then to F-35, to P-8, to Triton and so on, how do we shape an effective team to dominate in an air combat environment?

The platforms and technology is crucial but training to where we need to go and cross learning to evolve the combat force is absolutely essential for shaping the air force we need to deploy.

We see our new Air Warfare Centre as a key opportunity to do just that. One evolving aspect is that our Air Force used to conduct Fighter Combat Instructor courses; and we would send a ground controller to the course to participate.

Now the focus is on the evolution of holistic air combat capabilities and as part of that, we have a Wedgetail team participating in the Air Warfare Instructor course.

We've got several participants involved from the Wedgetail side: an electronic systems officer, a couple of the air battle managers, we have a pilot, and they're all working as a team in the airborne early warning and control space.

During the course they will evolve AEW&C tactics which are complementary to the overall Air combat domain and they will all graduate from the course as Air Warfare Instructors.

They are working that quarterback space, to understand the needs and opportunities of that network of operators and how we can change our TTPs to make them more effective.

More broadly, we are focused on being an enabler not just for the air combat force but the joint force.

For example, we are working with the Navy and the Army with regard to supporting expeditionary blue water operations and operating in concert with the new LHD and its evolving concepts of operations in the littoral space.

The enabler function is the key Wedgetail strength in terms of supporting the joint and combined combat force more generally.

Question: Wedgetail is a software upgradeable aircraft and is undergoing modernization along existing lines but you have some expanded capabilities in mind as well?

Group Captain Bellingham: We are modernizing the aircraft to enhance current C2 capabilities but we are looking at ways to exploit its extraordinary radar (via its scalability) to expand into the non-kinetic warfare space.

And we will do that as well through the cross learning we talked about earlier.



Figure 11 A Royal Australian Air Force E-7A Wedgetail taxies past a U.S. Air Force 90th Fighter Squadron F-22 Raptor at RAAF Base Tindal, Australia, Feb. 24, 2017. Twelve F-22 Raptors and approximately 200 U.S. Air Force Airmen are in Australia as part of the Enhanced Air Cooperation, an initiative under the Force Posture Agreement between the U.S. and Australia. (U.S. Air Force photo by Staff Sgt. Alexander Martinez)

We are working really hard at the moment in collaboration with our allies to get a team approach to accelerate our learning.

We are looking to build from the achievements we've done so far and build on that cooperatively with our allies.

We're working to get to the next level, and we're looking at the next generation of E-7, based on our operational experience and leveraging the collaborative networks we have established with allies moving into the fifth generation enabled air combat force.

Question: A final thought suggests itself.

Without the global engagement of Wedgetail in operations and exercises, the entire development process you described would not be possible.

And the Wedgetail would not be showing up if not for the presence of your KC-30A, a point that could be missed.

How important has the new tanker been to enabling Wedgetail to deploy and to shape its combat learning process?

Group Captain Bellingham: You have raised a very good point.

The two came into the force at about the same time.

Without the tanker, we don't get the endurance and the ability to stay on task.

We would not have the reach and persistence.

And our part of the world we have vast distances and lots of open water, we need the expeditionary capability that a tanker brings, and a good tanker that can offload a good amount of gas and has great reliability.

The KC-30A, what it's demonstrated on operations over the last two and a half years has again been phenomenal.

Second Line of Defense

Whilst it had a few initial teething problems with the boom and other things, that tanker is going from strength to strength.

Without it, we're irrelevant, because we can't do that expeditionary work which we need to be able to do.

That's important in the Middle East, but even more important in our part of the world.

An Update on Wedgetail: And Shaping a Way Ahead with a Software Upgradeable Multi-Mission 21st Century Combat Capability

During my current visit to Canberra in August 2017, I was able to continue my discussion with Officer Commanding No 42 Wing, Group Captain Stuart Bellingham about the Wedgetail and its evolution.

After the recent presentation by the head of the USAF Materiel Command underscored the challenge of agile software development for DoD, I had a chance to pick up some of the same themes from the Wedgetail experience which provided some useful insights into the way ahead.

"As we have discussed before, we have a software upgradable jet.

"This is brilliant and gives us a lot of agility.

"And leveraging the software has meant that we come from being a program of concern back in 2009 to becoming a cutting edge airborne command and control capability.

"We are not just focused on ourselves, but how we can evolve our jet to be a greater contributor in the joint and coalition space.

"In order to write software that supports us being able to share ones and zeros effectively is dependent on an agreed understanding on tactics techniques procedures and standards that support how we are incorporate software and how we build it to make sure we're actually all aligned so that when we go out and work together we're on the same wavelength, so to speak.

"That is a significant challenge.

"To do so, we are focused on engagement and education, trying to get people to understand the capability that we bring to the fight.

"With E7, everyone straight away just thinks traditional AWACS vice what we've got, which is a dynamic software upgradeable aircraft with a very different system and approach than the legacy AWACS."

Question: When we went to Fallon, it was clear that if the TTP efforts could be combined with software code rewrite at a place like NAWDC, the Navy's path to a kill web would be accelerated.

What is your thought about that kind of cross-linking?

Group Captain Stuart Bellingham: "It is essential.

"As we pair up the new platforms and sort through how to work together, we will shape the TTPs, for example, operating P-8s and Wedgetails.

"As our procedures evolve, we need to rewrite the software on each platform to maximize the ability to work together.

"In fact, later this year we are holding our first two day working sessions between the P-8 and Wedgetail communities which will be a foundation towards working towards that goal.

"When one looks towards the prospects of high tempo and high intensity operations, we will need well developed interoperability and that requires the new platforms, TTPs and software development all working hand in hand before we are in combat.

"Otherwise, we are at significant risk.

"If we can already have the same base line for how our ones and zeros communicate, that's half the battle to get there.

"Then we can just develop and evolve from that.

"I think it's going to be increasingly important.

"It's fundamental to how we're going to go forward because what is clear to me from recent involvement in Talisman Sabre 17, is that if we're not doing joint/combined, if we're thinking component or thinking single-nation type approach, we are vulnerable and we're not going to succeed."

Question: The SPO is next door to your hangar.

Could you talk about the working process between the code rewriters and the operators?

Group Captain Stuart Bellingham: "It's a tight team.

"We have a budget within which we have funded builds of software but we have a great flexibility within each build to provide the operators with their most urgent requirements.

"We have just incorporated what we term our in-service build or ISB, 5.0 onto our Aircraft, which is a new software build.

"We're already working on the next software build. It's not something that we do in a reactive sense.

"These are all proactive / predictive options that we have in place and that we will utilize to continue to enhance the capability of the aircraft. They're roughly at about 18-month apart for the block upgrades.

"Most of the great changes come from not just the engineers but from the guys who are actually operating the radar in combat.

"It's really challenging, not just for the engineers and the operators here in the wing as we try to harmonize and make sure that the programs are working but it's also a challenge for the people out flying the airplane because they need to keep current with the software builds."

"We forecast forward and we request budget allocation to support these upgrades."

Editor's Note: A key element in shaping the way ahead is leveraging the software upgrade radar and related systems on an aircraft like Wedgetail and working it interactively with other software upgradeable systems aboard ships, notably the evolving radar capabilities.

One such capability is being developed, built and modernized by CEA and to its contribution we now turn.

Second Line of Defense

CEA Technologies and Software Upgradeable Combat Systems

I have been writing for some time about the strategic shift or one could call revolution to building software upgradeable systems.

The new multi-mission platforms on sea or in the air such as the Australian ANZAC Class frigates or the Wedgetail are simply different from legacy platforms for they are modernized differently.

A key challenge for the acquisition and policy community is to adjust their thinking to the new reality and to understand how radically different the new “platforms” are compared to the legacy ones.

The acquisition system has been built around a 20th century systems engineering model, one which sets requirements and designs the way ahead in a manner in an iterative requirements process which is simply inappropriate for a software driven force.

During this visit to Canberra had a chance to visit a leading center on developing software based radar technologies for the Australian Defence Force, and to view how the company builds its radars and evolves its technologies.

CEA Technologies was founded in 1983, and specializes in the design, development and manufacture of advanced radar and communications solutions for civil and military applications.

