PATHFINDER

COLLECTION – VOLUME 3

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Edited by:

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CANBERRA

Cover Image: "The Australian Hornets (F/A-18s) out on the flightline 7.30 am, Diego Garcia" by Peter Churcher (26 February 2002), Australian War Memorial.

Peter Churcher's paintings have been seen in numerous exhibitions across the country since he completed art studies in 1992, and he has been selected six times as a finalist in the prestigious Archibald Prize. In January 2002, he was commissioned by the Australian War Memorial to record Australia's involvement in the war against terrorism. As official war artist, he was deployed to the Persian Gulf and Diego Garcia where he recorded the people, equipment and operations of the Royal Australian Navy and Royal Australian Air Force during Operation SLIPPER. At Diego Garcia, he captured the day-to-day experiences of Air Force personnel serving in an isolated tropical environment and his art provides a unique insight into modern warfare. The cover design is an oil-on-board artwork and was the first painting he completed at Diego Garcia.

Foreword

This is the third volume of collected Pathfinders produced by the Air Power Development Centre since the first Pathfinder was written in June 2004. Pathfinders have been a very successful medium to pass on ideas and engender debate regarding contemporary and future air power issues as well as providing historical analysis. They are normally 1000 words in length and produced every fortnight, generally interleaving between a contemporary air power issue and a historical piece.

The contemporary air power-related Pathfinders in this volume focus on an array of subjects—air power theory, strategy, operational art, tactics and technology. This volume starts with the Pathfinder titled 'Air power: why is it so contentious' which is a stirring analysis of why airmen command and lead air campaigns and why professional mastery is so important in what we do. I also draw your attention to the quote on page 1 pointing out that air power is more than its technical aspects—strategy and innovation are as important. It is easy for us airmen to focus on technology, but as we are members of a fighting service we need to be better than just technical masters of flying, fixing and sustaining airplanes. We also need to be professional masters of air power in terms of ensuring the Service's ability to 'create or enable the creation of effects by or from platforms using the atmosphere for manoeuvre'.

As we are the second oldest air force in the world, it is not surprising that there are many Pathfinders written about our fine history. We start with 'An Australian airman at the Dardanelles'. While Gallipoli is generally acknowledged as a land campaign, within the littoral battlespace, it is not known to many that an extensive air campaign was conducted over Gallipoli with most air power roles being executed. It is also pleasing to see the RAAF's contribution to the 'Battle for Australia' over the years 1942 and 1943 highlighted with Pathfinders on the RAAF's role in the Battle of the Coral Sea and the

New Guinea Campaign, and in particular that fine example of air-land integration—the Battle of Milne Bay—where the RAAF is often acknowledged as having been the 'decisive factor' in Japan's first defeat on land during World War II.

In drawing these threads together, it is important for us to understand our past so that we can plan and prepare for our future, taking advantage of the experiences of those who have gone before us. It is a truism that those who do not understand their history are often condemned to repeat the mistakes of the past. This is the essential reason why we study and analyse our history.

While we do not credit the authors of the Pathfinders at the time of their initial publication, we do acknowledge them when the articles are compiled into volumes. As such, at the rear of the volume you find the list of names of contributors. Take a look at them. Many Pathfinders were written by APDC members, but about a quarter were not. If you would like to develop a Pathfinder on a subject of mutual interest to you and the RAAF, please contact the APDC.

I commend Volume Three to you.

Group Captain Rick Keir
Director, Air Power Development Centre
May 2009

THE AIR POWER DEVELOPMENT CENTRE

The Air Power Development Centre, formerly the Aerospace Centre, was established by the Royal Australian Air Force in August 1989, at the direction of the Chief of Air Force. Its function is to promote a greater understanding of the proper application of air and space power within the Australian Defence Force and in the wider community. This is being achieved through a variety of methods, including development and revision of indigenous doctrine, the incorporation of that doctrine into all levels of RAAF training, and increasing the level of air and space power awareness across the broadest possible spectrum. Comment on this publication or inquiry on any other air power related topic is welcome and should be forwarded to:

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This is the key point: the effective employment of air and space power has to do not so much with airplanes and missiles and engineering as with thinking and attitude and imagination.

General Merrill A. McPeak,
Chief of Staff, United States Air Force

Air power: why is it so contentious?

In the wake of the success of the Wright brother's three-minute flight in 1903, the birth of air power as a military instrument was inevitable, and because of its ubiquity across all domains of combat operations, so was the consequential debate about its organisation, command and control.

Human beings have always been fascinated by the concept of flight, very clearly demonstrated by the preoccupation with flight visible in all

> **Key Points**
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> - Control of air power assets has been a bone of contention because of its enormous potential.
> - Professional mastery of air power is required to command air power assets effectively.
> - Air power achieves its full potential in improving the jointness of military operations.

ancient mythologies—both Western and Asian. Throughout recorded history, human beings have also been consciously developing increasingly sophisticated means to wage war against adversaries. Therefore, it is not surprising that even as one set of inventors and scientists were coming to grips with the idea of heavier-than-air flight, another set was already contemplating its use as a military capability.

Air power and its possibilities became a bone of contention vis-à-vis its command and control as soon as military strategists realised its enormous potential. Even though this acrimonious debate between the three main branches of a defence force is an on-going issue, and clearly not conducive to true jointness at the strategic level, it also indicates the acceptance of air power as an absolute necessity in creating a military power projection capability.

Mainly because of the contentious issue of its command and control, it took a world war and more than fifteen years of military flying experience to create the first independent air force. The acceptance of air forces as a third entity in creating a triumvirate of military capabilities was even more delayed and to an extent has not been

fully achieved even today. This can be seen in the thrust of some contemporary surface forces to 'own' their independent air arms.

Both soldiers and sailors accept the need to have years of experience and training in their chosen professions to be reasonably sure of success as a commander, thus making the position completely unavailable to anyone but an 'insider'. It is, therefore, surprising that some of these very same people feel easily capable of running an air force. Surface force commanders demand air power effects in conducting operations and equate this to organic command of air power assets. However, this discounts the professional mastery of air power required to command air force assets effectively. As a corollary, airmen do not, as a norm, demand the command of surface forces. The effectiveness of a joint force is critically dependent on professional mastery at the joint level, which can only be achieved through mutual respect of professional mastery of individual domains. Such individual domain mastery cannot be subsumed at the joint or seamless level because it is the essential building block for joint professionalism.

Even though the initial air power theorists were fanciful in their appreciation of the effects that air power could create, it was not their concepts that were at fault. In fact with hindsight, they could be considered visionaries because their theories have been proved possible by technological advances. Throughout its history, air power theorists have demanded greater capabilities from the scientists in order to fulfil their futuristic concepts regarding the employment of air power. This dovetailing of capability with technology has been raised to an art form in military air power.

Air power transcends the limitations of surface forces and is capable of operating over large areas, unconstrained by geography, time or distance. Its freedom of action in the third dimension bypasses physical barriers and permits concurrent non-contiguous operations across the entire conflict space. Technology has also provided it with the capability to engage a target with precision, discretion and proportion. This is not to say that surface forces are not capable of

similar actions. The difference is that air power is capable of optimally combining its ubiquity with the current need for accuracy and proportionality in such a way that it becomes the preferred option, especially in politically charged situations that demand immediacy of action.

A quick glance at the ten principles of war that are enshrined in the ADF's doctrine will reveal that the employment of air power in a planned and coordinated manner would support each one of them, perhaps in a more holistic manner than any other form of force projection. However, it must also be understood that no one force projection capability can ensure that all laid down objectives are achieved. It is the appropriate combination of all available capabilities that will achieve objectives in the most cost effective manner. Air power is a critical element in all such endeavours.

While all the arguments brought out allude to the overarching capabilities of air power, it is in improving jointness within the whole force that it achieves its full potential. Jointness between surface and air forces straddles the entire range of operations and the effectiveness of generating joint fires, which is critical to success in offensive response actions. In the conceptual move of the ADF from a joint force to a seamless force, the capabilities resident in air power and first-rate joint command and control would become the binding glue that works the seams.

Air force achieves the necessary balance to operate within a joint force and support the progression towards becoming seamless by ensuring that it provides optimum performance in three key areas. First, the capability to understand the characteristics of the operating environment and the ability to know and share the information, aspirationally in real time. Second, the ability to shape, that is, influence and manage the conflict space, where and when necessary and to the desired degree. Third, the ability to respond with carefully tailored, proportional, accurate and timely application of air power as part of a seamless force in a joint or multi-agency campaign to create the needed effects.

From its very inception air power has demonstrated its capability to be a crucial element in military capabilities, even though there still are different points of view regarding its efficient organisation and control. It will be prudent for all military forces with limited resource availability to clearly understand that the air power employment tenet of centralised command and decentralised execution was arrived at after careful analysis of historical experience. This is definitely not a call for only airmen to command air forces. This is a call to all who are in the profession of arms to recognise and respect the professional mastery of airmen required to employ increasingly sophisticated weapon systems that have overarching impact on the conduct of surface operations and to create strategic effects in their own right.

THE ASYMMETRY OF AIR POWER

Military forces have historically relied on asymmetry—the capability to surprise an adversary with unpredictable and innovative actions—to win battles and wars. However, the use of the term 'asymmetry' to describe a methodology for the conduct of war is a recent development. There are two main reasons for this. First, traditional warfare has generally been considered a relatively orderly or symmetric process

Key Points

- Asymmetry is a concept that acts as a force multiplier.
- Air power has the flexibility and discretion to shift asymmetry in favour of conventional forces.
- Well founded operational art will only be successful when employed within a sound security strategy.

which translates to a range of predictable options and manoeuvres on the battlefield. Second, the asymmetry associated with innovative manoeuvre and rapid action in an historical sense has not been equated with the asymmetry of unconventional modern warfare. Both these factors are underscored by the fact that until the mid-twentieth century, wars were mostly fought between the fielded forces of nation states, operating within the norms of international law.

The evolution of non-state or sub-state actors injected a new element into the equation of warfare. They gave asymmetry a new dimension by the use of non-traditional means to neutralise the advantages of a conventional force. Therefore, the contemporary use of the term asymmetry actually conveys a combined meaning of surprise as well as the employment of even non-military assets against military forces.

The current use of asymmetric means to wage war can be traced to the overwhelming conventional military superiority that democracies of the western or developed world normally wield. Faced with this technological, economic and conceptual superiority in the conduct of warfare, adversaries of these forces sought to balance this inequality by adopting methods of combat that were beyond the

conventional. Asymmetry as a concept means the redressing of lesser capability by its innovative use, thereby making the concept itself a force multiplier. Creating this asymmetry through conventional and unconventional ways is 'the face of 21st century operational art'.

In contemporary conflict, asymmetry is normally used to describe actions against the conventional military forces of nation-states by adversaries who are viewed as operating outside the confines of international law. This has given the term itself a negative and only partially correct connotation. However, if the concept is analysed objectively as a viable construct to achieve the desired effect and end-state in a conflict, its many merits will be clearly discernable. Of all the conventional power projection capabilities, it is air power that can most easily be adapted to shift asymmetry in favour of conventional military forces in any given situation.

In the global security scenario, a number of states are either failing or have already failed, thereby increasing the risk of guerrilla/insurgent/terrorist groups initiating irregular warfare in their regions. Irregular forces are by design asymmetric with no conventional trappings. State-based military forces are traditionally designed to secure the nation and therefore must innovate and adapt to generate their own asymmetry when faced with such an adversary.

In irregular warfare the environment is shaped by the adversary who can easily create asymmetry by operating unconventionally on their favoured ground. Under these circumstances air power has the capability to carry out surveillance and also respond lethally, if required, without having to take recourse to putting troops on the ground. This is classic asymmetry wherein the security of a state can be ensured without large scale military actions.

Air power contributes to three basic military roles in the pursuit of national security—the ability to find, the capability to shape and deter, and the capacity for timely response. These roles are not exclusive to air power but the advantage that air power has is that these roles can be conducted with enough flexibility and discretion

to shift asymmetry in the user's favour. Such asymmetry is critical to creating the necessary effects to resolve a crisis.

Intelligence, surveillance and reconnaissance (ISR) capabilities resident in air power are at the forefront of finding and identifying the sources of threat both at the tactical and the strategic level. This can be done by uninhabited aerial vehicles with extremely long endurance, manned platforms that have the capability to facilitate time-sensitive targeting and space based assets that are discrete and have a very wide coverage. Adequate ISR is critical to decision superiority that is, in turn, the foundation for asymmetry.

Air power assets operate outside geographical constraints and directly influence the deep battlespace because of their inherent reach, speed and flexibility. By the same token, they can also operate in different theatres simultaneously, creating a deterrent effect both physical and virtual. Constant monitoring of the battlespace and timely actions to shape the environment create asymmetric effects, especially against adversaries who do not have the same level of sophistication either in capabilities or concepts of operations.

Equally important as the other two roles and more effective in the short-term is the capacity of air power to respond, lethally if required, to emerging situations in a time-critical manner. This capacity can immediately create asymmetry of an order that will overwhelm the adversary. Time-critical precision attacks have the capability to produce strategic effects far in excess of the actual destruction caused. This is true asymmetry, not just because the adversary cannot respond adequately, but because of the potential for the effects to be catastrophic.

