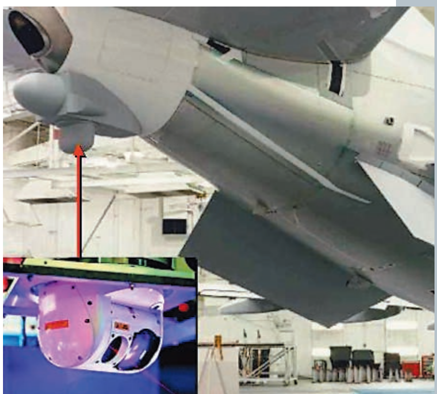
Airborne outpost onboard 'Wedgetail'

Dr Carlo Kopp



'Wedgetail' includes the most comprehensive defensive suite on any AEW&C aircraft, including Directed IR Countermeasures, laser warning and expendables (RAAF).

With nearly sixty years of global experience operating Airborne Early Warning & Control (AEW&C) platforms, the operational technique for using this vital capability is truly mature. The newest addition to RAAF force structure, the Boeing/Northrop-Grumman 'Wedgetail' AEW&C aircraft, is expected to become operational later this decade.

'Wedgetail' is without doubt strategically the most important new capability being acquired for the Australian Air Force. However, the RAAF has never operated any system in this class, and will face a steep learning curve in developing a new operational paradigm for 'Wedgetail'. Additionally, this is the first of a new generation of Western AEW&C aircraft equipped with modern 360-degree azimuthal coverage Active Electronically Steered Array (AESA) radars.

The importance of 'Wedgetail' cannot be overstated, as regional operators move to field a wide range of AEW&C types. India has ordered the Elta/Beriev A-50I with a variant of the Phalcon L-band AESA radar, and is apt to field a second tier system based on the EMB-145. China is flight testing a very similar A-50 derived system. Malaysia and South Korea are shopping for a mid range system, while Taiwan and Japan already operate AEW&C aircraft. By 2010 wealthier regional nations without AEW&C will be the exception rather than the rule.

The broader issues in introducing a new AEW&C capability are manifold. Not only must the aircraft be introduced into service, training systems developed, support infrastructure built, software support systems made to work, but also a doctrinal model must be created covering the strategic, operational and tactical usage of the aircraft. This will include the integration of technique with existing force structure elements such as the fighter and strike assets Air Combat Group. Specific flying technique, airborne offensive and defensive tactics, along with supporting fighter tactics will need to be developed. None of this is trivial by any measure.

Perhaps the best starting point for a discussion of these issues is the US Air Force Doctrine Document AFDD 2-5.2 on Intelligence, Surveillance and Reconnaissance Operations, the upper level guide to how the US employs its fleet of E-3C AWACS aircraft - and other intelligence, surveillance and reconnaissance (ISR) systems. As the biggest and most experienced operator of AEW&C capabilities, the US Air Force sets the global benchmark in this game. US doctrine emphasises a number of key issues.

The first is that the aim of all ISR operations, including AEW&C, is achieving and sustaining information superiority over an opponent. The opponent must always be at a disadvantage in understanding the bigger picture, and the more localised picture, in any area of operations. This is achieved by two means: the first being the gathering and analysis of information, primarily through ISR systems; the second being the offensive use of Electronic Combat systems to disrupt and degrade the opponent's ability to gather and analyse information. In air operations, 'Wedgetail' provides the RAAF with a key component of this ISR architecture.

The process central to any ISR system, including 'Wedgetail', is the 'ISR cycle', a repeated loop in which information is collected, analysed, disseminated and evaluated for use. In an AEW&C system this amounts to continuous surveillance of an area of interest, analysis of the situation, and distribution of the information product to users such as patrolling fighter aircraft or surface air defences.

As a system for executing an ISR cycle, 'Wedgetail' provides a long-range radar, an Electronic Support Measures system for passively detecting hostile radar emitters, an IFF system for tracking friendly aircraft, a JTIDS/Link-16 master terminal for combat identification and distribution of information to friendly assets, and a comprehensive voice communications suite, in addition to an onboard team of operators to manage and execute the cycle.

Considering 'Wedgetail' in the abstract sense (as an ISR system) is important, as it allows us to see the system as a component in a networked force, providing key information gathering, analysis and distribution capabilities, as well as an onsite command capability.