I had a chance during this visit to Canberra to discuss CEA and its approach with Ian Croser, Technical Director, CEA, with more than 30 years of experience in the radar business, a period in which radar technology has been transformed into a multi-function, multi-mission software enabled even defined combat capability.

Question: What is CEA Technologies?

Ian Croser: It's a private Australian company, but it has a significant shareholding from Northrop Grumman. It is an Australian controlled company. CEA works closely with Defence to achieve National strategic outcomes.

Question: During the tour of the facility, it was clear that you tightly control the development and manufacturing process, in part certainly to enhance the security of the product and the process. Could you describe your approach?

Ian Croser: It's hugely important to control the development and manufacturing processes because, the design and the development of individual modules and subsystems don't all come together at the same time. And that brings with it some real issues when you subcontract out design to subcontractors.

Because the moment you subcontract them out, you've effectively lost daily control over them.

Having the ability for our teams to be co-resident, and all talking to each other, solves so many problems for us. In time, in quality, in functionality, you end up with a better, lower cost and more secure solution.

Question: When you viewed the racks and the boards, you noted that none of these boards was COTS and that they all are built internally.

How important is it to control that board, from a security and also a performance point of view?

Ian Croser: From both points of view it's extraordinarily important because, if you are buying a board, you don't necessarily have all the controls over where the components come from, how they got to you, and how they're treated, before they actually get embedded in the board.

And they're all points at which somebody may do something that you don't desire.

From a performance point of view, COTS boards are all things for all people. Our boards are formed to fit into our space and weight and technology requirements, and we can better fit them into a smaller space.

For example, in the array digital backend area, if we had used COTS boards, it'd be many times larger than it is now, and it wouldn't actually fit into our design baseline.

You wouldn't be able to implement our approach.

There's really no choice but to build our own boards and embed them in the system.

Question: Let us turn to the radar revolution in which we have moved from building a largely single purpose commodity into a multi-mission, multi-function upgradeable system.

How would you describe the shift?

Ian Croser: A conventional, mechanically-scanned radar, for example, is comprised of a large number of configuration items, all of them different and very few are used in multiple positions.

That means that in design and in build there is a lot of effort to mature those different elements.

These separate pieces have to be integrated and failures in just one subpart, generally impacts availability of the whole system. Integration requires significant time and effort to bring together the separate parts to form the whole.

It is completely different with active phased array radars.

The high-density functional modularity has suddenly become available and implementable. As a result we are building a very small number of unique configuration items, but building lots of them.

When we put them together, we get the resilience of parallelism, so if one module fails, it's just one of a large number operating in parallel.

The functional and physical modularity along with the independence of modules means that the resilience to damage and the resilience to occasional failures, is very high.

This has enormous beneficial impact on the sustainment process. Individual failures no longer force repairs before or during a mission; you can just carry on with a small proportion of the array that might have failed or have been damaged.

The repair can then be scheduled at a time and place of convenience.

It shapes a whole new way of sustaining capability at sea, for example.

Question: This new generation of radars is software defined and software rich. How does the software approach change the nature of the development and modernization game?

Ian Croser: The modularity of the hardware has to be matched by the modularity of the software and the firmware.

If you can isolate the application specific personality of the radar from the software base, then the software and the firmware becomes similar to an operating system.

Second Line of Defense

It supports the rapid application change process without itself needing to change.

It's sitting there underneath, and interfacing into the hardware, and when you tell it to do something, it does it. So if you tell it to point a beam in a given direction, then all of the distributed functionality that is across the array will do that, without needing to be 'hard programmed' to achieve new outcomes.



FIGURE 12 HMAS PERTH OFF THE COAST OF UAE. THIS AIR WARFARE SHIP CARRIES ADVANCED CEA RADARS

The radar personality, the application specific functionality is built into a small dataset that informs the system how it should operate under a given circumstance.

All of the software/firmware functions are just waiting to be organized in different directions and different sequences and with different parameters to be able to do their desired functions.

It is that small dataset running in an organizational set of boards that tell the system what to do, when to do it, how to do it, without changing the software and firmware.

Question: This provides for inherent transferability across radars operating in air, sea or land and can allow for enhanced efficiency in joint capabilities and joint investment.

How would you describe this process or approach?

Ian Croser: The objective is to reduce the number of software baselines being maintained across multiple platforms and operating domains.

This approach frees up a lot of development capability, and it means that the commonality and the interoperability is inherent and enhanced.

Even if you haven't brought forward a particular function in a particular application and platform, if it's in the common software base, then it's a really simple thing to bring forward and use.

It's more about integration with the rest of the platform capability than it is about the radar itself.

Implementation of a 'Task Based Interface' and control methodology has effectively insulated the Combat Management System from major change cycles in response to new applications.

This software baseline, when combined with the modularity of the hardware, allows the design and build of scalable radar, which can readily fit into different platforms across land, sea and air domains.

There is not a lot of work to bring a new application online.

It changes the whole way in which you think about multi-function capabilities, different applications, and how those applications interact with one another.

Question: The US Navy is starting to move forward with procuring a new frigate. I have written about the significant opportunity for the US forces to leverage allied investments and capabilities in accelerating the modernization of US forces as well.

It would seem to me that the frigate is an ideal case not only in terms of taking a foreign design but most certainly with the outstanding and combat tested frigate equipment already deployed on the frigates of our allies.

It would seem to be a no brainer to look seriously at your radar for this program so that the US Navy can ramp up the time when they could get a functioning frigate at sea.

After all, powerpoint slides for potential systems kill audiences, not adversaries.

What are your thoughts along these lines?

Ian Croser: It could make sense for the US Navy on several grounds.

Cost is a clear advantage and risk is contained by having operational systems already in place.

Shared investments with a core ally can also accelerate joint capabilities.

Interoperability is built in and the Australian Navy is already shaping the Conops of the system at sea.

It is only in the past decade that navies have looked beyond the organic role of radars onboard ships to think of fleet interactivity among radars at sea.

CEAFAR certainly is designed to do this and with the inbuilt multifunction capability and commonality there is significant enhancement to distributed lethality.

Question: With the shift in focus towards, high tempo and high intensity operations, mobilization becomes as important as modernization to combat success.

It is clear in walking around the plant and looking at your approach, mobilization capabilities are built in.

Could you highlight this aspect of the inherent potential of your manufacturing process?

Ian Croser: The key to ramp up is to embed high functionality and high performance at printed circuit board level.

Because now, component reliability has far outstripped system availability, it is possible to provide programmable and function rich systems with wide and inexpensive growth factors.

If you put all the effort into embedding rich functionality into the board itself, the flow on sustainment costs also benefit, that's the really key process.

Now once you've got the board, if you've designed it right, it can be manufactured on standard automated production lines at very low cost.

Because of the modularity and building lots of a small number of configuration items, you can now build the synergy in manufacturing to push through large volumes of work, very quickly.

Second Line of Defense

And of course, all of the test jigs and all of the capability to manage those few items also benefit from the modularity.

So you end up with a whole different way of manufacturing, testing, integrating, and delivering high capability at low cost.

Editor's Note: Ensuring that one can get the kind of cross-learning, cross-training and cross-development necessary for software upgradeable air, ground and sea systems to work with one another to deliver distributed electronic warfare payloads in the integrated battlespace requires several other challenges to be met.

The first is sorting out how to train cross platform, but here pairing of platforms provides an important tool set to get a handle on such developments.

The second is ensuring that the TTPs being developed cross-platform inform development efforts so that integration is built in.

The third is configuring a security system within which such combat learning can be empowered.

The next pieces address these issues and the challenges to shaping an effective way ahead.

The Way Ahead for the RAAF in the Joint Forces Space and the Coming of the F-35: The Perspective of Air Commodore Kitcher

2016-09-04

Prior to the Williams Foundation seminar on air-sea integration, I had a chance to sit down with Air Commodore Kitcher and to discuss the way ahead for the RAAF in the joint combat space.

He was then the Director General of Capability Planning in the RAAF. He has recently been appointed Commander Air Combat Group.