By focusing on operating asymmetrically in relation to the adversary, an adaptable conventional force can retain the initiative and force the adversary to react to emerging situations that it has created. Shaping the environment through information superiority and response decisions and actions that create proportionate and discretionary effects are the asymmetric advantages that are resident in air power.

As the world is moving towards increasingly complex security scenarios, the ability of a military force to ensure the nation's security needs is becoming restricted. To ensure that the capability envelope is kept at an acceptable level, military forces the world over are looking for force multipliers and other nuanced concepts. Asymmetry remains a concept that is crucial to victory. Many adversaries employ unconventional techniques to create asymmetry on the battlefield. The challenge for conventional military forces is to adapt their operational art to create asymmetry while using conventional means against these adversaries. Such an approach to the application of conventional military power will deprive the adversary of a powerful tool and help conventional forces regain the initiative. Air power will be at the forefront of this innovative move.

Control of the air, precision attack, and ISR: the foundations of modern air power

Control of the air, precision attack and Intelligence Surveillance and Reconnaissance (ISR) are cornerstones of modern air strategy and key premises of Australian air power doctrine. Together they allow commanders to exploit the air environment and to conduct surface operations where and when required without effective interference from enemy air power. Control of the air is

> **Key Points**
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> - The ability to create precise effects is the hallmark of advanced air forces.
> - Control of the air is a means to an end.
> - The RAAF will continue to generate balanced capabilities to provide air power for Australia's security.

the key to this ability. It provides the necessary conditions to allow the full range of air and surface operations. From the air perspective, control of the air enables persistent ISR, precision attack and counter air, air mobility and air to air refuelling. This Pathfinder describes the connection between control of the air, precision attack, and ISR.

The ability to create precise effects is not only the hallmark of advanced air forces, but arguably the greatest contribution air power brings to the modern battlespace. The RAAF creates precise effects through its capability to conduct precision attack. This capability is reliant on its ability to control the air environment and provide persistent ISR to support these operations. It is essential, therefore, that the RAAF maintains its ability to gain control of the air or if necessary, alternate means of utilising the air environment to collect sufficient information to allow it to achieve precise effects.

Precision attack is the RAAF's chosen means of applying combat air power to create precise effects against an adversary to achieve desired campaign outcomes. It is defined by the precision of the effect created, and does not necessarily imply the use of precision weapons.

The ability to create precise effects allows the RAAF to shape its environment, deter possible aggressors and when necessary respond decisively. ISR provides the timely collection of information which facilitates the RAAF's ability to conduct precision attack.

Although gaining control of the air is generally the first objective in an air campaign, it is not the ultimate goal. Rather it is a necessary prerequisite for the conduct of all other operations to achieve campaign objectives. In addition to allowing surface forces freedom of action across their domain, achieving control of the air enables the Air Force to conduct the full range of its air operations including selectively applying precision attack in a time and place of its choosing. Gaining control of the air, therefore, is a means to an end. It allows Air Force the freedom of action it requires to optimally apply air power.

The air doctrine of most advanced Western air forces is underscored by the importance of winning and maintaining control of the air to enable the application of precise effects. This Western way of fighting air wars is a result of historical experience in conventional war, especially the two World Wars, and a predilection to seek and exploit technological solutions to military problems. The rise of air power can be seen in this light as a natural development in the quest for victory in the three environmental battlespaces–land, sea and air. By operating under an air environment that friendly forces control, Western surface forces are able to exploit their advanced capabilities, tactics and technologies to most effectively engage enemy forces. By creating precise effects, air forces are able to achieve campaign outcomes with discrimination and minimum force–both of which are important to Western democratic societies.

Similarly, RAAF doctrine is based on gaining sufficient control of the air to allow it to apply precision attack. With a permissive air environment (be it a favourable air situation, air superiority or air supremacy), ADF surface forces have the necessary freedom of action to conduct operations relatively unhindered. RAAF doctrine describes two ways of achieving control of the air, first, by fighting to achieve

it through a counter air campaign and, second, by creating sufficient control, in time and space through the use of superior tactics and technology, for particular operations. RAAF air campaigns, therefore, typically begin with operations to achieve sufficient control of the air to pave the way for the application of precision attack.

A permissive air environment alone, however, is not sufficient for the RAAF to achieve the sort of precise effects described in its air power doctrine. The ability to employ precision attack requires the convergence of information, command and control (C^2) and weapons systems to engage targets and create effects that achieve campaign outcomes. In particular, the provision of accurate and timely information is crucial to enable effects-based targeting through precision attack. This information is provided primarily through joint, interagency and coalition channels and relies heavily on airborne and space-based ISR. Although much information, especially in regard to fixed targets, is provided by spaced-based ISR assets, airborne platforms are required for highly specific information on mobile and fleeting targets, especially when weather may adversely affect space-based ISR. Providing a sufficiently permissible air environment for these airborne ISR assets, therefore, requires the RAAF or its allies to either fight for control of the air or else circumvent it for as long as required through technology like low observability (stealth). Air environments where this is simply not achievable, called denied access environments, pose considerable challenge for a strategy based on control of the air.

Without persistent ISR it is extremely challenging to bring precision attack to bear on fleeting, mobile or effectively camouflaged targets, particularly in dense urban environments. Operations in Iraq and Afghanistan against insurgent forces that are embedded within the broader community highlight the enormous difficulty in building sufficient information to effectively apply discriminate force, even in an environment of air supremacy. In denied access environments, the RAAF currently has no capability to achieve the level of persistent ISR required for precision attack across the spectrum of target types.

Advanced research into emerging technologies, such as extremely low observable platforms, may one day enable persistent ISR in such environments, but in the interim, strategies, techniques and 'work-arounds' are needed to mitigate lack of ISR access.

It is noteworthy that Western air forces have not had to conduct sustained operations to contest and win control of the air in any conflict since the Korean War, since wise adversaries these days choose not to challenge us in that way. The air operations to secure control of the airspace over Kuwait, Iraq and Afghanistan in the past two decades, for example, were all swift and decisive affairs. For the RAAF, air superiority has been established through allied air power in every major conflict it has been involved in. Fighting for control of the air through an air campaign, therefore, although doctrinally entrenched, has not been a particular feature of RAAF experience outside of a coalition setting. What these operations have highlighted, however, is the vital importance of gaining control of the air and the inescapable need for the RAAF to maintain the high-end warfighting ability to gain this control. For the RAAF, maintaining this capability will be the product of an equal mixture of retaining a technological edge, professional mastery and doctrinal agility.

High-end or low-end air power capabilities: the debate

As a security strategy development process, the linear extrapolation of current trends to predict the future has been historically proven to be a poor way to judge emerging threats. Military forces that structure around current threats are soon out-manoeuvred by those who perceive and exploit new asymmetries.

Currently, popular opinion is that the chance of a major conventional state-

on-state conflict is extremely low and there is general acceptance at the strategic level that most conflicts—present and future—will be fought to curb terrorism or insurgencies. This would automatically pit the military forces of a state against non-state, irregular and/or insurgent forces. The clear dominance of the state military forces in conventional conflict causes the irregular forces to resort to asymmetry in an effort to even the disparity in capabilities. This has resulted in a debate regarding the optimum force structure and capability spread that the military force of a nation must possess.

In countering these irregular threats state military forces have to, at times, employ high-end equipment at the lower end of the technology spectrum, leading to strident calls for military forces to tailor their capabilities to the low end, and structure to fight the lower-level battles. No doubt there is merit in training and equipping for the fight in hand, but changing the entire structure of the force to cater for these contingencies alone would be fraught with risk. Preoccupation with lower level conflict can also provide the opportunity for adventurism by a belligerent state that could in

turn generate second order effects, such as forced migration, spread of disease, natural resources scarcity etc, leading to instability.

Even if the majority of future military involvements are likely to be in irregular warfare, the probability of a state-on-state conflict can never be completely discounted. The recent Russian clash with Georgia is a sharp reminder. The solution, therefore, is to have a force that has both high-end and low-end capabilities, resident in differently equipped and trained units and formations, each tailored for a specific purpose. This is not a practical solution, even for a military force as large as that of the United States. The next best would be to have an adaptable force that is capable of dealing with the evolving conflict situation by transitioning fairly easily from one end of the spectrum to the other, as required.

If the need to have an adaptable force is accepted, the question is then its balance: whether to tailor the force to transition from high-end to low-end or vice versa. The optimal solution would be different for the three environments of land, maritime and air. From an air power perspective, transitioning a low-end capable force to meet high-end needs—definitely a cost-effective option—would be impossible for a number of reasons, given the speed at which these changes have to be made.

First, air power capabilities are extremely resource intensive to acquire and operate efficiently, both in terms of assets and personnel training requirements. Further, the lead-time required to operationally field these sophisticated systems completely precludes their acquisition at the beginning of a conflict. As far as air power is concerned, the resident capabilities of a force at the beginning are all that it will have throughout the conflict.

Second, air power is a technology-intensive warfighting capability that requires comprehensive training regimes to ensure its optimum employment. This can only be achieved in peacetime conditions. Therefore, even if the necessary equipment and assets are made available the force will not be able to employ them effectively—i.e. ramping up from a lower-end to a higher-end capability spectrum

will not be possible in the short term. The nature of contemporary conflict places a premium on adaptability and flexibility, which will be almost nonexistent in this case.

Third, air power is required to ensure adequate control of the air for the success of all operations. This requires the capacity to operate high-technology weapon systems in a complex and intense environment in a joint manner. This capability cannot be developed overnight but is the product of long-term planning and strategic vision, both in capability development, asset procurement and joint training. The fact that western coalitions have not had to fight for air superiority in the past forty or so years does not in any way dilute this critical requirement.

Fourth, the preponderant power projection capability of the developed world is the reason for the current adversaries resorting to asymmetry in the first place, in an effort to neutralise it. Technology-enabled capabilities, while difficult to obtain, themselves become effective asymmetric advantages when employed against forces operating at the lower end of both technology and capability spectrums. The employment of air power capabilities to carry out time-sensitive targeting and surveillance that can be long-term or responsive to rapidly emerging needs are prime examples.

Fifth, from an air power perspective the hardest capabilities to regenerate—both in terms of time needed and adequacy of competency—are the high-end ones. Therefore, it would be prudent for an air force to maintain these capabilities and not trade them in at any time. The core competencies of an air force are built on these.

It is always easier to scale down both technology and capability, rather than to try to ramp up resident capabilities in a time-critical manner. The argument for military forces to be tailored purely to combat terrorism and insurgency would have detrimental long-term consequences for the overall capacity of the force to ensure national security. Military forces across the world are operating under increased financial and other resource constraints. Under these conditions it becomes all the more important to ensure that the force

is correctly balanced to be able to provide the capabilities required at the time and place needed.

Air power at the cutting edge is resource intensive. However, it cannot be obtained at will and in a limited timeframe, making strategic long-term planning an imperative to ensure adequacy of air power capabilities. At least for air power, force structuring and capability development at the lower end of the spectrum is not a viable option. Air power's inherent characteristics of flexibility and adaptability will have to be heavily accented to ensure that adequate quantum of quality air power is available when the nation requires it the most. High-end air power—conceptual, technological, and operational— provided by well trained professional masters, capable of adapting to lower end conflict as required, is the only way forward.

Revisiting battlefield air attacks

On 20 August 2008, newspapers across Australia reported an ADF press release. It stated that: "… special forces had found 'senior provincial Taliban extremist commander' Mullah Akhtar Mohammed, ensured no civilians were nearby and called in an air strike to kill him in a remote part of Oruzgan province…"

On the face of it, there is nothing special about this press release, but a closer analysis of the action that took place reveals a fundamental shift in the *modus operandi* of

Key Points

- There is a fundamental shift taking place in the application of conventional force in contemporary battlefields and against non-traditional adversaries.
- The traditional distinction between tactical and strategic action is closing.
- A seamless force will be able to leverage the inherent capabilities of different elements to achieve joint objectives with minimal risk and maximum effect.

conventional forces in the conflict against extremist non-state entities. Instead of the ground forces attacking and capturing or killing the extremist group, they have relied on the precision, responsiveness and discrimination that air power provides in the application of lethal force, in close proximity of their own positions. This has become the norm rather than the exception for Western militaries in recent operations in Afghanistan and Iraq.

It is now generally accepted that the nature of warfare has changed radically in recent years, even though current events in the Caucasus have clearly demonstrated that conventional state-on-state conflicts are not improbable even today. Contemporary conflict produces a very different spectrum of threat that demands a completely new set of warfighting skills from the military forces of sovereign nations. Further, a majority of current conflicts encompass these unconventional threats, which will continue into the future. Military forces across the world have to be cognisant of this fact and develop

their capabilities accordingly to continue to be relevant in the broader national security agenda.

Necessity, it is said, is the mother of invention. The threats that NATO and coalition forces face in Afghanistan and Iraq are far from traditional; the adversary is ill-defined and diffused; the battlefield is not clearly demarcated and there are operational constraints imposed on them by moral, ethical and political considerations. This has resulted in direct surface engagement usually being initiated at the discretion of the adversary, thereby creating a situation wherein the coalition forces are perpetually reacting to emerging situations. While superior training and abundant firepower can win these encounters at the tactical level, it is difficult to achieve tangible success at the operational and strategic levels when the initiative is always with the adversary.