US doctrine identifies three key areas in which AEW&C is employed - air defence, strike control and maritime operations.

In air defence operations AEW&C systems provide early warning of inbound threats, identification between friendly, neutral and hostile aircraft, and command and control of friendly combat aircraft. Air sovereignty operations, in which hostile aircraft are dissuaded from entering defended airspace, are a variation on this theme, more so under circumstances where conflict is impending and intruding aircraft may be seeking openings for an initial attack.

Strike control operations expand on the basic model of air defence operations, by adding the battle management of strike aircraft packages and their escorts, communications relay capability into hostile airspace, and the capability to manage combat search and rescue (CSAR) operations.

Maritime operations amount to over-water execution of air defence and strike control operations, providing surface warships with an ISR umbrella and situational awareness in often complex environments. The ability of an AEW&C aircraft to provide early warning against anti-ship cruise missile firing aircraft, and inbound cruise missiles, is an absolutely critical function in maritime air and missile defence operations.

Since the 1960s US AEW&C aircraft have also provided the critical capability to manage aerial refuelling operations, marshalling tankers and receiver aircraft in time and space.

For Australia, an important role for 'Wedgetail' will be patrolling the northern maritime approaches in support of civil authorities, detecting and tracking aircraft and ships. While we have yet to see terrorists trying to cross the sea-air gap with hijacked aircraft or ships, such scenarios are possible and must be counted as another role for AEW&C aircraft.

In coming years the RAAF will have to develop specific doctrine and technique to cover all of these areas, exploiting US and EU experience and adapting it to unique Australian constraints, and optimise the doctrine to make use of the unique capabilities of 'Wedgetail''s MESA radar.

Air Defence Operations

While AEW&C aircraft can be applied across a broad spectrum of operational environments, a common thread relates to the operational techniques used in basic air defence operations, intended to support the interception of hostile aircraft.

The 'classical' technique for such operations sees the AEW&C aircraft launched and flown on a cruise climb profile to a specific station where the aircraft assumes a racetrack pattern patrol orbit. For a turbofan design like 'Wedgetail' the orbit will be at altitudes typically between 30,000 ft and 40,000 ft, subject to fuel weight and required detection range. Given the curvature of the earth, the higher the orbit, the better the detection and tracking range against low flying targets.

On station endurance is a function of the distance between the patrol station and the airfield from which the AEW&C aircraft operates, and the host airframe design. While aerial refuelling can add considerable endurance, practical limits will be imposed by crew endurance and consumables such as engine lubricants.

On station flying technique with conventional rotating mechanically steered antennas is to fly very lazy or flat turns at the ends of the orbit pattern, to minimise the airframe roll angle and thus minimise impairments to radar coverage while reversing orbit direction.

'Wedgetail''s MESA radar provides best range and angular resolution performance when using the side looking slab arrays, so there will be some degradation in track quality while a target is being viewed over the nose or tail, using the Top hat array antenna. Not unlike conventional AEW&C systems, 'Wedgetail' technique will aim to minimise time spent in turns.

AEW&C operational planning typically orients the racetrack pattern so that the axis of the orbit is normal to the 'threat sector', the range of headings between which a threat is expected to appear. The greater the distance of the orbit from an opponent's airfields, typically the narrower the threat sector; the greater the combat radius of opposing aircraft, the wider the threat sector.

The relationship between the distance between the AEW&C aircraft and the initial threat detection point is critical in terms of what azimuthal coverage the system needs to provide. For instance, submarine-launched cruise missiles dictate full 360-degree coverage continuously as they may appear at any azimuth or distance.

Once an orbit is established, the AEW&C system will 'go active' to support fighter patrols in the area and other assets such as tankers supporting the fighters and AEW&C aircraft. Conventional technique for defensive counter-air operations – where the AEW&C aircraft is used to block incoming strike, reconnaissance or fighter sweep sorties – is to position the fighters in Combat Air Patrol (CAP) orbits between the AEW&C aircraft and the inbound threat. A technique used often by the US is to align the axis of the CAP orbit with the threat, and position a pair of fighters at opposite ends of the orbit, so one fighter nearly always has its radar pointed at the threat axis.