Air Commodore Kitcher provided an understanding of how the RAAF was integrating its new platforms into the force, and how opening the aperture from the outset on joint capability was affecting that roll out as well.

Question: It is often noted in the USAF that 80% of the platforms which will make up the 2025 force are already here.

What is the RAAF's perspective?

Air Commodore Kitcher: "It is somewhat different from the USAF. And our challenge is also somewhat different. By 2025 our oldest platform will be a C130J, which remains the most modern C130 available.

"In 2025, we're not going to be operating a platform in the air combat space that's 20 years old. In Australia, we don't have to integrate an F35 with an F16, or an F35 with the classic Hornet.

"We will be operating some of the latest and most capable platforms across the air lift, control of the air, strike and ISR roles and our challenge is to get best combat value out of an integrated Australian and coalition force using these cutting edge capabilities.

"We'll retire classic Hornet, and introduce the F35-A which is much more than a replacement for the Classic. Our other air combat asset are our Super Hornets, which are only 5 years old, and both will be supported (amongst many other things) by Growlers, which will arrive in Australia next year.

"If we look at the maritime space, P3s are retiring, P8s and Triton are being introduced. Our first P8 turns up in November this year. If we look in the airlift space, C130Js will be our oldest platform, but they remain contemporary.

"The KC-30 Multi Role Tanker Transport is 4 or 5 years old with both the hose and drogue and boom air to air refueling capabilities being fully realised and another 2 effectively new KC-30 aircraft will arrive before the end of 2019. We also picked up C-17 aircraft #7 and 8 last year. C-27J is being introduced right now and we expect it to reach IOC before the end of this year.

"In the surveillance and control area, the E-7 Wedgetail AEWAC airframe might be 10 or 15 years old. However, the Wedgetail capability is equal to or better than any similar capability in the world.

"You'd have to say Wedgetail is a cutting edge AEWAC capability. There would be some capabilities that Wedgetail has that the new USAF Block 40/45 E-3G AWACS doesn't have, and vice versa, of course."

Question: So your challenge is ensuring that your force which is a young force in terms of new capabilities can work effectively together; and for this, you are also working with core allies such as the US, but need to shape a core Australian way ahead.

How would you describe the challenge?

Air Commodore Kitcher: "How do I make my US Air Force 'like' F35A work closely with my US Navy 'like' Growler and Super Hornet to achieve a mission?

"Similarly, how do I ensure these aircraft, plus the Australian bespoke Wedgetail can work effectively with the RAN LHD and Air Warfare Destroyer to achieve a Maritime support or strike mission?

"It's a good problem to have to ensure that we get the maximum collective capability out of our individual platforms in the Australian context, which means we've got to make them work with each other.

"Larger forces, like the US, may not have that same requirement, because they've got other assets that can do various specialized missions.

"And we face a major challenge to ensure that our new air platforms work in an integrated manner with evolving Navy and Army capabilities.

"We must shape solutions which support our Australian Concept of Operations.

Our force also obviously needs to be "integratable" and/or interoperable with the US and other allies, but we won't get there fully by simply buying US C2 and ISR systems.

"Not only do we need to make a particular platform or system work for Australia within our ADF capability context, but we need to ensure that it's truly interoperable in a coalition as well.

"This is a real challenge, because there are security issues, restrictions and requirements that exist that must be overcome to realize true high-level interoperability.

"However, solving these problems is far better than trying to keep something that's 30-year-old flying and make it work with the new equipment coming on line.

"To solve these challenges, we are focused on prioritising and integrating only the things that you 'should' to make a more lethal and effective force.

Second Line of Defense

"There is no need for all our capabilities to be fully connected to each other, there are levels of connectivity that will suffice. especially initially We must prioritise and identify what we 'should' do, and to what level, vice embark on a program of doing what we 'can' do.

"A component of the RAAF Project Jericho involves this kind of thinking and is looking at our Air, Maritime and land capabilities, determining the art of the possible with respect to connectivity, and then suggesting levels and priorities that should be pursued.

"This also includes components in the virtual and constructive areas such that we can also train more effectively in the joint arena.

"Improving our training capacity by complementing live training with virtual and constructive is vital, especially where availability of the scarce live resources necessary to generate a complex training scenario are limited, and security restrictions could inhibit operating live at appropriate levels."

Question: You have done a lot of worked to shape a fifth-generation enabled force, prior to the F-35 showing up.

How will the F-35 fit into that evolving effort?

Air Commodore Kitcher: "The F35 introduction's is catalyst for significant change.

"Although the jets don't arrive in Australia until the end of 2018, and IOC is not until the end of 2020, believe me, we are right in the middle of introducing the F-35A into service.

"In addition to personnel we have embedded in the overall F-35 program in the US, we have two RAAF aircraft and four instructors at Luke AFB. Our first cadre of dedicated F-35 maintainers and engineers departs for the US in Jan 17, and will be gaining the necessary experience so we can operate the F-35 in Australia from the end of 2018.

"Operating the F-35 will be one thing, but we also need to be able to sustain it, and the methods of sustaining the F-35 are also different to older platforms.

"We have been planning for a while now, and these plans will continue to evolve, but I'm not sure our system fully understands that this significant transition is well and truly underway.

"You can keep flying legacy aircraft forever if you want to spend enough money on them, but they all reach a point where they will become capability irrelevant.

"Our Classic Hornets are doing a great job in the Middle East right now, and due to the raft of Hornet upgrades we have completed, remain amongst the most capable Classic Hornets anywhere.

"However, they will reach a point in the near future, especially in the higher end fight, where their utility will be significantly diminished.

"The F-35 brings 5th generation qualities which will allow for a significant expansion across a raft of ADF capabilities. Air Maritime, Land and most importantly joint.

"We've chosen, and we have structured it such that the Classic Hornet will run out of effective hours and fatigue life at the point not too far after when the F35 is being introduced. There is contingency of course but not a lot. We don't have the luxury simply to reflect abstractly on this problem anymore, we're in the middle of solving it.

"That gives us a very aggressive F35 introduction schedule.

"For example, we're planning to change out a classic Hornet to F35 squadron over 12 months. A squadron will stop flying the classic Hornet at the end of December one year, and by the end of December next year they are fully up and running and operational on the F-35. That is a very tight schedule. We've got a plan to execute but as you would expect, it's not without risk.

"However, being a little bit smaller than what other forces might be, we tend to also be more agile.

"And that agility will see us deal with any risks that might materialize, or the other inevitable pop up issues.

"Due to this aggressive schedule, our ability right now to deal with many other things triggered by the F-35 is somewhat limited, we are rightly focused on introduction.

"Fortunately, most of these associated issues, such as the Mission Data Environment, have already been the subject of extensive work. We have been positioning our joint force to both provide the necessary level and type of data to maximize new capabilities such as Growler, Triton and F-35A, and process the vast amounts of data these capabilities will collect.

"There are definitely remaining challenges in this space, we've observed them here in Australia and also with our key coalition partners, but there is good work underway in parallel with the platform introductions.

"I'm sure after we introduce the F-35 aircraft we'll still have a lot of work to do to get us to the point where we maximize the F35 capability across the Australian defense force, and interoperability with the other F-35 forces, but this is natural and will be dealt with in due course.

"There is certainly a lot happening at once."

Question: But clearly, you are bringing in the F-35 with the mindset that it is not simply replacing the Hornet?

Air Commodore Kitcher: "I absolutely agree we are not just replacing the classic Hornet with another fighter.

"And we are looking from the ground up at complementary F-35 capabilities to maximize the F-35 effect across the joint space, such as the missiles we wish to see onboard our F-35.

"For example, we are looking at the Kongsberg JSM, we think that presents a logical option to consider far more seriously for our JSF maritime strike capability, and we're looking at that right now, as was announced at the 2015 Avalon Air Show.

Our requirement for a quality maritime strike missile internally carried on the F35 might also be ahead timewise of what the US and other coalition partners might have. It might also be ahead of what the US has programmed. We're certainly working on the F-35 MARSTK capability and are also developing options, with Australian Industry, that might lead to a dual mode seeker in the JSM.