A definitive way to seize the initiative from such adversaries is to carry out strategic attacks on their command and control structure and communications systems, which would significantly reduce their capability to operate independently in small, cohesive but dispersed groups. The dispersed nature of the adversaries and their proclivity to operate in proximity to neutral and innocent civilians makes carrying out such attacks complicated in both planning and execution. They will also be time-sensitive and will need to be carried out within a finite window of opportunity. Ground operations to achieve this will require a very large number of troops and may not be able to meet the stringent timeliness requirement. Further, ground operations of this nature carry the very real danger of suffering a high level of 'friendly' casualties.

Air power's inherent characteristics and capabilities can be tailored to carry out these actions efficiently without exposing ground forces to unnecessary attrition. There are two fundamental requirements for effectiveness and success in these missions; long endurance surveillance of very large geographical areas, and responsive, precise and discriminatory strike capability.

A number of technological innovations and breakthroughs have improved air power capabilities, especially in battlefield attack missions. Currently, air delivered weapon accuracy has improved beyond any precision capability that was envisaged even a decade ago. Attack-enabling innovations such as satellite guidance, data links, multi-mode seekers etc have made battlefield air attacks the primary choice in engaging the enemy.

Battlefield attack platforms have also changed, with the classic fighter giving way to the strategic bomber and uninhabited aerial vehicles. The speed, range and loiter capability of the bomber allows it to stay overhead the theatre of operations for hours, striking several widely separated and very often fleeting targets in one single mission. Uninhabited aerial systems often carry out the same role while also being strategically tasked. In essence, the demarcation of targets into tactical and strategic which led to the traditional division of air assets along the same lines is no longer valid. The changing nature of warfare has brought in a situation wherein a battlefield air strike that neutralises adversary leadership will have rippling effects well into the strategic level. Today, independent, remotely operated air power assets that can stay airborne for days on end can, and do, strike fleeting targets of opportunity successfully, creating disproportionately large effects in the on-going conflict.

The use of air assets to carry out battlefield air attacks has reached unprecedented levels in the conflicts being prosecuted in Iraq and Afghanistan. Their success in engaging time sensitive targets with accuracy while avoiding collateral damage and minimising ground forces casualties has once again brought the concept of battlefield air attack into vogue. All competent air forces are taking note of the changed circumstances in the battlefield and the exceedingly important role that they can play in achieving joint objectives if air power capabilities are appropriately honed and employed. This latest application of air power demonstrates its flexibility and reinforces the fact that whoever controls the air controls the battlespace below.

The success of the reported attack on Taliban leadership in Afghanistan is a signpost in the evolution of air power capabilities into a different domain, so far dominated almost exclusively by surface forces. A seamless force will take note of the clear success of the joint application of ground surveillance and air strike that has achieved spectacular strategic effects.

Countering improvised explosive devices: the air power contribution

Many of us have seen on TV and read in newspapers, the carnage left behind after an Improvised Explosive Device (IED) has detonated in a crowded marketplace or a congested roadway. IED operations by insurgents have so far killed thousands of people and their scale and relative success have constrained the freedom of manoeuvre of coalition forces,

> **Key Points**
> - IEDs threaten the freedom of manoeuvre of surface forces.
> - IEDs must be perceived as a system and countered accordingly.
> - Air power provides a significant number of options in systemic counter IED activities.

affecting their ability to conduct effective operations in places such as Iraq and Afghanistan.

Containing the IED threat has a politico-strategic dimension that require elements of national power—diplomatic, economic, information and military capabilities—to be comprehensively employed. However, this Pathfinder focuses on counter-IED military operations and in particular the air power dimension of such actions.

An Improvised Explosive Device is normally 'homemade' and fabricated in a simple unsophisticated manner incorporating destructive pyrotechnic or incendiary capabilities designed to destroy, incapacitate, harass or distract. Activation of an IED is done either through a time switch, remote command operation (wired, radio controlled) or by the victim (via pressure plate, infrared or trip wire). Even though air power has the capacity to completely isolate a theatre of operation, IEDs will always be available to insurgents by virtue of the fact that they are improvised from commonly available material. Countering this threat therefore, will *per force* have to be a multi-faceted operation conducted in theatre.

Until relatively recently, the fight against IEDs consisted mostly of distancing or protecting personnel and equipment from the blast

either by avoiding likely IED sites or using better armour. Today, however, a more holistic counter-IED effort is underway that is designed to counter not only the IED itself but also the terrorist networks responsible for their deployment—in other words treating the IED threat as a system with recognisable nodes. Due to the dispersed nature of most IED systems, attacks against the live IED itself will only have tactical impact and not adversely affect their broader employment. The military systemic approach to a comprehensive counter-IED action will be to:

- Isolate the entire IED system from its external sources of support;
- Interdict all the nodes of the system to disrupt the IED capability; and
- At the tactical level, neutralise emplaced IEDs.

Countering the IED threat is a joint activity that requires a fully integrated and systematic approach, and synchronisation of effort by different agencies at the strategic, operational and tactical levels.

The primary requirement to prevent insurgent groups from employing IEDs is to isolate them from their support infrastructure. Air and space capabilities are well suited to this task in the larger theatre by continuous visual and electronic monitoring of the surface environment. This continuous monitoring can lead to the identification of insurgent lines of communication and supply as well as their supporters, all of which can be interdicted. Concerted surveillance and intelligence operations can disrupt the IED network and target the strategic supply lines and the personnel and locations used to build and distribute the IEDs. In this way, the entire system can be neutralised.

Interdiction of an IED system is a job well suited to air power. The inherent rapid response capability of air power makes it possible to identify and interdict enemy safe houses, IED factories and caches. Further, if IEDs are being transported, either between warehouses or for operational deployment, air platforms are the interdiction weapons of choice due to their ability to carry out discriminatory and precise strikes rapidly and from long ranges. Besides destroying

the physical components of an IED system, air platforms can also interdict the communications and the electronics nodes associated with triggering them, unconstrained by terrain or physical distances between the system nodes.

Airborne assets also contribute significantly to the forensic analysis process designed to neutralise IED systems. This involves fusing large amounts of intelligence and surveillance data to backtrack from an IED attack to determine the sources from which the attack emanated to locate the bomb-making facilities and the associated support organisation. In both Iraq and Afghanistan, airborne assets use their inherent ability to quickly locate an IED attack point, identify suspicious individuals or vehicles in the vicinity and mark them with laser designators for apprehension by ground forces if possible, or destroy them outright if necessary.

Neutralising the effects of an IED requires that the device is either prevented from detonating or sufficient protection is provided to make it ineffectual. Until recently, Western nations concentrated on improving the protection provided to ground forces with improved armour and flexible tactics. The insurgents, like all complex adaptive organisations, have countered by increasing the sophistication of the IEDs and by specifically targeting Explosive Ordnance Teams that difuse identified IEDs.

IEDs can only be completely neutralised if they can be found, which is a difficult task. Airborne platforms carry a wide variety of sensors and their speed and loiter capability ensures that a few platforms with discerning sensors can cover a large geographical area with high fidelity. Some IED-detection sensors under development for airborne platforms include lasers and stoichiometric diagnostic devices, which can detect very low levels of explosives compounds. Other specialist sensors include ground-penetrating radar and infrared cameras, both of which can search for either the IED itself or indicators of its presence such as disturbed soil or command wires.

Besides destroying or disabling an IED in situ, another means of preventing their detonation is to prevent the activation command

being sent to the device. A common means of activating an IED is by using radio transmitters to trigger it when the target is within range. This can be countered by electronic jamming devices that use low-power radio frequency (RF) energy to block the signals of radio controlled explosives detonators, such as cell phones, satellite phones and long-range cordless telephones. Other electronic countermeasures (ECM) include high-power, high-frequency RF energy to neutralize the electronics controlling the IED. While ground-based ECM systems can counter simple transmitters, airborne systems offer greater effective range and are more flexible in their application, as they are traditionally designed to operate in a very complex airborne electronic warfare environment.

For Western nations, most of the impact of IEDs is felt not in terms of the cost associated with countering them or replacing damaged equipment, but through IED-related deaths. If not carefully countered, this can have a devastating morale-sapping effect on the force as a whole that will transcend the purely tactical environment. Therefore, reducing the strategic impact of IEDs is the long-term objective of all counter-IED activities. In current counterinsurgency campaigns, support personnel providing ground based logistical resupply to coalition forces have suffered heavy casualties, largely from IEDs. Air power can reduce the exposure of extended logistics lines by providing air logistics support, thereby bypassing the IED threat.

There is no doubt that IED systems pose a significant threat to conventional military forces. Like most threats, the best way to neutralise them is to conduct coordinated and joint countering activities across the entire threat system. Air power brings decisive, lethal and responsive direct-effect weapons as well as a vast array of joint-force enablers to the counter-IED effort. The probability of success in neutralising these sophisticated systems is greatly enhanced by the optimum employment of air power capabilities.

IRREGULAR WARFARE AND AIR POWER

War is war and warfare is warfare
                              —Colin Gray

Colin Gray's observation that war is simply war is a masterpiece of eloquence and simplicity that has been somewhat forgotten in recent years.   Since the end of the cold war there has been a steady stream of attempts to define new forms of war in response to trying to explain the apparent rise of various non-traditional forms of warfare, globalisation, ethnic and religious issues, terrorism and transnational threats. The reality is, however, that

nothing has dramatically changed the enduring principles of war and conflict—they have simply evolved—particularly in the realm of unconventional warfare. For air power, the core functions of *counter air*, *precision attack*, *intelligence, surveillance and reconnaissance (ISR)*, and *air mobility* remain enduring for the conduct of both unconventional and conventional warfare.

Since the 1980s there has been rise and demise of various supposedly new extrapolations of warfare.   In traditional warfare, the Soviets' first discussed *Military Technical Revolution* and *Revolution in Military Affairs (RMA)* in the 1980s. This concept quickly gained momentum after the 1991 Gulf War where writers highlighted the combined use of precision weapons, advanced ISR techniques and integrated command, control and communications (C3) systems as the realisation of the emerging RMA.

However, it has been in the realm of non-traditional warfare that the maximum discussion and fervour for new forms of warfare have

emerged. The post Cold War era saw the emergence of what was referred to as *4th Generation Warfare (4GW)*. Whereas *3rd Generation Warfare* was highlighted by modern manoeuvre warfare between states, 4GW reflected a post Cold War era dominated by non-linear operations between state and non-state actors. The plethora of intra-state conflicts during the 1990s gave rise to the terms *low-intensity conflict* and *limited warfare*. In the last decade, terms such as *asymmetric warfare* have emerged to describe the rise of transnational threats such as terrorism. More recently, terms such as i*rregular warfare* or *complex irregular warfare* have surfaced.

In recent years, the term *hybrid wars* has emerged and gained considerable support in the US as an alternative to describe the new convergence of warfare between state and non-state forces where there is a blurring of the modes of conflict. Confronted by superior conventional forces, adversaries of western nations are increasingly using a combination of irregular and conventional tactics to conduct more successful hybrid warfare. Irregular tactics can include insurgency, terrorism, criminal activity and cyberwar. Hybrid war advocates cite Hezbollah operations in Lebanon and Taliban operations in Afghanistan as prime examples of this new type of warfare.

While this attempt to define an emerging form of warfare is thought provoking and admirable, it is not entirely innovative or constructive. The continual attempts to reinterpret the evolving nature of war in another definitive form are unhelpful. They tend to place the theory of war in an ever changing 'new panacea' cycle similar to the business world where every 5-10 years there is a 'new' management initiative that supposedly reflects profound changes in business processes and promises vast rewards for those who adopt. Such continual change is unrealistic for modern defence forces.

Likewise, while the characteristics of unconventional warfare differ somewhat in their application and importance to conventional warfare, the fundamental nature of war remains the same. As Clausewitz observed, 'all wars are things of the same nature'. War

remains violent; it remains a clash of wills. There is probably greater value in collectively referring to the various recent interpretations of war as simply irregular warfare. For example, the Australian Land Warfare Studies Centre (LWSC) has proposed the term *complex irregular warfare*.

Recognising that it is not the nature of war but the conduct of war that changes, there may be greater value in reviewing doctrine and more importantly, tactics (i.e. the conduct of war) than the enduring theory of war. The Australian Army has recognised this key difference in embracing *Adaptive Campaigning* as its *Future Land Operating Concept*.

There are major roles for air power in irregular warfare. *Counter air* missions were immediately flown after the devastating 11 September 2001 attacks and have since become a standard requirement in national security operations such as OP ACOLYTE (2006 Commonwealth Games in Melbourne), OP DELUGE (Asia Pacific Economic Cooperation Fourm 2007) and OP TESTAMENT (World Youth Day in Sydney 2008). *Air Mobility* has also become a critical air power role in current operations, providing Special Forces the ability to quickly respond to or prosecute the adversary and as the vital enabler providing the reach to sustain globally deployed ground forces. Airborne *ISR* has proved to be particularly valuable in providing time critical and persistent capability to find, fix, track and monitor the adversary. The huge demand placed on airborne ISR in current operations, constant desire to enhance ISR capability to detect Improvised Explosive Devices (IEDs) and operatives, and transition of traditional maritime patrol aircraft to more capable ISR platforms conducting operations over land reflects the importance of this air power role. Further, the ability of air power to prosecute an adversary with precision, speed and discrimination has become the preferred attack mechanism alongside direct Special Forces action on the ground. Importantly, all these roles are critical in integrated combined operations.