How and where the AEW&C system is positioned is thus critically dependent upon the scenario in question. At one extreme is the high density Cold War Euro-theatre air battle model, replicated over Iraq in 1991, where multiple AEW&C systems are put up to form an unbroken barrier across the FEBA

Aerial refuelling is vital to extending the on-station endurance of AEW&C aircraft. (US Air Force)

(Forward Edge of the Battle Area) with continuous 24/7 coverage. Fighters are then tasked either as ground alert interceptors or airborne CAPs, the latter available to respond immediately to inbound threats. If the incoming raid is visibly a large one, then additional ground alert fighters are launched to provide a second and third echelon of interceptors to engage those threats that got past the airborne CAPs. For any high-density environment of this kind, exhaustion of fighter missile payload is a genuine issue, as fuel expenditure can be offset with adequate tanking capacity.

It has been customary for decades to attach fighters to AEW&C aircraft as High Value Asset Protection CAPs (HVAPCAP). This practice will not vanish as the central importance of the AEW&C platform remains - both as an ISR system and battle management asset.

Geographical depth is always an advantage in air defence operations, an implicit by-product of the geometrical constraints in AEW&C coverage. Where there is enough distance between the airfields hosting opposing aircraft, and good early warning of hostile aircraft launches, then AEW&C aircraft and fighter/tanker packages can be launched reactively. This is the model used by the US Air Force to cover Alaskan approaches during the latter Cold War, where E-3 AWACS, F-15C and KC-135 packages were reactively launched to fend off probes by Soviet long-range bombers, such as Bears, Backfires and Blackjacks.

This model is viable for Australian operations in the deep north where the threat is a combat aircraft with relatively short ranging weapons, as JORN early warning of inbound aircraft can be exploited to trigger the launch of an AEW&C aircraft and fighter/tanker package. The package would then be best positioned to stop the inbound hostiles within the sea-air gap before they can launch their weapons. The game then distils down to a race between the outbound AEW&C/fighter/tanker package and the inbound hostiles to first get to the volume of airspace from which weapons can be launched.

The reactive launch model becomes increasingly ineffective as the range of opposing weapons increases, as it may not be feasible to effect intercepts before the inbound hostiles launch. The proliferation of air-launched cruise missiles presents this environment, as the most likely one Australia will face post 2010.

In an environment where cruise missiles with ranges well in excess of 250 NMI are used, the time penalties associated with reactive launch, climb to altitude and cruise to station can compromise the situation. In such environments the AEW&C/fighter/tanker package must be airborne continuously, although the distance to station can be traded to an extent. It is cheaper and easier to orbit an AEW&C/fighter/tanker package at 200 NMI offshore than at 400 NMI.

Cruise Missile Defence

The biggest single strategic capability issue Australia will face post-2010 is in providing robust defences against cruise missiles, which are rapidly emerging as the weapon of choice in the Asia-Pacific-Indian region. With supersonic and subsonic cruise missiles being developed regionally, licenced or bought from Russia, cruise missiles are readily available and permit regional air forces to launch strikes without having to grapple with more skilled Western fighter pilots in air combat. The German bombardment of Britain with V-1 cruise missiles in 1944 is the case study: where air superiority is expensive to win, then use large numbers of cheap cruise missiles.

Defending against air-launched cruise missiles amounts to a special case of conventional air defence operations, with the caveat that inbound aircraft carrying cruise missiles should always be intercepted before they launch their weapons. It is always easier to intercept an aircraft with a large radar signature than it is to hunt down the multiplicity of cruise missiles launched, each with a small radar signature. In performing system analysis on air intercepts, typically two missiles must be budgeted for each target, to ensure a high kill probability. Killing a dozen cruise missiles requires two dozen air-to-air missiles versus a pair to kill the launch vehicle.

'Wedgetail' system is well suited to cruise missile defence operations since the AESA permits modes in which more rapid scans of specific sectors can be performed, increasing the probability of detecting cruise missile class targets. The high peak power of the MESA is also suited to this regime.

Another factor favouring the RAAF in defending against air-launched cruise missiles is the depth of the sea-air gap, which provides time to repeatedly sweep areas for subsonic cruise missiles. A 450 KTAS speed weapon with 500 NMI max range provides for about an hour to intercept it (numbers of AEW&C aircraft and fighter missile payloads permitting).