"But it is clear that just like in the case of Wedgetail and KC-30A, we want to put the F-35 into the hands of the warfighters as rapidly as possible.

"They will make it work.

"I know that despite all our best efforts and intent, we won't be able to plan the F-35 introduction perfectly from Canberra. We are doing our best job to make sure we deliver the capability to the men and women in the field, as efficiently and positively as possible.

Second Line of Defense

"When we throw the F-35 at them, they're going to do all sorts of stuff with it that we will not have even thought of.

"I look forward to letting our smart young man and women, who have grown up in a different environment to those of us here in Canberra, get their hands on the F-35 and do some amazing things with it. I'm also quite looking forward to getting back out there myself, and see this first hand.

"Our job is to set up the program and set in motion the framework for that kind of tactical innovation to happen, to position them for success.

"We should not get in their way with excessive top down guidance and legacy thinking."

A Plan Jericho Perspective on Working the Integration Challenges

During my visit to Australia last Spring, I discussed the evolution of Plan Jericho with the do-leads of Plan Jericho, Group Captains Campbell and Mitchell.

I had a chance at the end of the Williams Foundation seminar and the following week AFTER the Jericho Dawn exercise to talk with them about the exercise and its place and significance within the Plan Jericho effort.

The exercise involved changing how the air and ground communicated with one another in the maneuver space. As such, the exercise could seem to be a look at new technologies to connect the force.

But this would miss the real point of the effort, which is the reshaping the concept of operations and the co-evolution of the ground and air forces.

And the reshaping effort requires an ongoing operational training regime to understand what further changes are required to ensure that the air-ground maneuver forces work in an effective manner.

It is about technological enablement, but changing the culture and approach of the forces as they work the new technology into new approaches.

<http://www.sldinfo.com/an-update-on-plan-jericho-from-the-perspective-of-jericho-dawn-a-discussion-with-group-captains-campbell-and-mitchell/>

The focus of that interview was upon the challenges of working through C2 innovation to get better force structure operational capabilities.

During my most recent visit, I had a chance to sit down at Russell with the new co-lead, Group Captain Carl Newman and Group Captain Mitchell.

In various articles which we have recently published on *Second Line of Defense*, we have highlighted barriers to getting the kind of 21st century combat force we need to deal with the threats which come at us in high intensity warfare.

Not only have we launched a Forum to deal with the challenge of shifting from slo mo to high intensity warfare, but we have been highlighting in some of our recent interviews some of those challenges.

One of those is clearly the fragmented and cumbersome security system which places layers of players in place and ensures that we will not achieve the kind of C2 in a dynamic threat environment which our forces will need.

For example, during our recent visit to the Naval Air Warfare Development Center at Fallon, we discussed with many of the participants the security challenge and the critical necessity to shape a new approach.



Figure 13 Director Plan Jericho, Group Captain Pete Mitchell (right) briefs personnel attending the Senior Airman Conference held at the Air Warfare Centre, RAAF Base Williamstown, August 2017. Credit: Australian Department of Defence

We concluded during that visit the following with regard to this challenge:

One of the critical advances in the coming together of many 21st Century technological advances is the exponential growth in ISR (Intelligence, Surveillance and Reconnaissance) is a critical component of a countries military battle planning and execution, and that can be a very good thing.

However, what we picked up at Fallon builds on some of the comments we heard in our visit to the Navy Jax, P-8, Triton community.

To put it in our words the “mechanics” of getting actionable timely intelligence to the aircrews and Fleet commanders is often a weak link. The “Intel” can be there but the process is often not helpful. It can be both a macro issue and a micro issue.

On a “macro” level there is a move to send “Intel” up first to higher command then back down. This challenge was discussed at Jax Navy in the context of declaring Triton ocean surveillance information part of a national strategic collection effort. Of course it is an easy solution to let the Intel flow both up and down concurrently.

Hopefully this is in work toward a successful resolution.

<http://www.sldinfo.com/air-wing-fallon-the-challenges-facing-predeployment-training-for-the-carrier-air-wing/>

The conversation with the Plan Jericho co-leads started with this security challenge.

“One of our challenges is the security and policy framework needed to engage at the appropriate level with our Joint colleagues in shaping a transformation approach.

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"Plan Jericho is addressing some of these challenges and sees as a key way ahead getting much greater integration between the air, land and naval forces.

"But this will not happen if we cannot reshape our security processes and approaches.

"We need to cross-pollinate across the various elements of the force structure to get the kind of operational integration which we need."

"We need to shape the kind of cross platform Training, Tactics and Procedures (TTPs) which allow for and can accelerate integration.

"We have done that on a case by case basis but have not figured how to do that across the board or at the strategic level."

"We are talking about the joint space, where we have influence but not ownership.

"We need to consider revolutionary innovation concepts, not the biological build approach which we are pursuing.

"The RAAF could pursue revolutionary concepts but if everyone else is pursuing evolution we will have significant gaps in our approach to achieve the kind of operational integration which we will need."

Laird: At the end of the day, we're talking here about changing authorities.

We're recognizing the technologies can talk to each other, for example Wedgetail with Naval radars,

This needs to happen so that the ability of the machines to talk with one another, can unleash the man-machine relationships which we will need for high intensity conflict.

We talk about man to machine, but it's machine to machine that we're unleashing as well.

Then we're changing what the man does with the machine to machine conversation.

We can make this sound harder than it is, but at the end of the day, you start with things Wedgetail or Growler talking with your new naval radars and you are going down the transformation path.

The Plan Jericho Team: Absolutely.

We can see that.



FIGURE 14 DIRECTORS PLAN JERICHO, GROUP CAPTAIN PETE MITCHELL (LEFT) AND GROUP CAPTAIN CARL NEWMAN, BRIEF PERSONNEL ATTENDING THE SENIOR AIRMAN CONFERENCE AT RAAF BASE WILLIAMTOWN. AUGUST 2017. CREDIT: AUSTRALIAN DEPARTMENT OF DEFENCE

One of the barriers that we see at the moment is the security and policy framework that actually prevents that from happening.

We see progress along these lines within Air Force, but we need ensure we can work with the Navy and Army as well to establish a joint framework.

Laird: It seems that the E7 is really a forcing function aircraft for you in this overall effort to rework TTPs to get more joint integration.

Recently, for example, the F-22s in Australia worked closely with Wedgetail to expand their capabilities to work together.

There are examples that have already been demonstrated and it seems this aircraft and its evolution is especially useful in the kind of approach which you are taking with Plan Jericho.

The Plan Jericho Team: That is a good point.

The E7 has significant potential and we need to ensure we establish a roadmap and growth path that meets the joint force needs and then leverage that growth path as a key driver for much of Air Force's airborne integration efforts.

Laird: So in effect, you need to have a fifth generation security system to go along with the platforms shaping a fifth generation air force, and in this case the Australian owned Wedgetail is a key enabler and forcing function system.

In this case, it is far more than simply a platform.

The Plan Jericho Team: What we're actually looking at within Jericho next is defining and distilling what the key themes, concepts, and characteristics and risks are to shaping a fifth-generation force.

"What are the defining characteristics?"

"If we can define those, then we have the opportunity to actually have a revolutionary look at security, logistics, integrated tactics and even what a 5th Gen workforce needs to look like.

"At the recent Williams Foundation Seminar on Electronic Warfare, Group Captain Glen Braz hammered home the point that we need to view Growler as part of the joint force, not as supporting the joint force.
Second Line of Defense

"And making that the reality is the challenge.

"And part of what we need to address is leveraging the forcing function of such efforts as Growler integration to reshape the security piece.

"We see the Air Warfare Centre as an important piece of working the key problems of joint TTPs beyond the single platform.

"We're not just building on what we've currently done.

"We're actually looking at developing tactics in a more integrated manner.

"And this approach is something we are looking to permeate through our force.

"For example, the Growlers are collocated with our Super Hornets.

"We need to see how to integrate these assets.

"The Growler is a very different payload asset; the Super Hornet community can not simply operate in a legacy manner as a kill chain.

"We need to shape a kill web and clearly Super Hornet and Growler integration is part of the equation.