The RAAF is either directly conducting or supporting these operations in the Middle East and in Australia's immediate neighbourhood. They are being conducted in an operational environment against an adversary conducting irregular warfare. The USAF recently promulgated doctrine on *Irregular Warfare* in order to articulate the air power contribution to such operations. Air Forces of calibre will seize the opportunity to identify and learn lessons from current operations. For the RAAF, this provides an important opportunity to review and update its doctrine at all levels to encompass the concepts of operations for irregular warfare.

Air bases: sustaining air power

Air forces provide nation-states with responsive, adaptable and effective air power as an integral part of the military contribution to national security. They can conduct a wide range of air operations, from defence of the homeland to humanitarian assistance, wherever their nation's interests are engaged. However, the application of air power through the full range of military operations is completely reliant on assured access to secure air bases, in the right location with the essential support personnel and services. Availability and adequacy of air bases are therefore, critical considerations in planning air operations.

Key Points

- Air bases are capability systems in their own right, critical for the delivery of efficient air power in support of national security objectives.

- Air forces must retain the capacity to complement forward bases with specialist personnel and services to fully exploit air power's inherent flexibility.

- Even when operating from permanent bases, air forces must retain a core group of uniformed personnel to ensure organic capability to carry out combat operations.

Navies, armies and air forces all require bases to generate forces with the necessary capabilities to conduct operations. However, there is a fundamental difference in the way air forces utilise their bases to project power as compared to both navies and armies. Once the necessary force level capabilities have been generated, land and maritime operations are usually conducted away from naval and army bases, while air bases remain a crucial component throughout the application of air power. Inadequate air basing capabilities, not aligned towards air operations that fundamentally change the characteristics of a military base, will not permit air forces to employ air power in support of national security objectives. These nuances will be further explored and explained in a forthcoming CAF Occasional Paper. From the advent of air power as a military capability, the nature and location of air bases have been as important

a component of planning air operations and therefore, designing air forces as any other air power system. Ideally, an air base, whether permanent or expeditionary, will be a capability system in its own right that enables the optimum sustainment and so employment of an air forces' air power. It will also retain its inherent flexibility and provide a range of services such as being a command and control node and logistics hub supporting not only the air force but also a wide range of users.

Depending on the context, the success of air operations is reliant on forward air bases within the nation or on foreign air bases made available through political and diplomatic arrangements between governments. To fully exploit the operational freedom that such arrangements provide, air forces, especially those involved in expeditionary operations, must have the capacity to complement such forward bases with support personnel and services as necessary.

Operations away from home bases may require air forces to deploy personnel and systems that have an organic capacity to establish the full range of services from a base that has not been operational. For example, during the 1999 Operation STABILISE in the then East Timor, the air head at Dili was critical to the rapid deployment of forces. However, the airport infrastructure at Dili had been largely destroyed. In order to provide the basic infrastructure to conduct air operations, the RAAF's Expeditionary Combat Support Squadrons with force protection elements were the first to be deployed. They provided the skilled personnel, deployed systems and base protection to ensure that the airlift into East Timor was successful. The ability to create the infrastructure to conduct efficient operations is an intrinsic part of an air force and is fundamental to its ability to deliver air power that is effective and responsive.

An air force needs a critical mass of adaptable personnel to efficiently operate an air base in order to ensure that it can leverage air power's inherent characteristics of reach, flexibility and timely and rapid response to achieve stated objectives. The responsiveness of air power across the spectrum of conflict can only be realised by ensuring the

availability of an essential core group of military personnel with the skill sets required to establish, secure and operate an air base, often at short notice and in hostile circumstances.

Air bases are vulnerable and valuable, making them attractive targets. Aircraft and air bases are lucrative targets to adversaries who lack conventional air power capabilities. Forward deployment of air power assets is likely to be into hostile or uncertain security environments. In such cases, the personnel deployed to establish and operate air bases must also include base protection forces to provide adequate security for the deployed contingent, infrastructure, aircraft and systems. To develop the technical mastery necessary to support expeditionary air operations, air force personnel train for and practise supporting air operations from permanent air bases. This technical mastery must be complemented by specialised training provided to personnel for specific roles demanded in military air operations. The development and refinement of these essential skills will determine the way in which air force personnel are trained, the permanent air bases are operated and the larger air force organisation is shaped.

Specialised skills and professional mastery of air power are essential to understand specific air base requirements for each operation and to comprehensively plan, execute and sustain air operations. Air forces may choose to operate their permanent air bases using only uniformed personnel or a balanced combination of uniformed and civilian personnel. Depending on the size of the air force, the balance will vary. However, the forces' organic capability to deploy and operate from forward air bases, especially in combat operations, will depend on the availability of a minimum core group of uniformed personnel. Some air forces may seek to realise the full potential of their air power by operating a range of air bases in dispersed locations on a full-time footing. A smaller air force will not be able to sustain such an option.

Air forces must provide the capability to deploy and support responsive air power. This includes providing the capacity to operate permanent air bases from which they generate forces and the bases

from which they conduct deployed operations. These bases must have the full range of essential air power support services to optimise the use of the air forces' air power assets. The provision of these services, particularly from expeditionary bases, is a critical organisational consideration for smaller air forces whose resources are constrained for financial, political and other national reasons. Such air forces must adopt innovative designs and operating models to ensure the efficient generation and sustainment of their personnel and air power systems. They must also maintain an adaptable organisational capacity to conduct effective expeditionary air operations where and when required without compromising their capability to generate and renew their forces.

Superbase #1:
RAAF Amberley past to future

RAAF Base Amberley is the largest air base operated by the Air Force. Amberley currently employs approximately three thousand Service and civilian personnel and provides the permanent air base facilities for the F-111 strike squadrons and the C-17 strategic airlift squadron. RAAF Base Amberley is also the centre of the RAAF's expeditionary deployment capability, hosting the Headquarters of the Combat Support Group and the Airfield Defence Wing. Amberley is currently undergoing a major multi-phase redevelopment program to make it the RAAF's first superbase.

Key Points

- The expansion and development of the RAAF has historically been driven by strategic considerations for the air defence of Australia and achieved through establishment and design of air bases.

- Australia's ability to generate and apply air power is entirely dependant upon the provision of air base facilities and infrastructure.

- The superbase concept being initiated at Amberley will significantly enhance the ability of the RAAF to prepare for and conduct a wide range of concurrent air power operations.

From its inception, Amberley air base has played an important role in the expansion and strategic development of the RAAF. In 1925, Wing Commander (later Air Marshal Sir) Richard Williams prepared a detailed strategic argument for expanding the RAAF, including the establishment of a permanent air base near Brisbane. This view was supported in 1928 by Air Marshal Sir John Salmond, a senior RAF officer commissioned by the Australian government to review the state of Australia's air defences. Both Williams and Salmond concluded that Australia's strategic requirements necessitated the establishment of permanent air bases and flying squadrons at Perth, Darwin and Brisbane for the air defence of western and northern Australia. But, with the advent of the Great Depression, another

decade was to pass before the government's attention again turned to the defence of Australia.

It was not until 1938 that the RAAF established a presence at Amberley with the acquisition of a property (a dairy farm called Amberley) situated 50 km to the southwest of Brisbane. RAAF Station Amberley became operational on 17 June 1940 and the base was established on a war-time footing from the very outset. Although the superbase design model is a 21st Century concept, Amberley was a major RAAF air base during World War II and fulfilled a wide variety of functions for the generation of Australian and Allied air power. Throughout 1940-41, Wirraways and Hudson bombers based at Amberley prepared for the air defence of Brisbane and conducted patrols in search of German raiders and submarines. No 3 Recruit Depot and No 3 Service Flying Training School were also established at Amberley in 1940 and the station became one of the main air bases for the war-time expansion of the RAAF and the provision of aircrews as part of the Empire Air Training Scheme.

The entry of Japan into World War II gave renewed impetus to the tempo, scale and range of activities undertaken at the base. As the Pacific War intensified, No 3 Aircraft Depot was established in March 1942 and Amberley was transformed into a major centre for the assembly, maintenance and salvage of combat aircraft. Amberley also became home to hundreds of United States Army Air Forces personnel and served as a major assembly area and staging base for the vast numbers of the Allied coalition's servicemen and aircraft moving into the war zone.

After the war, and the RAAF's post-war demobilisation of formation and units, Amberley was retained as a permanent RAAF Station. In 1946, No 82 Heavy Bomber Wing Headquarters moved to Amberley. To this day No 82 Wing remains at RAAF Base Amberley and has retained responsibility for the RAAF's strike roles with successive generations of RAAF bombers – Lincoln, Canberra, Phantom and F-111 aircraft operated by No 1, 2 and 6 Squadrons. Amberley has always been more than simply the RAAF's bomber base. It has

provided the permanent air base support for a wide range of air power systems including RAAF and Army rotary wing squadrons. During the 1980s, Amberley also became the major operations and training centre for the RAAF's Combat Support, Security and Airfield Defence capabilities.

Amberley is currently undergoing a multi-million dollar redevelopment involving the extension and construction of runways, and the upgrading of engineering services, logistic support capacity and base facilities. Phase One of the project has been completed and future development of the base will ultimately see the Amberley superbase employing approximately 800 additional personnel and providing permanent base support for F/A-18F Super Hornets, F-35 Lightning II, KC-30B Multi-role Tanker Transport and C-17 Globemaster aircraft. The superbase concept also extends to the co-location of other ADF units such as Army's 9th Force Support Battalion which took up residence at Amberley in March 2008.

The superbase concept allows the RAAF to take advantage of economies of scale, synergies for greater efficiency and a variety of other benefits for the better generation of air power and the conduct of air operations. Air power relies on the ability to coordinate and integrate a range of air power systems working together to achieve strategic, operational or tactical objectives. The co-location of strike, fighter, air-to-air refuelling and air lift aircraft at Amberley will significantly enhance the Air Force's ability to effectively generate and apply air power by providing increased opportunities for the RAAF to develop, network and practice a wider array of air power operations involving multiple air power systems.

The grouping of a number of air power systems together offers the potential for more effective and efficient use of resources through the consolidation and improved integration of RAAF and industry services. It will also provide better opportunities for base personnel to develop their technical and professional skills by undertaking postings to a range of different units, supporting different systems and capabilities, without the need for postings to geographically distant

locations. A key feature of the superbase design is the construction and extension of multiple runways and support facilities that will enable an increased number of platforms to operate simultaneously from the base. The breadth and mass of the infrastructure also adds to the strategic depth of the RAAF to support air operations-allowing the base to accommodate a significantly increased tempo of operations, including the support of operations by additional Air Force, joint or coalition forces.

The optimum combination of air power and air power support systems on the Amberley superbase will ultimately provide an enviable capacity for concurrent activities. During peacetime, superbases have the depth to simultaneously conduct peacetime activities, such as support to civil surveillance programs, while conducting a range of training, exercises and maintenance that are essential to the raising, training and sustaining of the force.

Force transformation: shifting power to the edge

Concepts that have been developed for the private sector to manage business relationships can also have significance to the military. In particular, the new ways in which businesses interact for mutual benefit are relevant to our vision of net-centric capability. In the United States Department of Defence (US DoD), such concepts are being applied for the purposes of horizontal fusion and arrangements that assist to align operational missions, capabilities, C2 and information.

Key Points

- Value chains have fundamentally altered the private sector and may have military applicability.
- The concept has validity for the warfighter operating in complex and dynamic environments.
- To benefit from this concept, conscious decisions regarding levels of decision-making would have to be made.

Over the past decade the concept of value chains has become a key business approach. Value chains are typically associated with supply chain management, but are also applicable to broader relationships within the organisation. They also have applicability to the organisation's external relationships. Classically, the service provided by each supplier needs to add value up the chain. Thus, just as the end consumer has choices as to the value he or she wants from products or services (the quality and type, as well as the cost), similar relationships and choices exist throughout the value chain. As each organisation's strategy may differ, it is reasonable to expect that suppliers' services also need to be differentiated.

In the private sector, the value chain concept has been transformational in three ways. First, it has enabled organisations to work backwards from their own outputs to refine the value expected of their suppliers. Second, it has enabled businesses to analyse their relationships with other firms to optimise their market strategy,

position and profitability. Third, it has prompted the development of business networking, in which the relationship and management of value is shifted to the parts of the organisations responsible for providing or receiving respective services. This concept, also known as edge networking, represents a decentralisation of decision-making that might seem to conflict with the requirements for good governance. Yet there are examples of success in such decentralised arrangements, used in conjunction with central governance oversight.

From a military perspective, the benefits of value chain and business networking concepts in the private sector have not been immediately obvious. The value chain approach can be applied to the needs of warfighters in different operating environments, and could be extended to comprise not only logistics but also other supporting capabilities such as information system and ISR support. In ISR terms, this equates to a shift from a broadcast (or push) to a user defined (or pull) approach. However, the benefits of tailored services need to be balanced with the synergies and economies of a standardised approach, thus not all value chains within the military environment can be optimised.

An adaptation of edge networking is emerging within the US military. In the *Power to the Edge* concept, the Pentagon has identified that realisation of net-centric benefits may necessitate fundamental changes to command and control. The power exercised by a force comes from a combination of having correct and timely information to understand the situation, the authority to initiate necessary action and the resources to accomplish the task. Rather than these capabilities being entrenched within hierarchical structures, the US concept is based upon appropriate distribution of information, allocation of decision rights and direct interaction between force elements. Essentially the concept focuses capabilities in the parts of the organisation that need them the most, that is, those that interact to achieve net-centric capability—the edge.