Submarine launched cruise missiles are more problematic since they can be launched from positions much closer to the intended target. If a submarine commander is prepared to risk a close approach, then as little as minutes may be available to stop the missile. Where such a risk exists, an AEW&C platform - or any aircraft with a surveillance radar capable of tracking a cruise missile - must be positioned so that the target of the cruise missile attack is under the footprint of the radar.

In perspective, submarine launched cruise missiles are harder to defend against, but due to the slow transit speeds and limited payloads of regional diesel-electric boats they present a lesser strategic risk than air-launched missiles. The latter can be delivered to their launch points at 450 KTAS, and once launched the aircraft may cycle back to its base for a reload and another sortie, with sortie rates limited only by missile stocks, and numbers of aircrew and aircraft.

Maritime Air Defence

AEW&C aircraft have been central to maritime air defence for decades, with the US Navy decades ago operating land and carrier based systems, and all major navies today operating the latter. With the plethora of Russian, clone Russian and indigenous cruise missiles in the Asia-Pacific-Indian region, cruise missile defence is central to the viability of any surface warship, and commercial shipping in wartime.

The operational issues are essentially the same as observed with conventional air defence and cruise missile defence, with the important caveat that warships are far less forgiving of cruise missile hits than are most land based targets.

While Air Warfare Destroyers will provide a good capability to engage high and medium altitude targets at long ranges, the geometry of cruise missile attacks using sea skimming supersonic missiles presents genuine problems for defending naval surface units.

'Wedgetail' provides a land based option to support the RAN, with the caveat that distances to station will be the critical factor in viability, as continuous 24/7 orbits over naval task forces or groups will be essential where a risk of attack exists.

Since Australia is opting out of significant long-range strike capabilities in the future, the option of defeating an opposing anti-ship cruise missile firing strike force by attacking its airfields will not be a credible option post-2010.

The ability to provide 'Wedgetail' and fighter support for naval forces operating at 1,000 NMI or greater distances from the continent will be contingent not only on numbers of Wedgetail and fighter aircraft, but critically on the number of tankers available.

Strike Control

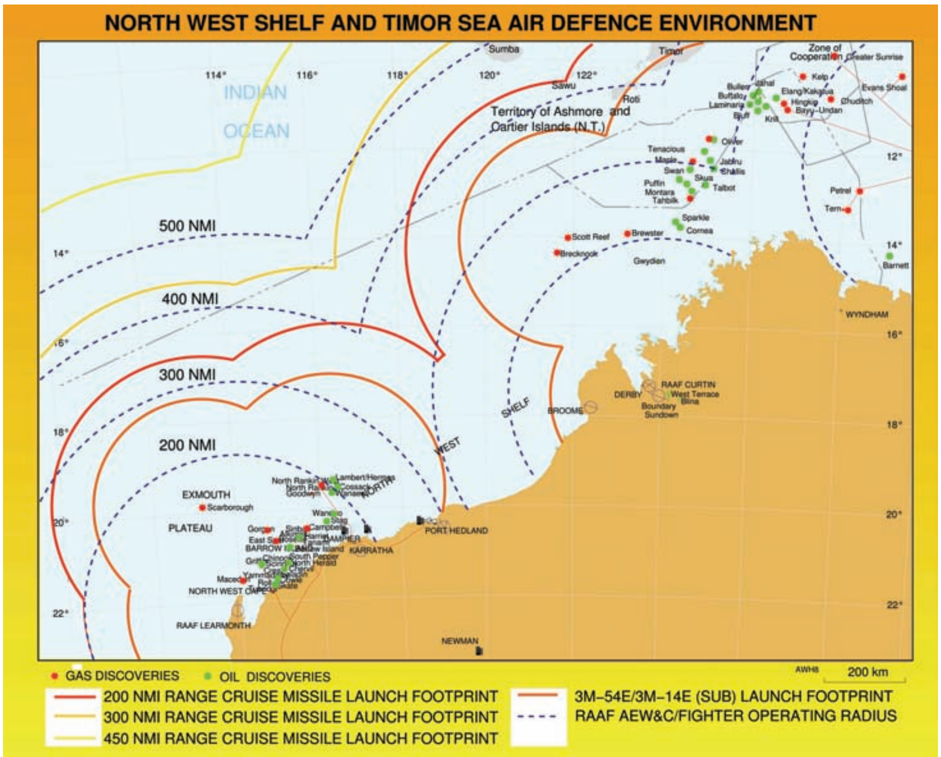
The use of AEW&C aircraft for battle management of air strike operations is a technique practised since the 1950s, and was central to operations in Southeast Asia, and every major air campaign since.