"And we are not simply inheriting approaches born elsewhere outside of Australia in this domain.

"And a major piece of the effort is about training the right kind of workforce.

"We need to shape a workforce very open to the kind of integration we are talking about here and indeed demanding further progress as part of the professional lives."

Building in Integration: Reshaping Training and Encompassing Development

The Australian Defence Force has set a tough bar for itself – shaping an integrated force and crafting an ability to design such a force.

This is a tough bar but one which they are trying to energize in part by leveraging their new platforms to shape a way ahead beyond the classic after-market integration strategy.

But how best to do this with regard to training and development of the force?

And how to maximize the combat effectiveness to be achieved rather than simply connecting platforms without a significant combat effect?

When we visited Fallon this year, we were impressed that the training command is adding new buildings which are designed to shape greater capability to get the various platform training efforts much better connected.

Fallon is known as the Carrier in the Desert; but as the carrier and its role within the fleet evolve and encompass distributed lethality and the kill web, so must the Carrier in the Desert evolve.

It starts with the addition of two new buildings, which embrace the shift.

One building is to house the integrated air enabled force; the second houses the simulators that drive the process of their integration.

The first building, building P420, will house the integrated training effort.

"The entire building is a SCIF (Sensitized Compartmented Information Facility) at 55,000 square feet.

"We will have offices in there.

'We will have auditoriums.

'We will have classrooms.

'We will have mission-planning rooms.

'And the building will also house the spaces from which we monitor and control missions on the Fallon Range.

"We will be able to do all of our operations at the appropriate classification level for the entire air wing."

The additional new building will house the simulators.

"Building P440, which is 25,000 square feet, will host initially the simulator devices for the integrated training facility.

"These include F-35, E-2D, Super Hornet, Growler, and Aegis."

<http://www.sldinfo.com/the-way-ahead-for-nawdc-naval-aviation-and-working-the-kill-web/>

We were also interested in the clear desire to shape Training, Tactics, and Procedures (TTPs) cross platforms where possible.

The F-35 coming to the carrier deck also has key radar capabilities, notably built by the same company, Northrop Grumman, and working integration will provide a key opportunity to enhance the capabilities of the CAG in supporting fleet operations.

Clearly, tools like Live Virtual Constructive training will become increasingly more important in training for the extended battlespace and there is a clear need to work integration with live assets today with US and Allied forces in order to lay down a solid foundation for something like LVC.

The team emphasized the need to have the advanced assets at NAWDC to allow for the kind of integrated training, which is clearly necessary.

They would like to see E-2Ds and F-35Cs physically at NAWDC to allow for the kind of hands on experience, which can build, integrated cross platform training essential for the development of the skill sets for dominance in the 21st century battlespace...

Hence, a different pattern is emerging whereby training is as much about combat development TTPs as it is about single platform proficiency.

"The problem is right now, we don't have aircraft here to fully develop cross platform integration, because we don't have enough time spent together to figure out the optimal direction to drive that kind of integration."

<http://www.sldinfo.com/expanding-the-reach-of-the-battlefleet-the-evolving-role-of-the-advanced-hawkeye/>

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But what is missing is a capability to connect training, notably cross platform training with software code rewriting of the sort, which the new software upgradeable platforms like F-35 clearly can allow.

Indeed, we added to the above article the following:

One could also add, that the need to build ground floor relationships between code writers and operators needs to include the TTP writers as well.

During my visit to Canberra, I had a chance to discuss with Air Vice-Marshal (Retired) John Blackburn how the training approach could be expanded to encompass and guide development.

“We know that we need to have an integrated force, because of the complexity of the threat environment will face in the future. The legacy approach is to buy bespoke pieces of equipment, and then use defined data links to connect them and to get as much integration as we can AFTER we have bought the separate pieces of equipment. This is after-market integration, and can take us only so far.”

“This will not give us the level of capability that we need against the complex threat environment we will face. How do we design and build in integration? This is a real challenge, for no one has done so to date?”

Laird: And the integration you are talking about is not just within the ADF but also with core allies, notably the United States forces. And we could emphasize that integration is necessary given the need to design a force that can go up an adversary’s military choke points, disrupt them, have the ability to understand the impact and continue on the attack. This requires an ability to put force packages up against a threat, prosecute, learn and continue to put the pressure on.

Put bluntly, this is pushing SA to the point of attack, combat learning within the operation at the critical nodes of attack and defense and rapidly reorganizing to keep up the speed and lethality of attack.

To achieve such goals, clearly requires force package integration and strategic direction across the combat force.

How best to move down this path?

Blackburn: We have to think more imaginatively when we design our force.

A key way to do this is to move from a headquarters set requirements process by platform, to driving development by demonstration.

How do you get the operators to drive the integration developmental piece?

The operational experience of the Wedgetail crews with F-22 pilots has highlighted ways the two platforms might evolve to deliver significantly greater joint effect. But we need to build from their reworking of TTPs to shape development requirements so to speak. We need to develop to an operational outcome; not stay in the world of slow motion requirements development platform by platform.

Laird: Our visit to Fallon highlighted the crucial need to link joint TTP development with training and hopefully beyond that to inform the joint integration piece.

How best to do that from your point of view?

Blackburn: Defence is procuring a Live/Virtual/Constructive (LVC) training capability. But the approach is reported to be narrowly focused on training. We need to expand the aperture and include development and demonstration within the LVC world.

We could use LVC to have the engineers and operators who are building the next generation of systems in a series of laboratories, participate in real-world exercises. Let's bring the developmental systems along, and plug it into the real-world exercise, but without interfering with it.

With engagement by developers in a distributed laboratory model through LVC, we could be exploring and testing ideas for a project, during development. We would not have to wait until a capability has reached an 'initial' or 'full operating' capability level; we could learn a lot along the development by such an approach that involves the operators in the field.

The target event would be a major classified exercise. We could be testing integration in the real-world exercise and concurrently in the labs that are developing the next generation of "integrated" systems. That, to my mind, is an integrated way of using LVC to help demonstrate, and develop the integrated force. We could accelerate development coming into the operational force and eliminating the classic requirements setting approach. We need to set aside some aspects of the traditional acquisition approach in favor of an integrated development approach, which would accelerate the realisation of integrated capabilities in the operational force.

CONCLUSION: SHAPING A WAY AHEAD WITH ELECTRONIC WARFARE CAPABILITIES

With the introduction of the Growler, this has provided a natural hook into the broader discussion of the evolving payloads, which need to be part of an integrated 21st century combat force.

A number of presentations provided a look at the technology and con-ops of evolving EW capabilities.

These presentations provided the perspectives from industry and from Australian services and the joint perspective.

And a broad brush look at the technologies was provided by an American presenter as well.

What was clear was that this is becoming a vital area for R and D as well as integration into the evolving force structure.



FIGURE 15 JOHN CONWAY

The presentation by MAGGEN Kahryn Toohey, head of Australian Army Development, underscored the importance of re-energizing the work of the ground forces in the evolving combat environment.

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It is clear that the Aussie Army, like the US Marine Corps sees the importance of making EW effects available throughout the ground maneuver force. The question is how best to achieve this result.

And the presentation by Captain Steve Dryden, from the Royal Australian Navy, also emphasized the increased salience of focus and concern for the Navy with regard to information warfare issues.

Although he did not discuss this aspect, a key element shaping the way ahead for Navy contributions will clearly be radar technologies and their ability to communicate across the fleet and the ADF and to provide for a multi-mission information warfare functionality.

This will be enhanced as the new radars coming on line from CEA enter the fleet; and as the RAAF and the RAN work integration between Wedgetail and Air Warfare Destroyer among other dynamic innovations going forward.

The Army and the Navy have had specialized capabilities throughout their history, but the need now was to shape an integrated capability or as Lt. General (Retired) Davis put it a server available to the warfighter to pull down EW capabilities as appropriate to the fight.