The obvious way of achieving this concept is to empower those at the organisational edge to receive necessary situational awareness information, make decisions and interact directly with others that make up the net-centric force, rather than having to coordinate through the hierarchy. This is known as horizontal integration, which provides benefits of shorter decision cycles, increased flexibility and improved decisions within a harmonised force. This is directly linked to current thinking in the RAAF regarding decision superiority. Such arrangements can also have disadvantages, such as potential violation of the principle of unity of command and the loss of administrative efficiencies and oversight that are a characteristic of a hierarchical structure. Thus, such integrative arrangements might be advantageous primarily in highly uncertain and dynamic operating environments. The US DoD is investigating possibilities that, in the primacy of such dynamicism, flatter team structures might be used rather than traditional C2 hierarchies.

Horizontal integration is a fundamental aspect of net-centric capability within the tactical environment, in combination with vertical integration that caters for changes in command intent and the ability to receive from and contribute to wider situational awareness. Technical solutions, such as tactical data links between platforms, enable situational awareness and coordinated manoeuvre. These are increasingly being implemented across the range of ADF capabilities under the NCW roadmap. They must be complemented with measures to ensure that these 'edge' capabilities have the resources and authority to effectively act and interact within the coordinated force. Such measures, comprising adjustments to C2, doctrine, training and readiness management, collectively represent the human dimension that is the key to net-centric transformation.

Decision superiority

An analysis of history suggests that strategically out-thinking the adversary is often just as important to prevailing in conflict as out-gunning him. Warfare and conflict are clashes of will. They may be contested in the theatre of operations but, fundamentally, they are won or lost in the mind. In conflict, therefore, superior decision-making, enacted with operational competence, is the foundation of effective action and the primary path to success.

Key Points

- Decision superiority allows a force to seize and maintain the initiative—a fundamental prerequisite for military success.
- Diverse education and broad experience are critical to superior decision-making, especially in complex and ambiguous environments.
- Decision superiority is the outcome of an organisation's processes, structures and design that facilitate superior decision-making.

For Air Force to prevail in future conflict, it must possess decision superiority—the ability to dominate the decision space—to out-think, out-manoeuvre and outwit any potential adversary. Consequently, Air Force is pursuing decision superiority as a human, organisational and operational imperative. But what is decision superiority and why is it so important?

Decision-making is a human endeavour. It is conducted by people, between people, and regardless of the machines, technologies and mechanisms of waging war at any level, involve people analysing choices, deciding, acting upon those decisions, reviewing outcomes, learning, adapting and if necessary reconsidering. Decisions, therefore, are essentially distilled thought—the result of a cognitive process in which people make choices between various alternatives. It involves a determination of will to make a decision, even if the decision is to do nothing, to defer action, or to consciously not decide. Decisions can be the product of rational or irrational thought, made by rational or irrational actors, or they may be

intuitive, emotionally derived, subliminal or any combination of these. Fundamentally, however, decisions are a human cognitive process, which comprise acts of will and lead to chosen courses of action. The implications of this for military forces are substantial, and go to the heart of our understanding of the nature of conflict and the conduct of operations.

The ability to dominate the pace of decision-making and to make and enact sound decisions is critical for the success of military forces. Effecting change in an adversary, be it through physical force or non-physical means, is achieved in practice most successfully through the exercise of greater judgement and in making better, more timely decisions than the adversary, that is, in achieving superiority in decision-making. Superior decision-making allows a force to achieve and retain the initiative, which is a fundamental principle of all military action. By achieving and retaining the initiative, military forces are able, to the greatest extent possible, to control the pace, direction and flow of battle, enabling their forces to adaptively plan and implement pro-active action while forcing their adversary to adopt a re-active posture.

This is essentially what is meant by out-thinking an adversary. In complex and ambiguous situations, it is not possible to know with certainty how an adversary may act. The very best that can be achieved is a subjective appreciation of how one's own actions cause a response and which of ones own actions work 'best' and which do not. This is the basis of a simple 'adapting' or 'learning' cycle in which options are generated, tested, evaluated and retained if successful and rejected if unsuccessful. Being able to do this better than an adversary means achieving decision superiority in that particular and defined context. Being able to adapt faster than an adversary means being able to deal with new and unexpected situations as they arise more effectively than they do and thereby out-manoeuvre them to achieve desired effects or outcomes. Being superior decision-makers through superior adaptability and being able to make and enact

'superior' decisions therefore, is the key to prevailing in conflict and consequently of vital interest to Air Force.

Decision superiority may appear at first blush to simply mean the ability of individuals to adapt and make superior decisions. While this is an important part of the idea, decision superiority is a far more inclusive and nuanced concept than the name might suggest. A definition that captures the multi-faceted nature of the concept and the significant undertaking necessary to achieve and maintain it is:

> *Decision superiority is the degree of dominance in the cognitive domain an organisation achieves through its decision-making processes that enables it to acquire and maintain an advantage over its competitors.*

Using this definition, decision superiority refers not only to the human aspect of making 'better' decisions, but also to the broader organisational and operational attributes and philosophy that embraces the value, necessity and demands of prevailing in the decision-space. From this perspective decision superiority has three domains—human, organisational and operational.

The human domain—concerning the individual members of the organisation—is undoubtedly the most important. It entails the acquisition of knowledge through reasoning, intuition or perception, that is, cognitive processes and the resultant decision made by individuals who comprise the organisation. While much has been written on decision-making within a variety of environments, most researchers agree that effective decision-making can be enhanced and augmented through education and training.

Effective organisations are those designed to decide. Subsequently, structuring an organisation to decide effectively is essential in achieving decision superiority. This structuring involves implementing effective and appropriate organisational design that facilitates an adaptive stance and promotes decision-making and implementation throughout the organisation. This organisational design includes implementing pathways of communication (both

electronic and personal), and processes that enable decisions to be made and enacted quickly, transparently and effectively. It ensures that identified decision-makers at all levels throughout the organisation are resourced, authorised and held responsible for making and implementing decisions in a timely and considered fashion. Organisations structured to decide—decisive organisations—therefore, have a culture that values superior decision-making and are structured for institutional learning.

The ultimate manifestation of decision superiority is in the operational domain. Being able to prevail over an adversary is a function of out-manoeuvring them operationally. The operational dimension of decision superiority therefore, shapes how a force is commanded and employed to optimally exploit the capabilities at its disposal.

Decision superiority, consequently, encompasses not only the outcomes of good decision-making, but also the processes, structures and organisational design that facilitate and enable superior decision-making. It refers not only to the human aspect of making 'better' decisions, but to a much broader organisational attribute and philosophy that embraces the value of adaptability as the best means of making superior decisions. Decision superiority is an enabling concept, which if utilised as an underpinning philosophy of the Air Force enterprise, has the potential to fundamentally alter the way the RAAF operates. It is a tool set that enables disproportionately greater outcomes for a given input.

Realising true net-centric capability: integrated readiness management

Network Centric Warfare (NCW) is a concept first introduced by US Vice Admiral Arthur Cebrowski and Mr John Garstka in an article in the US Naval Institute Proceedings in 1998, and subsequently described in a book of the same name published by the US DoD Command and Control Research Program. It reflects the US Joint Vision 2010 view of future warfighting as a system of systems and describes the value of increased effectiveness gained through the linking of dispersed forces.

Key Points

- NCW creates force multiplication through sharing of situational awareness, information and the harmonisation of manoeuvre.
- Professional mastery is a primary requirement to build force effective force level training.
- Synthetic training has a number of advantages that enhances integrated training.

The NCW concept has since been embraced widely by military forces across the world, under varying terms but with a common theme of force multiplication through sharing of situational awareness information and the harmonisation of manoeuvre to achieve unity of effort. The ADF introduced its NCW Roadmap in 2005, which was updated in 2007 to better summarise the initiatives and milestones for information integration of the force. It is now complemented by a supporting roadmap for improvement of Intelligence, Surveillance and Reconnaissance (ISR) capabilities.

In itself, technology integration initiatives can enable an improvement in effectiveness, but such a result is not assured unless other measures align the organisation, processes, training and culture with a net-centric approach. The NCW roadmap highlights the need to improve these aspects through research into the human dimension of NCW.

In the past, our raise, train and sustain arrangements in Air Force have been oriented towards achieving readiness of individual force elements. Regardless of the importance of NCW, professional mastery in such areas of specialisation will remain critical. Our requirements for professional mastery are well understood and have associated competencies and processes by which they can be measured to gauge readiness. The same might not be said in respect of force-level capability.

Our method of assessing force-level preparedness has been based largely upon aggregation of the levels of individual readiness, rather than any measure of how well the elements interoperate. Similarly, the doctrine and tactics, techniques and procedures that address collective interaction are exercised periodically and rarely are effectively measured.

Thus, a conceptual view of the ADF approach to preparing for operations would feature a focus on specialisation during preparation, with the focus shifting to integration during operations. The extent of this shift brings about a corresponding level of risk, which is more prominent in joint and coalition environments. Too great a shift will mean that collectively we do not train as we fight. To quote a recent presentation from a USN Pacific Fleet commander, 'the conflict zone is no place to be exchanging business cards'.

The challenge therefore is to ensure an adequate level of force level training whilst not impacting the attainment of professional mastery achieved through training within capability specialisations. Indeed, given the current tempo and demands upon our workforce, it is difficult to contemplate the burden of additional training. Nevertheless, there is merit in introducing an integrated approach to training and readiness management that balances specialised and force-level competencies through the following principles:

- Scenario-driven integration, based upon the likelihood that elements will need to interoperate and the benefits of training between these elements;

- Existence of associated doctrine, procedures and technology to support this interoperability;
- Use of synthetic training to complement live training; and
- Definition and measurement of training objectives to determine readiness and identify areas for improvement.

These four principles for integrated readiness management essentially translate as: establishing the need, enabling integration, training, and measuring readiness. The first two elements are satisfied through the existing preparedness framework and joint warfare doctrine, as well as the developing efforts on irregular warfare. A comparison of the needs for integration with current exercise activities would reveal gaps in our collective training to support integrated readiness.

Synthetic training is often referred to as Distributed Mission Training (DMT) in that it allows force elements from dispersed geographic locations to interoperate. It also allows training to be in the form of live, virtual or constructive capabilities, or a mix thereof. The benefits of using synthetic training to resolve gaps in our collective training are substantial. They include C2 integration, flexibility of employing elements within the force, tailoring exercises to meet collective and individual training objectives, ability to include aspects of the environment not easily replicated in a live environment, greater ease of scheduling training activities across multiple force elements, choice of live, virtual or constructive involvement (depending upon availability and respective training objectives) and the ability to achieve training objectives with resource efficiencies compared to live training alternatives.

Thanks to initiatives such as Joint Combined Training Centre (JCTC), Air Force will increasingly participate in synthetic training at joint and combined levels. This training will range from discrete and focused events (such as a 2v2 between a RAAF Hornet simulator and a USAF F15E simulator), to work-up and mission rehearsals (such as RAAF air battle managers practising working with allied virtual and constructive elements in a synthetic ISAF Battlespace),

to virtual exercises (such as the Wedgetail simulator participating in a Virtual Flag exercise).

Another benefit of synthetic training is that it is well suited to integrated readiness management through objective setting and measurement, and after action review. Objectives can be deliberately established for typical scenarios and refined for more specific situations. Measurement against these objectives will identify required remediation and provide a more accurate indication of force readiness. A tool and method of readiness management has been trialled within various parts of the ADF and by JCTC in Exercise Talisman Sabre 07. Indications are that use of such tools in conjunction with integrated training activities will provide an effective bridge between the raise-train-sustain and operational environments.

The planned introduction of integrated training and readiness management will be gradual, having begun with Talisman Sabre 07 and continuing in 2008 with limited training events and use in exercises. This will help maintain and ensure recognition of our professional excellence in training and in operations. It will require understanding across Air Force of the benefits and a commitment to taking advantage of synthetic training and readiness management portunities. In this way, we will train as we fight and Air Force's overall operational capability, effectiveness and survivability will benefit.

Centralised ISR:
the bedrock of campaign success

Historically, military forces have been complex organisations. But the changes that are taking place in the threat spectrum and the demands being made of modern military forces are giving a completely new dimension to the complexities that face them. The greatest challenge that military planners face today is that of uncertainty. This complexity and the ensuing uncertainty have been amplified manyfold by the advent of the information age.

It is universally agreed that today we are living in the information age.

> **Key Points**
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> - ISR is a part of the national intelligence network and is critical to military operations.
> - ISR inputs are provided to all elements of national power as required and are not exclusive to military forces.
> - Only centralised coordination of ISR assets and processes will create optimum relevance, accuracy and timeliness in their employment.

Even in our day-to-day lives most of us receive a large quantity of information from many different sources. This flood of information, wanted and unwanted, can become overwhelming if not properly managed. Advances in technology have effectively brought this phenomenon to the battlespace. In the military domain, such 'information overload' can lead to a situation wherein critical information may not be readily discernable to commanders, causing possible paralysis of the decision-making apparatus—a recipe for failure.