In many respects the basic constraints applied differ little from what we observe in air defence operations, with the important caveat that the AEW&C aircraft must be positioned close enough to the FEBA to reliably surveil airspace which is being penetrated by strike packages and their fighter escorts. Fighters tasked with offensive sweeps, loose escort or close escort are then directed by the AEW&C system against defending fighters, and penetrating strike aircraft are provided with continuously updated location information on hostile interceptors.

The principal issue with all strike control operations is the exposure of the AEW&C aircraft to opposing defences, be these fighters or long-range Surface Air Missiles. While driving the AEW&C orbit closer to the FEBA provides a deeper look into enemy airspace, it also puts the aircraft closer to opposing defences.

While many of the regional environments the RAAF will have to plan around are littoral, and thus not requiring significant depth for strike operations, often this terrain is mountainous, providing large areas of concealment in radar shadow if the AEW&C aircraft is standing off at a large range. This provides opportunities for mobile long-range SAM systems, and high performance fighter aircraft to approach undetected to distances where they would otherwise be detected over flat terrain or ocean. Perhaps the best case study was Israeli fighter operations against the Syrians in 1982, exploiting the blind zone created by mountainous terrain along the Lebanon-Syria border.

Strike control operations are thus potentially the most risky environments in which an AEW&C aircraft can be operated.



Air defence operations against combat aircraft and cruise missiles will present genuine challenges for the RAAF, with a limited number of AEW&C aircraft, and a small tanker force. The geographical constraints for potential high value targets are depicted in this chart (Author).

AEW&C Survivability in Combat

Modern wars, especially air wars, can be described as 'information centric', in that, the ability to apply coordinated military force rapidly and precisely hinges on the ability to achieve information superiority, which amounts to having a superior picture of the battlespace relative to an opponent. This is achieved by having airborne ISR systems, including AEW&C, and the electronic combat and offensive capabilities to deny the use of such systems to an opponent. NCW for all of its merit is little more than providing fast digital connections between the ISR systems and combat elements - take away the ISR systems in a networked force and the system collapses.

The reality of any high intensity air wars fought in the 21st Century is that air superiority can only be achieved through prior information superiority. In such an environment ISR systems, especially AEW&C aircraft, and electronic combat systems, such as jamming aircraft, become the highest priority targets in an air battle. The player who can kill the opponent's AEW&C and jamming aircraft first, or drive them out of the battlespace, achieves information superiority and thereafter, air superiority, winning the battle.

The Soviets recognised this reality in 1982, after the Israelis using E-2C AEW&C aircraft and Boeing 707 standoff jammers completely routed Syrian forces in the battle for Lebanon. The message was reinforced in 1991, when the US Air Force and Navy repeated this success against the much stronger Iraqi air defence system.

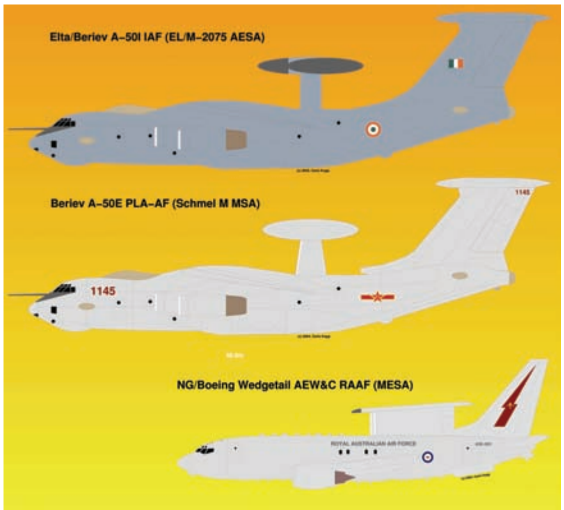
The result of these experiences was a concerted effort, through the 1980s and continued during the early 1990s, to devise weapons capable of defeating airborne ISR platforms, especially AEW&C aircraft, and airborne standoff jamming aircraft such as the EF-111A Raven and EA-6B Prowler.