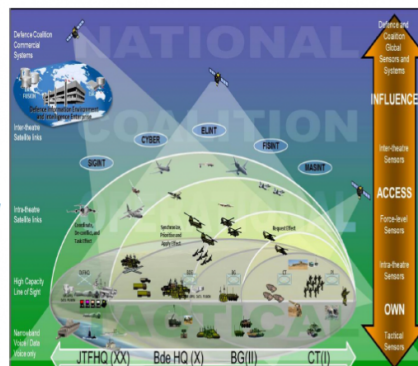
The Department of Defence has formed a new department, the Information Warfare Division within the Joint Capabilities Group, which is standing up capabilities to shape interactive IW tools and approaches.

Brigadier Stephen Beaumont, Director General Information Warfare, Joint Capabilities Group, argued for the importance of shaping an enterprise wide EW system approach.

His perspective was encapsulated in the following slide:

Force Level Electronic Warfare (EW)

1. An enterprise EW system
 - effectors
 - collectors
 - support systems , the EW backbone
2. An increasingly diverse mix:
 - dedicated EW platforms
 - multi-role platforms with EW capabilities
 - Platforms with EWSP
3. Challenges:
 - moving and processing data
 - analytics, tools and visualisations

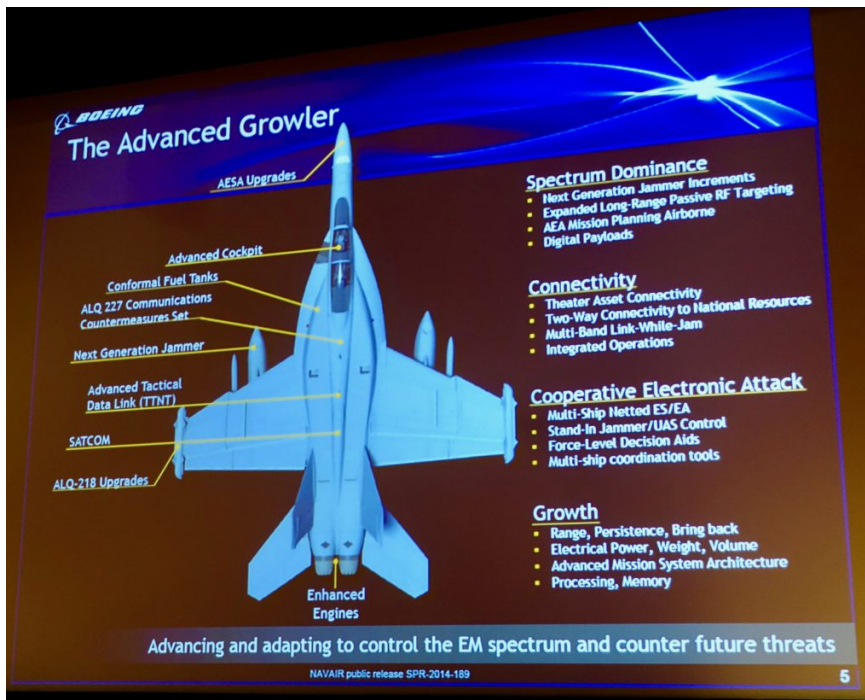


Indeed, one could view the importance of such an office to be a clearinghouse to inform the various players operating within government and the services of the activities of each other, as well as the technology capabilities available to them through the work of their compatriots operating throughout the ADF and government or among partners and allies.

This is such a dynamic and fluid area of development and operation that it is clear that open-ended learning is a core requirement for mission success.

The presentation by the Boeing representative focused on upgrades to Growler, which are necessary certainly to keep pace with the threats.

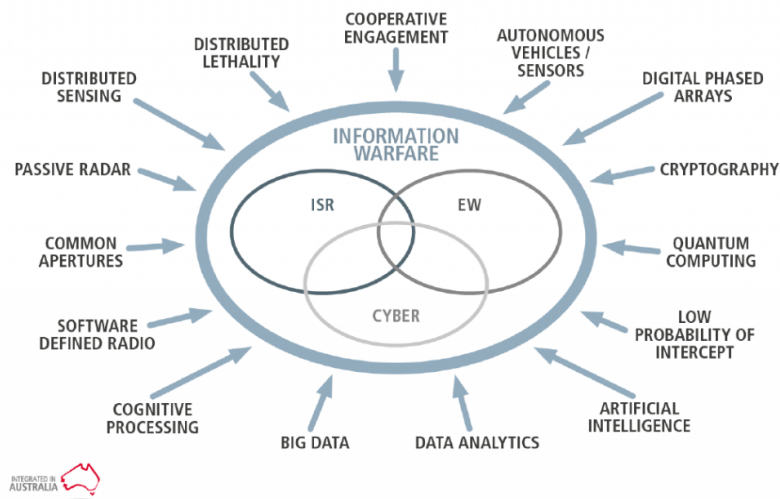
A key addition will be next generation jammer, which is designed to enhance the ability to handle multiple targets at once and to be supportive of the evolving air combat force.



The presentation by Raytheon, the company building the next generation jammer, focused upon the need to shape a broader information warfare enterprise encompassing ISR, cyber and EW.

To put into the words of the work we have shaped on Second Line of Defense, an enterprise that could support Tron Warfare.

Evolution of EW



Finally, Jeffery McCreary from the Georgia Technology Research Institute provided a broad ranging overview on the evolution of technologies and how that would affect the EW domain, indeed transform it.

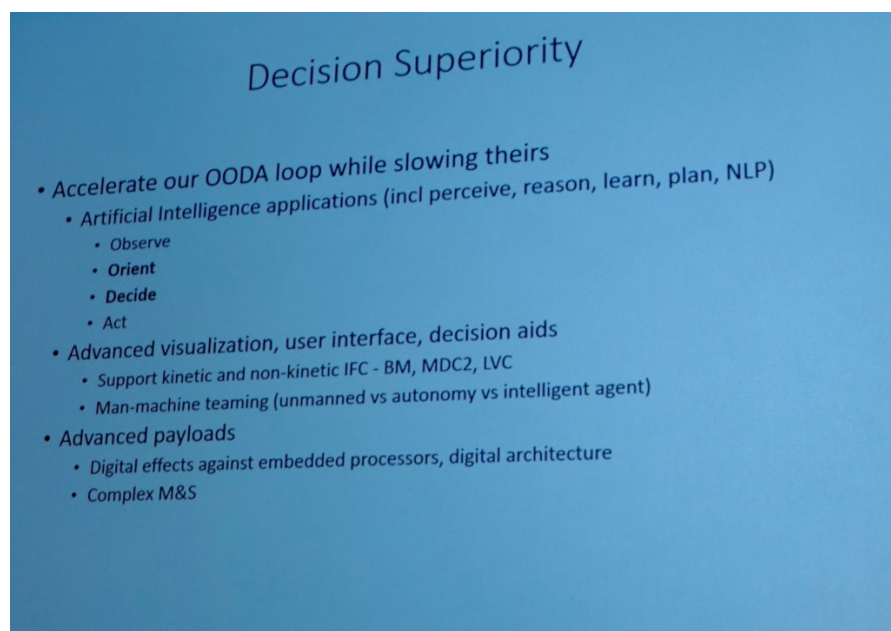
He focused on the importance of EW within the C2 or decision-making cycle, and the importance of disrupting the adversaries decision making cycle.

In order to do this, the force will need to rely more on artificial intelligence machine based contributions to enhance the blue side and disrupt the red side within the force equation.

And to do this, improvements needed to be made in terms of how warriors can act upon information, through new visual display technologies and other key ways to enhance the ability to gain strategic control over the flow of tactical information.

Within the evolving force structure, unmanned elements will be able to play a greater role within the man-machine interface to gain the upper hand in the electro magnetic spectrum.

The core objective is clearly decision-making superiority.



The goal is to accelerate blue side's OODA loop while slowing red sides OODA loop.

The seminar organizer, John Conway, highlighted during the seminar and in talks after the seminar, the centrality of building EW into the operational art for the evolving combat force.

It is about reshaping the payloads, which can be delivered by the integrated force across the spectrum of warfare.

The introduction of the Growler is an important jump-start to Australian capabilities, but it comes into the force as the Aussies are working force integration hard.