It is, therefore, not surprising that in recent years, intelligence, surveillance and reconnaissance (ISR) has assumed critical importance, especially in military operations. The ADF defines ISR as an activity that synchronises and integrates the planning and operations of sensors, assets, and processing, exploitation and dissemination systems in direct support of current and future

operations. This is an integrated intelligence and operations function. ISR is a part of a larger national intelligence network and seeks to provide decision-makers, at all levels, with detailed information and intelligence regarding likely courses of action, doctrine, strategy, tactics, infrastructure and any other factor that could have a bearing on an adversary's will and warfighting capability.

ISR is a process-based activity that creates understanding by adding value to available information through analysis and assessment. Value is added by the process of analysis using knowledge and other factors that convert information to intelligence. A human element is always part of this transformation. Military forces use this process-based approach as a fundamental tool, mainly because the focus of military operations is the ambiguous and uncertain domain of the adversary's thoughts, ideas and intentions.

On the positive side, information technology, coupled with high-speed communications has provided commanders at the highest strategic level access to an ever-widening picture of the battlespace. Simultaneously, it also provides the warfighter at the tactical level with the capability to apply force—both kinetic and non-kinetic— with extreme precision, based on this information and intelligence.

Currently strategic national security is increasingly being viewed within the paradigms of a National Effects-Based Approach (NEBA). NEBA is oriented to encompass all the disparate elements of national power, mainly the military, diplomatic, economic and information capabilities, which will be used in combination on an as-required basis to ensure national security. The military forces rely on the concept of network-enabled warfare to operate within the NEBA. This is about creating a force with sufficient flexibility and adaptability that is capable of generating the desired effect within the context of a given operation. This force should be able to respond rapidly to emerging threats and also capitalise on fleeting opportunities in the battlespace. From a technical perspective, it is about networking the entire force by facilitating the sharing of huge quantities of information by the

use of communications technology. This could involve ISR inputs to agencies other than the traditional military forces.

The primary capability that network-enabled warfare brings to military operations is increased situational awareness (SA) at all levels. SA is critical in all phases of a campaign, from the basic planning stage to the conduct of operations and the concluding drawdown. Currently available technology facilitates the fusion of information from multiple ISR assets and its display in widely dispersed data screens, even in cockpits. However, to ensure that this information translates to adequate SA, it will have to be analysed to present a credible picture of the situation in the field. This is the basic human factor in ISR. Unfortunately, this aspect of ISR is often overlooked because of over emphasis on technology.

ISR provides SA at the operational level to fine-tune campaign plans and, at the tactical level, the capability to carry out time-sensitive targeting. A robust command and control (C2) and ISR capability that is networked adequately is a critical factor for success in a campaign.

ISR has to be timely, accurate and relevant—a primary foundational requirement. While accuracy is a laid down absolute, the other two attributes are almost always relative. Accuracy of information can be judged in more or less black and white terms, being either right or wrong. However, timeliness is relative to context and puts a strain on the analytical process. The more time that is available to analyse information the better the intelligence output and SA should be. However, this process has to be optimally dovetailed with the urgency to get the intelligence to the decision-maker. Similarly, relevance also is relative to the context and level of decision-making.

Large amounts of data/information/intelligence can be made available at the strategic level where the time and 'collaborative space' available for decision-making is the maximum. However, the availability and analysis needs to be centrally managed to ensure the appropriate prioritisation according to the commanders' requirements. As the level of the decision-maker moves down to the tactical, the available

time also becomes constrained, making it necessary for intelligence of direct relevance to the mission only to be passed to that level. The human element in this process cannot be over emphasised.

The current challenges facing the ISR process are daunting. In the future these challenges will only increase in number and complexity as the adversary becomes inured to the warfighting methodology of nation-states. The operational tempo in the modern battlespace means ISR has to be almost real-time if it is to be relevant. The distilling of intelligence from the large amount of information that is collected—and doing it within the ever decreasing time-span available—is a difficult task. Further, to ameliorate strategic ambiguity, it is also necessary to analyse a broader range of information, increasing the pressure on an already compacted timeframe availability. Consequently, the pressures on the human analysis process are incredibly high.

Only centralised coordination of the ISR process will be able to ease these pressures and optimise the relevance, accuracy and timeliness of the output from information gathered from different sources—from satellites to human sources in the battlefield. Any other model is bound to fall short and have a negative impact on the chances of campaign success.

Active electronically scanned array radars: part 1 – overview

In this two-part Pathfinder series, we will be looking at a significant evolution in airborne technology that will soon be part of the Air Force's inventory–the active electronically scanned array (AESA) radar. Since their inception in the 1960s in ballistic missile early warning systems, AESA radars have been heralded as extraordinary multi-tasking pieces of equipment able to act not only as multi-mode radars but also as electronic warfare scanners, jammers, airborne modems

Key Points

- AESA radars are an aircraft designer's dream, requiring less space and providing longer range with less risk of mechanical failure.

- They can act not only as multi-mode radars but also as EW devices and even electromagnetic weapons.

- As manufacturing costs come down, AESA radars will be more common in military aircraft.

and even as electromagnetic weapons able to fry electronic circuitry. A simple overview of how AESA radars work is provided in this part, while Part 2 discusses how significant this technology will be in the airborne environment.

What exactly are AESA radars? In principle, radar works by transmitting a small pulse of electromagnetic energy and then detecting any portion of the pulse reflected back. To transmit the pulse, some form of an antenna is required. Traditionally, for airborne applications, these antennas have been mechanically rotated parabolic dishes whose size ranged from about 30 centimetres in small fighter aircraft to over 9 metres in Airborne Early Warning and Control aircraft. While the radar principle will work over a wide range of frequencies, most airborne applications use microwaves, as they require smaller antennas and this frequency band provides good angular and range resolution. To locate a target, the parabolic antenna (and hence the electromagnetic beam) is repeatedly moved through a pre-programmed search pattern. To change the radar's

mode of operation—from, say, air-to-air to air-to-ground—requires a mechanical readjustment of the antenna, which means there is a break in radar coverage.

AESA radars, on the other hand, are flat grids made up of thousands of tiny modules that can transmit and receive radio energy, called TR modules, linked together by high-speed processors. (Think of a pizza with thousands of small olives all lined up and you will get the idea.) These TR modules are digitally controlled, self-contained solid-state devices made up of a transmitter, a receiver, a power amplifier, a phase delay unit and a small spike-like antenna. Typically, four TR modules are mounted on a 2.5 centimetre cube giving a density of about 3000 modules per square metre, once mounting brackets are factored in. Each TR module has a peak power of about 10 W with an average power of about 2 W; therefore a square metre of TR modules will have a peak power of about 30 kW and an average power of about 6 kW. By way of comparison, a GSM mobile phone has a peak power of about 2 W and an average power output of about 250 mW.

The advantages of this simple building block approach to radar design are many. Vastly simpler mechanical designs are possible, as there is no rotational movement of the antenna head. In addition, as the antenna does not rotate the radar occupies less space. Less space means that either a larger antenna can be fitted into a given volume, thereby improving the radar's range and angular resolution, or it weighs less—always an important factor in aircraft design. Because the receiver is always aligned with the transmitter (unlike a rotating radar where the antenna head will have rotated when distant returns are received), AESA radars have much longer ranges than equivalent conventional radars. As there are fewer moving parts, an AESA radar is also less prone to mechanical failure. Further, as an AESA radar has multiple transmitters and receivers, this means that it does not have a single point of failure but instead can gracefully degrade. AESAs are able to lose approximately five percent of the TR modules before the radar unit in them requires repair due to decreased performance.

The beam of an AESA radar is steered by electronically adjusting the phase of a row or column of TR modules compared to their neighbours using the phase delay units. This electronic control allows the radar's beam to be steered with vastly greater agility and precision than mechanically steered radars, taking micro-seconds (10^{-6}s) rather than tens of seconds (10s) to reposition the beam. Fast scan rates allow AESA radars to operate in multiple modes (air-to-air, air-to-ground, synthetic aperture radar, weather, jamming etc) in near real-time. Fast scan rates, along with variable power output and no side lobes, means that AESA radars are resistant to electronic counter-measures (ECM), as it is difficult for an ECM device to find the correct azimuth and elevation of the transmitter's main lobe to attack. They also have a low probability of interception, as the radar only 'looks' in any particular direction for a very small fraction of a second. As the radar antenna of an aircraft is a significant radar reflector in its own right, the faceplate of AESA radars in military aircraft are often tilted upwards, typically 15 degrees, to reduce its own radar cross-section to ground-based radars.

There are, however, drawbacks to AESA radars. The power efficiency of a TR module is approximately 50-67 per cent. As a result, the modules produce a lot of heat, which must be removed to improve reliability. Due to the high density of modules in a typical radar, air-cooling is impractical, so most AESA radars are liquid cooled which adds to the complexity, power requirements and weight of the system. With TR modules reportedly costing around US$2 000 each and with a typical AESA radar requiring several thousand modules, an antenna alone might cost US$4 million. However, as the technology improves and more aircraft are fitted with AESA radars (especially in the civil sector), manufacturing costs will reduce significantly.

So, in many respects, AESA radars are an aircraft designer's dream. Not only do they provide additional functionality, they do so with improved performance and reliability with less weight, size and power consumption.

Active electronically scanned array radars: part 2 - the significance of AESA radar technology

In the first part of this series, we discussed how AESA radars work; this part will look at the significance of this technology in the airborne environment.

To demonstrate the versatility of AESA radars, consider the problems associated with detecting and defeating a low-level, high-speed cruise missile against a cluttered, noisy, background. Before we start, we need to explore the problem of detecting cruise missiles with radar. A radar with a high Pulse Repetition

> **Key Points**
> - In civil use, AESA technology will provide significant safety enhancement.
> - Future development may include airship-mounted radars able to monitor all modes of transport within Australia.
> - The advantages of AESA radars are so compelling that it is unlikely that any military organisation will procure any other sort of radar by choice.

Frequency (PRF) provides unambiguous, nose-on speed resolution and good clutter rejection, while a radar with medium PRF provides good low-speed resolution but suffers from low detection range, and a low PRF radar provides unambiguous target ranges but suffers from poor clutter rejection. Therefore, to detect a low level, high-speed cruise missile in clutter, using mechanically scanned radars, would require either three different radars or a single radar capable of sweeping at high, medium and low PRF–a time consuming process with a mechanically scanned antenna. With an AESA radar, however, different parts of the radar antenna can be assigned to perform these different scans almost simultaneously, allowing the missile not only to be detected but tracked as well. Then, by linking the radar with the on-board electronic warfare system, an electronic attack (such as jamming, spoofing or directed energy) can be mounted against the missile–through the radar–at greater ranges than would be possible

using a typical fighter aircraft's onboard electronic warfare system alone.

Predominately because of their cost, the main airborne use of AESA technology at the moment is in fighter aircraft, specifically the F/A-18E/F, F-22 and F-35. As the current crop of fighters, such as the F-15, F-16 and F-18A/B, undergo mid-life upgrade programmes their radars will be replaced with AESA technology. AESA radars will also be fitted to the new crop of Airborne Early Warning and Control aircraft, where the true impact of being able to rapidly switch radar modes has yet to be fully determined, and will then trickle down to maritime patrol aircraft and eventually military transport aircraft.

As the technology matures and costs reduce, AESA technology will find its way into the civil sector where its multi-mode features will provide a significant safety benefit. Traditionally, the only function that radar performed in civil aircraft was weather detection. By introducing AESA technology, civil aircraft will not only have an improved weather radar, they will also have improved airborne collision avoidance (through the AESA radar's air-to-air modes) as well as improved ground avoidance (through its air-to-ground modes reducing the probability of controlled flight into terrain). In addition, taxing aircraft will be able to monitor other taxing aircraft, thereby reducing the probability of a runway incursion or a taxing incident.

AESA radars are also capable of performing highly specialised radar functions such as Synthetic Aperture Radar (SAR)—detecting small stationary objects and producing a picture-like image—and Ground Moving Target Indictor (GMTI)—detecting moving surface targets.

Besides being a radar, AESA radars can be a broad-band noise and reactive jammer, not quite as good as a dedicated jamming platform but much better than having to fit a dedicated jamming pod on an aircraft with the associated weight and performance penalties. They can also act as a directed-energy weapon, again not as powerful as a dedicated system, but an AESA radar can focus its energy on a target for longer (because it can also track it) and thereby overcome the lack of peak power by increasing dwell time on the target to burn

electronic circuits. Surprisingly, an AESA radar can also act as a high speed data link by attaching a modem, generating data transmission speeds of approximately 548 Mbps and data receive rates of up to 1 Gbps. These data rates are significantly better than the 1 Mbps of the current military standard airborne data link (Link 16).

Future development of AESA technology, besides reducing size, cost, weight and improving efficiency, include very large apertures (about 6 million TR modules mounted on a 6000 m² antenna). An antenna of this size might need to be carried on an airship rather than an aircraft, but would allow very small objects, perhaps even humans, to be detected over very large ranges–ideal for border security. Other avenues under development include conformal arrays, where the TR modules are mounted on the skin of an airborne platform, or, even better, the TR modules are part of the platform's structure. Such arrangements would allow airborne vehicles to have spherical radar coverage. With spherical radar coverage and approximately 16 airships at 60 000 feet, all modes of transport within continental Australia–air, land, sea and space–could be monitored. Such a system would provide real time border security, air traffic control, ballistic missile detection, cruise missile detection, road and rail traffic monitoring and national weather radar.