The design aims of the Antey S-300V/VM and later variants of the Almaz S-300PMU SAM systems included attacking ISR aircraft and airborne jammers from very long ranges. The model centres on the idea of driving highly mobile S-300V/VM or S-300PMU-2/S-400 missile batteries as close to the FEBA as possible, in radar/radio silence, and then sniping at ISR aircraft and airborne jammers with long-range missile shots from concealed positions. The stated role of the 9M82 Giant (S-300V/SA-12a) SAM and newer long-range missiles in the S-300PMU-2 Favorit and S-400 suites is exactly this. With ranges against high flying targets between 100 and 200 NMI, this class of long-range SAM presents a genuine risk to an AEW&C platform. Moreover, trading an S-300V, S-300PMU-2 or S-400 battery for an AEW&C aircraft in battle is typically worthwhile, in dollars and combat effect. It is worth observing that China operates at least 12 batteries of S-300PMU SAMs, and is expected to acquire the S-400. Vietnam has ordered the S-300PMU-2, while Indonesia is claimed to have also sought these missiles.

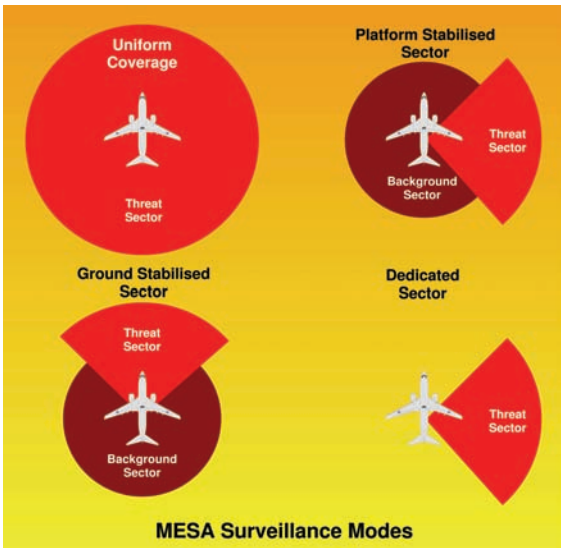
Soviet thinking on achieving information superiority was not confined to using long-range SAMs. One of the intended roles of later variants of the MiG-25 Foxbat, and the MiG-31 Foxhound, was to fly high altitude high-speed dashes to take shots at NATO ISR aircraft, especially the E-3 AWACS. This is inherently expensive in combat losses, as multiple Foxhounds or Foxbats would have to be traded for each AWACS, JSTARS, Rivet Joint or Raven killed. By the early 1990s Soviet thinking shifted to the use of very long-range BVR AAMs, allowing the fighter - and aircrew - to survive most attacks and be reused. The result was the emergence of the KS-172 and R-37 missiles during the early 1990s, and reported adaptations of the Kh-31 missile. These missiles are now appearing in Asia, with India collaborating on the R-172 and China claimed to have licenced the Kh-31.

The evolution of specialised 'counter-ISR' weapons is a direct consequence of Western information superiority and should be seen as such.

The big issue for Australia in the longer term is developing a fighter force, and operational doctrine, which permits the 'Wedgetail' force to survive in an environment where arbitrary regional nations may be operating weapons like the S-300PMU-2/S-400, R-37, R-172 and Kh-31 - or have the option of fielding such weapons with a warning time of as little as months. The US Air Force approach has centred on using the F/A-22A to kill the S-300PMU-2/S-400, Sukhoi fighters carrying BVR missiles such as the R-172, R-37 or Kh-31, and opposing ISR and jamming platforms.



The importance of information superiority has been widely recognised in Asia, with India and China both aiming to field variants of the Beriev A-50 before the end of the decade. Smaller nations such as Malaysia and South Korea have been evaluating types for purchase (Author).



The MESA phased array carried by 'Wedgetail' is the most advanced AEW&C radar in existence. Phased arrays have the important capability of manipulating beam direction and shape very quickly, allowing complex search modes in which the system spends more time searching specific sectors to improve detection and tracking performance (Author).