In short, the seminar provided a case study of shaping a way ahead for broadening the capability, which the evolving 21st century combat force, can deliver.

The Way Ahead for the RAAF in the Integrated Defense Force: The Perspective of Air Marshal Leo Davies

The RAAF is certainly leading the pack in shaping and crafting a fifth generation air force.

In my most recent interview with the Air Commander Australia the strategic shift was described very clearly.

Question: You have raised the question of the shift in recruitment and training with regard to your pilots.

How would you regard the shift on the demand side for the pilot?

Air Vice-Marshal Robertson: You go from having to manage a package to being a node, a sensor, and a shooter in a network.

We are no longer operating as little bespoke package and building block of a force.

If you're doing this properly to prepare for a fifth-generation fight, you start them in the middle of the web, and our warfighters understand what they can contribute and where they can draw upon to be a sensor and a shooter in that web.

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And that's not just airpower, that's across the entire joint space.

This requires us to fundamentally change our exercise approach to train aviators in the kill web. It is a fundamental in dealing with the kinds of adversaries we find in the real world.

We cannot take yesterday's "block and tackle" combat aircraft approach to train to be the kind of distributed mission commanders we need in the future air combat force.

We need to focus on the sensor-shooter relationship in which we can deliver distributed kinetic and non-kinetic effects.

And this comes from within the kill web.

Put another way, you are training for autonomy in all of the weapon shooter nodes and crafting the overall impact accordingly.

Our decisive advantage is going to be in our ability to operate in high-tempo ops, fully networked.

That's what will make it a completely unfair fight.

It's not going to be about mass and numbers; that will always have a part to play.

But our decisive advantage has to be our ability to just run our kill web at high speed.

We have parts of our organization that are now thinking at the tactical and operational level in fifth-generation sense, but we are yet to exercise the enabling and support function in that same mindset.

That's a challenge for us.

<http://www.sldinfo.com/the-way-ahead-for-the-raaf-in-an-integrated-defense-force-the-perspective-of-the-new-air-commander-australia-air-vice-marshal-zed-roberton/>

With a major reshaping effort under way as described by Air Commander Australia, how does the Chief of the RAAF see then the role of the RAAF?

"Our core business is to ensure that we can be a responsible element of whatever coalition the government determines we need to work with to meet Australian interests

"Australia and the Air Force in particular need to be equipped, trained and agile enough to be effective.

"Our core business is to focus on day-to-day management of sovereign Australia territory and interests.

"And that can vary from our contribution to the monitoring of fisheries, or of dealing with people smuggling, or of being aware of what's in the sky above us, and what might be in the sky above us in years to come, is our everyday evolution of a defense force.

"We can do that better if we understand our neighborhood as well as we understand our own country.

"We have consciously begun to shape a trained workforce and a strategy which prioritizes our international engagement and our relationship with our neighbors,

"We've had strong military-to-military relationships with our neighbors for many decades. And we look to strengthen and improve our effect in this domain."

Question: You are being a more integrated force, but this template, which you are shaping, could then form a solid foundation for the kinds of innovation, which your government might see as important in the years ahead.

What kinds of innovations do you see in the mid term from this perspective?

Air Marshal Davies: Clearly, situational awareness of the air and space domain is critical, but so is an ability to affect an adversary; potentially at long range as part of an integrated package.

"What form this will take is a work in progress and will reflect judgments about need in the period ahead within a coalition context.

"If we shape a force that can only do parts of the warfighting continuum we will have failed.

"That is why in our exercises with partners such as in Talisman Saber 2017 we are working the spectrum of conflict both to shape capability, but to lay a solid foundation for thinking about future operational needs."

Question: As we go forward, it is important to think through the military force we are building up against the objectives, which Australia and its allies can establish within the region and beyond.

You are building a very flexible and in that overused term, agile force, but these tools need to be matched up against objectives.

Clearly, as you have said, protection of Australian territory is crucial but beyond that what approach do we need?

Air Marshal Davies: As you suggest, military capability is a necessary but not sufficient condition for success.

"It is crucial that we sort out objectives among ourselves in the region and beyond,

"What are the most crucial challenges to be met?

"How and where do our approaches overlap and where do they differ?

"And we need to remain aware that the military responses are only one of those options that each respective government has.

"We need to be credible

"And building of credible military options, should they be needed, requires coordination with our allies."

Question: How do you view the fundamentals of the Australian approach going forward?

Air Marshal Davies: A key element is simply our unique geography and the nature of our neighborhood. We have a unique geography, which provides protection as well as challenges within our region.

"As I mentioned earlier, this means shaping robust and clear relationships with our closest neighbors.

"It means working with allies like the US and Japan to shape very flexible military options to adapt to changes in the region.

"Space is becoming increasingly important.

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"We have used space largely as a communications domain, but as adversaries adopt new approaches, we need to reconsider how we do business as well.

"And we are adding Tritons and F-35s, which means we can reshape our networks, and access to space will be needed to enable configurable and redundant networks.

"Antarctica will become increasingly important in the period ahead. It is the world's back door and states will look to use transit over the pole to shorten operating distances to areas of interest.

"We want to make sure that we are able to properly defend our ability to maintain Antarctica as a neutral environment."

Question: Integrated air and missile defense is clearly an important coming capability for Australia.

How best to approach that challenge?

Air Marshal Davies: We have a project, Air 6500, which is designed to get to this capability, and we have tactical pieces relevant to such an effort.

"But we are certainly not there.

"We should be starting with, "How are we going to coordinate air warfare destroyers, space-based communications, F-35, future frigates, Triton and P-8 into an integrated operating picture?

"How do we coordinate all of the command and control, including the civilian air traffic control sensors?

"How do you get them onto the same sheet of music?

"How do you begin to get all the different parts of the national orchestra to play a tune we have not finished writing yet?

"We are working to shape intellectual warriors who allow us to use those disparate elements, and pull them together.

"And without that web, without that integrated air and missile defense, within which we have to plug our allies, or at least make it pluggable, we'll have fallen short.

"That is one of the next big steps for us."

APPENDIX: THE F-35 AND TRON WARFARE

2014-11-23 By Ed Timperlake

21st century warfare technologies concepts of operations and tactics and training are in evolution and revolution.

At the heart of reshaping US and allied approaches to airpower and its evolution is the emergence of the F-35, the significant impact which a global fleet of F-35s will have on US and allied capabilities and the approaches to leveraging other capabilities in the warfighting tool kit.

There is always the reactive enemy, so that the roll out of new approaches shaped by the impact of the F-35 will see reactions from various competitors and responding to these reactions will part of the re-set of evolving US and allied airpower and combat approaches.

The F-35 is at the heart of change for a very simple reason – it is a revolutionary platform, and when considered in terms of its fleet impact even more so. The F-35, Lightning II, has a revolutionary sensor fusion cockpit that makes it effective in AA, AG and EW.

US and Allied Combat pilots will evolve and share new tactics and training, and over time this will drive changes that leaders must make for effective command and control to fight future battles.

An issue has been that the F-35 has been labeled a “fifth generation” aircraft, a sensible demarcation when the F-22 was being introduced.

But the evolution of the combat systems on the aircraft, the role of the fusion engine, and the impact of a fleet of integrated F-35s operating as a foundational element will make this term obsolete.

The global fleet of F-35s will be the foundation for a fundamental change in the way air power operates and with it overall combats concepts of operations for the US and allied insertion forces.

It is not an in and of itself platform; it is about what an integrated fleet of F-35s can deliver to TRANSFORM operations.

The decade ahead can be very innovative if what the fleet brings to the fight is learned and applied and the combat warriors leverage what they learn and then the application of those lessons to reshaping the force are applied.

As a senior RAF pilot involved with the F-35 program has put it well: “While much of the world still debates the existence of the F-35, we are moving rapidly forward to figure out how to use the aircraft and leverage it.”

At the heart of the transformation is the combination of two powerful trends: the emergence of Tron warfare and the forging of a combat cloud integrating combat capabilities.

The F-35 fleet operates at the cutting edge of both.

The Emergence of Tron Warfare

The F-35 is known as a 5th generation state-of-the-art combat aircraft with stealth for survivability.