For a given size and weight, AESA radar technology provides significantly more capability than competing approaches, due to more power, lower losses and increased flexibility. Further, the AESA design provides inherently superior countermeasure resistance, enhanced range resolution, and more flexibility to support non-traditional radar modes such as jamming and ESM. In addition, AESA technology supports high reliability/low maintenance designs with associated lower life-cycle costs. These advantages are so compelling that it is unlikely that any military organisation will procure any other sort of radar by choice.

Uninhabited combat aerial vehicles: reality or elusive dream?

In the complex and high density modern battlefield, missile-armed uninhabited aerial vehicles (UAV) have become an accepted and ubiquitous presence over the past few years. What these platforms offer is long loiter times compared to manned equivalents, demonstrating a persistent on-call precision strike capability. They, however, do not have autonomy or any other combat characteristics, or even the aerodynamics needed to operate as a dedicated air-to-air fighting platform. These are the fundamental characteristics required in a true uninhabited combat aerial vehicle (UCAV). So, the question is whether or not the concept of an operational UCAV is too far-fetched to be converted to reality in the near to mid-term future?

> **Key Points**
>
> - Technological advances in composites and artificial intelligence have reinvigorated the development process of Uninhabited Combat Aerial Vehicles.
> - There are still a number of issues to be ameliorated before any meaningful employment of UCAVs can be undertaken.
> - The level of autonomy that can be granted to future UCAVs, even those with the most advanced artificial intelligence on-board, will have to be decided at the highest political level.

As in the case of most air power concepts, the UCAV concept was developed almost in parallel to the early flights of unmanned drones. The confirmed success of uninhabited flights and their immediate maturity for battlefield use gave rise to the concept of them being employed in combat duties. The advantage of such a combat platform, especially in carrying out dull, dirty and dangerous missions that would place aircrew under unacceptable risk, was readily recognised. However, until quite recently the technology required to develop platforms with the necessary capabilities were either not available or were only in their initial development stage.

Now it is believed that the technological challenges that stymied the growth of the UCAV concept into reality can be ameliorated. Composite material technology has advanced enough to provide the necessary impetus to UCAV development with work in the field of artificial intelligence and computer generated autonomy fairly well advanced—enough to make enthusiasts predict the imminent arrival of the complete UCAV in its operational debut. There are, however, a number of issues to be addressed before this dream can become a reality.

The first issue, as in the case of all cutting edge developments, is the cost factor. An autonomous UCAV will cost a great deal more than the currently operational UAVs. Further, any design that incorporates stealth will make the cost of development as well as the unit price of the platform go up even more. Under these conditions, the affordability of UCAVs—in the numbers that are being predicted—would perhaps remain a question mark, thereby restricting their operational employment to few air forces. This could also be thought about as a silver lining, because the overall identification and integration of UCAVs in combat conditions could well prove to be a quagmire.

Second; the need for high speed capability in UCAVs, because of their perceived use to defeat sophisticated air defences in the first day of a war with minimum attrition. This requirement translates to more powerful engines, greater fuel carrying capacity and larger number of dedicated weapons, which in turn will make the vehicle a much larger platform than any of the current UAVs. The technical and operational sophistication required to employ UCAVs will also increase the logistical foot print correspondingly.

The third issue, which may be the most difficult to overcome, is the fact that future UCAVs are conceptually meant to operate in hostile air spaces, whereas the current UAV operations are almost completely restricted to benign and uncontested air space. The characteristics of the vehicles required to operate in both these situations are very different and extremely difficult to incorporate into a single entity.

More than that, for optimum effectiveness, UCAVs need to be able to operate as self-contained platforms from their launch to recovery, much in the same way as manned combat aircraft operate. This requires granting significant autonomy to on-board artificial intelligence and other data processing capabilities. Even if artificial intelligence development reaches a theoretical point of fool-proof validation, it is difficult to imagine any government allowing autonomous UCAV operations in today's restrictive political and strategic environment.

Even in circumstances where only limited numbers of friendly UCAVs are operating, a critical issue that is yet to be resolved is the need for the UCAVs to be able to communicate effectively with each other and manned aircraft both to avoid collision and to disseminate data that has been gathered by their on-board sensors ahead of the manned package arriving in the battlefield. However, rapid improvements in communications technology may ease the situation fairly soon.

Even before any success has been achieved in operationally employing UCAVS, there is already a growing belief that two independent, mission-oriented types of UCAVs need to be developed simultaneously. The first would be the strike platforms that are meant to open up the enemy air defences in the initial stages of the war and send back collected data in real-time and the second would be UCAVs optimised for air combat that will protect the strike platforms from enemy fighters and other airborne threats. In addition, there would also be the need to have stealthy tanker UAVs with autonomous refuelling capabilities to enhance the range of the entire strike package. The scenario has suddenly become extremely complicated! For the time being however, the UCAVs being developed are being designed with stealth characteristics as their primary self-defence. This is expected to allow the strike UCAVs to operate without supporting packages.

The real issue is actually not so much whether a truly autonomous UCAV can be built, but its suitability and affordability as an

alternative to other conventional strike packages. As in any other case, trade offs between survivability, onboard sensor suites, weapon carriage capability and combat performance requirements would have to be made, within the constraints of finite resources. The problem here is that the UCAV does not have the mitigating factor of a human on board to smooth over inherent drawbacks in performance and capability.

Even with all these teething problems, UCAVs will become a reality sooner rather than later. What has to be understood very clearly, by planners and operators alike, is the fact that even after UCAVs become a viable option for employment in extremely dangerous situations, they are not an instant panacea to problems that face the conduct of air strikes. They lack the spatial awareness and judgement inherent in a manned aircraft, and the intuitive 'sixth sense' that a pilot's peripheral vision brings in moments of extreme stress and danger. At least for the foreseeable future, application of air power will be most effective and efficient when carried out with a human in-the-loop.

Hypersonics: serious science

'Hypersonic' platforms are defined as those travelling at Mach five or above; a minimum of five times the speed of sound. In July 2006, Pathfinder 49 introduced us to a future with hypersonic platforms and discussed some of the implications of the technology. It listed a number of challenges, risks and benefits likely to be faced by military forces introducing such systems and in meeting the forever-altered nature of threats if they were owned by an adversary. Importantly, most of the challenges and risks still do not have effective solutions. When hypersonic platforms finally become operational they will dramatically alter the nature of force projection from the third dimension.

Key Points

- The realisation of hypersonics into practical air power applications may revolutionise air warfare.
- Despite recent advancements, development of the technology needed for practical hypersonic systems continues to be problematic.
- University of Queensland and DSTO are well positioned to collaboratively lead the way in the progression of hypersonic systems.

Hypersonic is still considered by many to be a disruptive technology. Defined simply, a disruptive technology is one that unexpectedly displaces an established technology in such a way that revolutionary change takes place—the internal combustion engine is an example. Hypersonics is a disruptive technology as it has the potential to render large proportions of established military inventory and tactical doctrine obsolete, radically and forever altering the way warfare is conducted. Those who lead in this field could gain a formidable advantage.

Hypersonics is not a new science. In 1949 a US version of the German V-2 rocket reached 5150 miles per hour. In May 1961 Russian Major Yuri Gagarin became the first human to travel at

hypersonic speed during the world's first piloted orbital flight. In June the same year Major Robert White exceeded Mach 5 in the X-15, a US research aircraft; in November he broke his own record reaching Mach 6.04.

Despite advances since those pioneering flights, hypersonics continues to be a challenging science. At Mach 5 the temperature in the boundary layer on the surface of the vehicle rises to 1 000°C, and dynamic pressure increases to 25 times atmospheric pressure. This alters the state of the particles within that layer dramatically. The pressure and heat cause molecules to dissociate, meaning molecular bonds are broken and they become plasma; a soup of individual atoms and electrons where chemical reactions cause new compounds to be formed. The complexity of atmospheric effects increases and aerodynamic behaviour begins to diverge from conventional subsonic and supersonic principles. These complex conditions of flight and the massive energy levels required to achieve such speed demarcate hypersonic from supersonic, and challenge scientists to extend the application of this field to practical use.

For the last 50 years, development of air-breathing hypersonic platforms has remained in the experimental domain with, until recently, only marginal progress. The successful launch of an experimental hypersonic vehicle incorporating a promising new technology in 2002 was a breakthrough that indicated the transition of hypersonics from hypothetical future to foreseeable reality. Nations world-wide have committed more resources to the development of hypersonics technology. Notably, India and Russia have recently embarked on project BrahMos-2, which aims to build hypersonic missiles to be fitted to Sukhoi SU-32 aircraft and, most likely, naval vessels. Clearly, the threat of hypersonics in our battlespace must be considered as an emerging reality. It is therefore imperative that we consider its impact on emerging capability systems and our approach to conducting warfare as a priority.

Scientists at the University of Queensland (UQ) have been actively progressing the field of hypersonics for the past 20 years. The Defence

Science & Technology Organisation (DSTO) recently enhanced its 'hypersonic' links with UQ by funding a Hypersonics Chair at the University and committing to collaborative development of the 'T4 shock tunnel'—the University's ground test facility for modelling of hypersonic flight—another step in realising practical applications of the technology.

The collaborative efforts of UQ and DSTO will focus on the supersonic air-breathing engines known as SCRAMJETs. Together, UQ and DSTO accomplished the world's first successful flight of a SCRAMJET or Supersonic Combustion Ramjet during the launch of HyShot II at Woomera, South Australia on 30 July 2002. HyShot III, launched successfully in 2006, reached speeds in the order of Mach 7.6 and HyCAUSE reached Mach 10 in 2007.

The development of SCRAMJETs seeks to overcome a major limitation of rockets: their reliance on fuel and oxygen carried on-board. Because a SCRAMJET draws oxygen from the air through which it travels, it can be smaller than a rocket capable of achieving a similar range and speed.

In military applications, a hypersonic air breathing weapon can be much smaller than a comparable supersonic weapon or short range ballistic missile (SRBM). For a given platform size, hypersonics can improve weapon effectiveness by reducing time of flight and/or increasing stand-off range, and also increase the weapon effect markedly due to the massive increase in kinetic energy.

Fitting hypersonic weapons to conventional air platforms however, will remain problematic. Even with the size reduction, such systems are unlikely to fit into fighter-sized aircraft due to the size of the initial booster system required to reach the high supersonic speeds necessary for combustion to begin in the SCRAMJET.

Countering offensive hypersonic systems presents another demanding challenge. Their tremendous speed means the window of opportunity to detect, identify, track and respond will generally be far too short for current-day defence systems. Even if a system could

respond quickly enough, the time available to launch and accelerate the defence weapon to a suitable intercept speed will be insufficient. Additionally, achieving the targeting accuracy and manoeuvrability required to bring the two hypersonic projectiles to a common point in space will be a problem well beyond the capability of current systems.

Directed Energy (DE) weapons have, in the past, been proposed as viable defences. In fact, these systems would face similar targeting and engagement dilemmas. It is a popular misconception that since directed energy weapons transmit energy at the speed of light they have an almost instantaneous effect. In reality, they operate by dwelling on the target and raising its temperature sufficiently to cause failure. This would be particularly difficult against a hypersonic target because they are hard to track, very resistant to external heating—considering their own requirement to withstand very high temperatures—and offer very little dwell time for the directed energy to take effect.

The difficulty in countering hypersonics works in favour of a force that understands and can employ the technology. With DSTO and UQ on the task, we can reasonably anticipate improvements in hypersonic system design, further expansion of the research and, hopefully, practical application of the technology. Australia is now well-placed as a nation in the global, hypersonic race.

Evolution of australian military space

At first glance, the importance of Australia's military involvement in space would seem to be limited. Measured in terms of ownership of space assets, or space launch capabilities, Australia's military has been a small player in events. However, the ADO has had a long association with space; this Pathfinder will explore just a few examples of that association over the past half-century.

Key Points

- Defence has been involved in space activities since the dawn of the Space Age.
- CAF now has a central role in managing Defence's space involvement.
- Defence is working towards being an informed consumer of space products and services.

The birth of the Space Age occurred on 4 October 1957, when a Soviet rocket launched from the Tyuratam range in modern-day Kazakhstan propelled the first artificial satellite, *Sputnik I,* into a 22-day orbit around the Earth. This development surprised the world and brought home the growing realisation that such a rocket could just as easily deliver a nuclear warhead.

Prior to this event ADO, through the Weapons Research Establishment (WRE, now DSTO) at Woomera, SA, was already supporting the launch of rockets that flew above the edge of space, nominally agreed as starting at 100kms altitude. The British *Skylark* missile carried research payloads up to 150kms, and was first launched on 13 February 1957. Launches of this type have continued to form part of the Woomera landscape.

Over the past several decades testing at Woomera has been conducted in support of, first Britain, and then the European Launch Development Organisation (ELDO). Trials involved guided weapons, ballistic missiles and missions to launch satellites into space.

The culmination of the WRE space-launch trials at Woomera occurred just 10 years later, on 29 November 1967, when Australia

became the fifth country (third from its own territory) to launch a satellite. The WRESAT (Weapons Research Establishment Satellite) project took less than a year from concept to launch, with the satellite being developed by WRE in partnership with the Department of Physics at the University of Adelaide. The battery-operated satellite collected data about the composition of the upper atmosphere but lacking solar panels it had only enough power to send back data during its first 73 orbits around the Earth. WRESAT finally re-entered the atmosphere on 10 January 1968 and disintegrated over the Atlantic.