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The F-35 Lightning II is often discussed in a performance trend clustering over time with the F-22 Raptor, the Russian Sukhoi PAK FA T 50, and various emerging PLAAF aircraft such as Chengdu J-20 and the just announced J-31.

A 5th Gen well designed stealthy aircraft can operate very effectively in both a Fighter (AA) and Attack (AG) role until it can't.

Yet reducing the F-35 to stealth essentially misses the point of the impact of an F-35 global fleet on reshaping US and allied combat operations.

I highlighted what I think is the key shift in an interview with Wendell Minnick of Defense News in a discussion of the emergence of the J-31:

The physical resemblance between the J-31 and the F-35 — despite the difference in relative size — indicates an effort by China to reproduce the F-35s stealthy external design, Timperlake said.

“If it is a success in being physically stealthy and they build a lot it could be a problem” for our allies in the region, he said.

However, stealth is simply a survivability feature and analysts must learn more about the internal systems. The real combat engagement operational and tactical question is the F-35 fusion cockpit and whether the Chinese actually have anything close to it, Timperlake said.

“Fusion will make all the difference in looking at the J-31 as a real competitor or just a linear generational development aircraft with perhaps enhanced survivability that will still need a hub spoke battle management [concept of operations] — [airborne warning and control system] or [ground-controlled interception] being essential for them,” he said.

The US and Allied fleet of F-35s will also add an “electronic” or “tron” warfare component to the fight, an “E” for electronic. It is not necessary to designate the F-35 as the F/A/E-35 but that would be more accurate. Adding the “E” is both an active and passive capability and will changing the entire design dynamic of combat aviation.

Electronic Warfare (EW) was designed inherently into the F-35 airframe and Fusion Cockpit. The revolutionary design of a Fusion Cockpit will as time goes by give the air battle commanders of the US and allies an emerging new strategic command and control way to fight and win.

EW is a complex subject with many discreet but also connected elements. Over time all things electronic in the military took on many dimensions. Electronic Counter-measures (ECM) begat Electronic Counter-Counter (ECCM) measures, Command and Control (C&C) has grown to C5ISR. Information war in certain applications created a multi-billion dollar domain called “cyber.”

Additionally there has to always be considerations of Electro Magnetic Pulse concerns (EMP) and the counter measures of ‘hardening’ of electronic components. There are a lot of other EW issues in “tron war,” such as Infer-Red Sensing (IR) and always protecting “signals in space” information being transmitted and trying to jam the bad guys “signals in space.”

Tactically, it has been said on the modern battlefield — air, sea or land — if not done correctly, “you emit and you die.”

EW can include offensive operations to identify an opponent’s emissions in order to and fry spoof or jam their systems.

In successful “tron” war, often-kinetic kill weapons can be fired. The kinetic kill shot is usually a high-speed missile designed to HOJ (home on jam). There is also the ability to emit electronic “kill” or spoofing signals i.e. to emit miss signals to an enemy’s incoming weapon sensors.

But what is necessary to succeed in evolving capabilities to fight in the age of “Tron” Warfare?

In taking a lesson from history, pre-WWII AA&T long lines research found that in order to build and keep operational a U.S. phone system, the AT&T visionaries found that the key to success was the need for “robust and redundant” systems.

That lesson of always focusing on robust and redundant systems in combat is extremely critical in the electrical element or “tron” component of the modern way of war.

Over two human Generations from WW II the F-35, was designed as being both inherently robust and redundant with many sensors and systems built into the airframe structure from the initial airframe stealth design forward. All F-35 systems designed and developed sent “trons” into the aircraft cockpit “Fusion Engine.”

Trusted fusion information generated by inherent aircraft systems queued up electronically by threat will send to the cockpit displays, and the pilot’s helmet, battle ready instantaneous Situational Awareness.

A combat certainty is that “electronic warfare” or as referred to in this Special Report as “tron” warfare will grow in importance and will evolve as a critical component of future combat engagements.

As very briefly described above the issue of all things “EW” or “tron” war is extremely complex because electrical components engage in empowering a nation’s ability to fight and win and covers so many facets of combat.

Because of the growing role of shared situational awareness and shaping of what some are calling the combat cloud, tron warfare is part and parcel of the transition in air warfare. Tron warfare is about protecting you ability to operate in shared communication space and to deny your adversary the ability to do so.

As Secretary Wynne has noted: “Whether we call it the combat cloud or the ability to share targets and situation awareness; the bulk of our and allied air fleets will be fourth gen for a long time. Getting max use from this mixed fleet will be the Hallmark of the next few decades. ‘Tron’ warfare should therefore be a prelude to Maximizing Probability of Kill; while minimizing the probability of being killed.”

To put it another way, the F-35 fleet allows the air services to shape a new foundation for engaging in Tron Warfare, but because “no platform” fights alone, it is a foundation from which other elements of the airpower and combat capabilities picture are woven in for 21st century operations.

One additional notation in this research is that there is an emerging focus on the concept of “Combat Cloud” computing for military operations. It is a debate going in many different directions much like in US “Information War” as initially proposed in “The Revolution of Military Affairs.”

Information War (IW) proposed as part of RMA eventually migrated especially in US forces to a very significant focus on “cyber” or computer empowered systems. The word “cyber” is now covering a multitude of capabilities issues and technological progress.

So perhaps a good place to start to understand the newest item of analysis “cloud computing” could begin by studying both the F-35 individual cockpit inward and the ability of each aircraft to be connect to a network of additional F-35s and other weapon systems.

The “E” in F-35 will eventually change strategic battle management Command & Control (C&C), especially using the military concept of no platform fights alone.....

Just like Wade McClusky seeing a Japanese wake as to the position of the targeted Carriers, often signals-in-space have the ability to give away positions, the F-35 may have a battle winning way to avoid giving away its position, along with its basing location, because of both stealth and the very long reach of its passive sensing.

Just like the F-111 El-Dorado Canyon strike an “emcon” strike, stealth enabled, can come as a complete surprise.....

If the F-35 did not exist it would either have to be invented or many different technologies would have to be aggregated to even try and achieve what the aircraft can do—and that effort would have exploitable seams, and an increased C&C demand with an increased vulnerability to enemy “tron” counter measures.

Going active F-35 can engage in combat as USAF Secretary Mike Wynne says empowering another revolutionary capability—a “sensor/shooter” dynamic engaged with legacy systems. Dynamically using fifth generation aircraft as target location systems may not be seen as satisfying to the traditionally trained pilots, but it can serve a vital role for forward observers in concealed locations.

The F-35 is not in direct competitions with Growler, E-2 and AWACS it will just drive combat innovation especially using its EW capability on the emerging Virtual/Constructive Fallon range—technology, training and tactics will come together in perfect harmony to allow Squadron Pilots and Commanders the environment to innovate dynamically and to “train, train, train.”

The use of Growler Electronic strike as part of an air wing strike package along with AWACS, E-2s and surface ship enhanced C&C can empower F-35C s in its non-stealth mode. The design factor of ever increasing F-35 airframe payload utility/accuracy can be embraced by taking advantage of the tremendous weapon load carried on F-35 hard points and utilizing the F-35 “fusion” cockpit to identify with precision accuracy hitting all types of ground targets.

The “E” capability of F-35 can augment the Growler “tron” warfare capability.

However, if the tactical situation requires it, the F-35 can attack in stealth/passive mode or after the beginning of air superiority with successful SEAD the F-35 can attack with slung wall-to-wall ordinance relying its “tron” or electronic counter-measure capability.

The ability of the Strike Commander to mix and match his con-ops in battle has increased immeasurably. And clearly flying with the F-22 will enhance this overall capability as well.

Just like the example of the Israeli Air Force flying F-4s and attending “Top Gun” the F-35 will allow tactical innovations to take place in many Allied fighting forces and the training and sharing will make all countries combat forces better.

Editor’s Note: For the complete Special Report on Tron Warfare, see the following:

<http://www.sldinfo.com/wp-content/uploads/2014/11/21st-Century-Approach-to-Tron-Warfare.pdf>