Although the WRE and Defence played a supporting role in this endeavour, and Australia declined to invest in further rocket capabilities, Defence was able to monitor and validate the technologies being tested, and provide advice to government on other areas of potential investment. Of note is the research conducted by the WRE to observe rocket launches and the trail left by the rockets through the ionosphere, which proved the basic principles of HF Over-The-Horizon-Radar. Research conducted throughout the 1960s formed the basis of Project Geebung, which led to the development of the Jindalee radar network.

Australian military involvement with space continued when in 1969 the Government agreed to host a ballistic missile early warning facility at Nurrungar, near Woomera. Defence and United States Air Force staff jointly operated the facility until Nurrungar's closure on 1 October 1999. After its closure the critical functions performed at Nurrungar continued in new ways, including Defence involvement in the management of the Relay Ground Station for early warning data located at the Joint Defence Facility at Pine Gap, in the data processing operation in the United States, and in associated research and development.

While now an ever-present utility, integrated in almost everything we do, it should be remembered that the US Global Positioning System (GPS) was only declared operational in 1995. Australia has had a long involvement in this program, with ADO representation in the

program office commencing in 1982. In the mid-1980s Australia was one of the lead nations involved in supporting the testing of this system, with our unique Southern Hemisphere location allowing us to confirm its performance. After NATO, Australia was the first nation to establish an arrangement with the US for developmental testing, along with access to the Precise Positioning Signal (PPS). The ADF currently owns the spectrum license for the GPS frequencies in Australia.

Given our need to maintain communications over long distances, and during deployed operations, the value of satellite communications was also recognised early. It should be noted here that Army and Navy, with their need to maintain contact with mobile elements divorced from fixed infrastructure, were leaders in the development of this capability. The use of commercial and allied military satellite relays led to the lofting of the Defence payload on Optus C1 in 2003.

Thus, while Defence has not been a consistent owner of space-based assets, it has long recognised the value of space-based capabilities. Defence has worked towards being an informed consumer of space products and services, principally in partnership with other nations. Through our allies and commercial partners, the ADO has been able to exploit the advantages provided by space.

However, although Defence has been closely involved with space-related activities for decades, it is only recently that this involvement has been coordinated. An ADF Space Review conducted in 2005 identified the need for a coordinated approach to space, and the Defence Space Coordinating Office (DSCO) was subsequently established as a ***Joint*** office within AFHQ in September 2006.

DSCO's mission is to '*provide Defence-wide coordination, monitoring and consideration of space assurance, space protection, surveillance of space, and space-related warfare efforts integral to overall Defence warfighting capability*.' DSCO's remit also incorporates aspects of coordination of space strategic planning, common space-specific

elements of capability efforts, space engagement, space support to operations, and space personnel management.

Chief of Air Force (CAF) is responsible for space, and space-related capabilities. DSCO supports CAF in his roles as:

- Coordinating Capability Manager for Space (across the ADF)
- Capability Manager for Space-related Warfare (SW)
- Capability Manager for Space-based Positioning, Navigation and Timing (PNT)
- Capability Manager for Space Environmental Awareness (SEA)

RAAF Wedgetail

The introduction of the JDAM into the RAAF provides enhanced precision and discrimination—factors that are critical against an unconventional adversary

Australian observers arrive Jakarta, 14 Sep 1947
(Spence second from right)

RAAF Ansons (type shown) flew in search of Sydney

X-15 in flight

Global Hawk

New Guinea, Jan 1944. Members of No 4 Squadron prepare a storepedo of Christmas comforts on an Australian Wirraway.
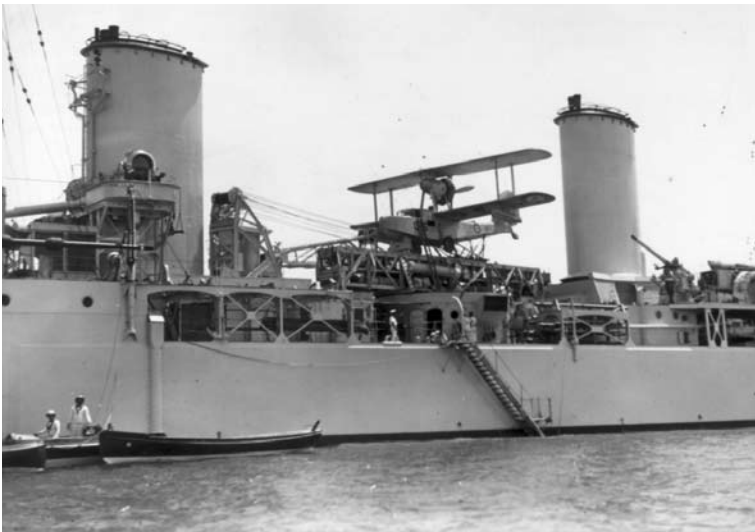
HMAS **Sydney** *with its amphibian aircraft on catapault, 1936 (View close to that presented to* **Kormoran** *on 19 November 1941)*

HISTORY

Not to have an adequate air force in the present state of the world is to compromise the foundations of national freedom and independence.

Winston Churchill,
House of Commons, 14 March 1933

An Australian airman at the Dardanelles

The Australian Flying Corps (AFC) was still in its infancy when the first Australians went ashore at Anzac Cove on 25 April 1915. Although a Half-Flight had been dispatched to join the concurrent campaign against Turkish forces in Mesopotamia (Iraq), no units or individual AFC personnel were available for the Gallipoli landings. Ground fighting at the Dardanelles very likely inspired several soldiers of the Australian Imperial Force to subsequently transfer to the evolving air arm—among them future air marshals George Jones and Roy

> **Key Points**
> - An Australian artillery officer, Captain Keith Jopp, played an important part in the air war during the Gallipoli campaign.
> - The Australian Flying Corps was engaged in a concurrent campaign against Turkish forces in Mesopotamia.
> - Captain Jopp's story illustrates that, even in the earliest days of World War I, air power was demonstrating the multi-role versatility that was to transform modern warfare.

Drummond, and Captain Sir Ross Smith—but the campaign itself offered few opportunities for members of the Australian services to experience war in the air. One who did, however, was Captain A.H.K. Jopp of the 1st Australian Division.

Because Britain's Secretary of State for War, Lord Kitchener, was reluctant to send Royal Flying Corps aircraft to support operations at Gallipoli, this role fell initially to a single squadron of the Royal Naval Air Service (RNAS), later expanded to two RNAS wings totalling more than 50 aircraft. While there were sufficient navy pilots (including Charles O. Gilmour (1892-1940) from Somerset, Tasmania), at first there were few trained observers for directing naval gunfire. This shortage was made good by selecting volunteer midshipmen from the Navy and artillery men from the Army. As a result, Captain Keith Jopp took to the skies over Gallipoli for the duration of the campaign in aircraft of the RNAS.

When World War I started, 24-year-old Jopp already had six years' service in the Militia, serving with the Royal Australian Artillery in Sydney. Eight days after recruitment for the Australian Imperial Force (AIF) began on 10 August 1914, he enlisted as a Lieutenant. At Brisbane late the next month, he embarked from Brisbane with the 7th Field Battery in the troop transport *Rangatira*. In Egypt he volunteered for service with No 3 Squadron, RNAS, led by the now-legendary Commander C.R. Samson. As observer, he spotted for the ships' guns engaging Turkish defensive positions and the logistical network delivering vital supplies to the peninsula.

On 30 August 1915 Jopp was flying with Samson, by then commanding No 3 Wing, while observing for the monitor *M-15* during the bombardment of Akbashi Liman where two enemy steamers were unloading supplies. From a height of 6000 feet Jopp watched as the monitor's first shot fell 800 yards short of the target, and the second fell on the beach nearby. Jopp sent corrections to the monitor and the range was found. As the next shell splashed into the sea, a terrible panic ensued in the harbour as loading was abandoned and workmen fled to the hills. The ships began to make for the Asiatic shore, but from a range of 18 000 yards the monitor managed to hit one steamer with its eighth shot, despite the intervening hills. The next shot hit the second steamer. One vessel sank while the other was engulfed in fire. As a result, the Turkish command ordered that daylight work at the port was to cease except on important occasions.

In addition to directing gun fire from the air, Jopp also participated in bombing both strategic and tactical targets. On 24 November he took part in a raid on the Ferejik rail junction where the Salonika-Constantinople railway joined with the branch line from Dedeagach. The attack resulted in damage to the permanent trackway, causing severe disruption to supply lines. When one of these missions discovered a large encampment of enemy troops at Kara Bunar, Jopp served as the observer in the aircraft subsequently dispatched to bomb this target. They dropped a 112-pound bomb that demolished three

tents, while a further bomb killed a large number of men seeking shelter in a nearby ravine. As a result, the camp was abandoned soon afterwards.

Although infrequent, aerial combat was also a part of Jopp's experience as a flyer. On 10 August Flight Commander Richard Bell-Davies, RN, and Jopp in a Henry Farman aircraft encountered a German machine over the Anzac position. The opposing pilot did not see the approach of Bell-Davies' aircraft, and he was able to get close behind him. Jopp was armed with a rifle and began firing at the aircraft. On the fifth shot the pilot looked around before his aircraft went into a vertical dive and escaped. Australian troops watching below cheered, as they thought the enemy had been shot down. On another occasion Jopp was up in a Henry Farman spotting for the monitor when he saw an enemy aircraft. His pilot was again able to approach fairly close behind the enemy's tail before being discovered. Despite the aircraft diving to 20 feet above the ocean, they were able to remain with their quarry as Jopp attacked their aircraft all the way back to its base at Galata. Once again, their efforts met with no success.

During these missions Jopp also came under enemy fire which on one occasion succeeded in forcing his aircraft down. During a reconnaissance mission over the Suvla Bay area with Samson, their Maurice Farman aircraft was hit in the engine by a piece of shrapnel. Samson managed to get the aircraft down on the only piece of suitable land, just south of the salt lake at Chocolate Hill (Yilgin Tepe). The magneto was found to have been completely destroyed, but the engine also suffered further damage when the Turkish artillery began to bombard the field. As a result, further damage to two cylinders was done by fragments, but the airframe itself and the crew were otherwise unharmed. Samson and Jopp rode to the landing pier at Kura Chesme, where they caught the mail trawler back to the air base on Imbros.

Following the successful evacuation of the allied beachheads established at Anzac, Suvla and Helles, No 3 Wing was sent back to England and its members on temporary assignment returned to duty with their various services. Captain Jopp returned to the artillery

of the Australian 1st Division. For his services during the Gallipoli campaign he was mentioned in dispatches. Not long after the AIF arrived in France in 1916, he was promoted Major, mentioned in dispatches for a second time and awarded the Distinguished Service Order. Throughout his time at the Western Front he was plagued by bouts of malaria contracted in either Egypt or on Gallipoli. Eventually he was released from active duty, returning to Australia in October 1917. After the war Jopp took up residence in Durban, South Africa.

Taranto: Operation *Judgement*

Just after sunset on 11 November 1940, Fairey Swordfish torpedo-bombers took off from the British aircraft carrier *Illustrious* and headed for the principal Italian naval base at Taranto. At 2258 hours, the first wave of twelve Swordfish located their primary targets, Italy's six battleships, and dropped their torpedoes. Around midnight, a second wave of nine Swordfish arrived over the harbour to complete the operation. In the wake of their attack, the British had sunk the battleship *Conte di Cavour* and left the battleships *Littorio* and *Caio Duilio* heavily damaged.

Although overshadowed by the later and far larger carrier battles in the Pacific, it was this action by the Fleet Air Arm of the Royal Navy that first demonstrated the pivotal role that air power was to play in naval warfare and signaled the end of the era of the battleship as the dominant force in naval warfare.

The origins of the attack on Taranto began in the 1930s as Mussolini increasingly preached aggressive Italian nationalism and the creation of a New Roman Empire. He ordered the enlargement and modernisation of the Italian military, especially the navy (*Regia Marina*), to directly challenge Britain's dominance of the Mediterranean. When Italy entered World War II it possessed the fourth largest navy in the world.

Mussolini began his bid for an Italian Empire in October 1935 with a brutal invasion of Abyssinia (Ethiopia), the last independent country in Africa. The League of Nations condemned Mussolini's aggression and Britain began preparations for peace enforcement operations

against Italy. The Australian Government made available to the British two RAN ships that were currently in the Mediterranean, the heavy cruiser *Australia* and the light cruiser *Sydney*. The Royal Navy's plans for military action against Italy centered on an attack on Taranto using carrier based aircraft. Planning for the attack required the gathering of intelligence on the harbour, harbour defences and the ships at anchor.

HMAS *Australia* carried the new Supermarine Seagull V amphibious reconnaissance aircraft, regarded by the Royal Navy's Fleet Air Arm as superior to any comparable type then in service. The Seagull V was an aircraft built in Britain by the Vickers Company to specifications drawn up by the RAAF in 1926, although the design proved so successful when the prototype was flown in mid-1933 that it was subsequently introduced into British service in 1935 as well, under the name 'Walrus'.

The RAN's aviation support was provided by the RAAF's No 101 Fleet Cooperation Flight. Throughout the Abyssinian Crisis, Flying Officer James Alexander (later Air Commodore) flew reconnaissance missions, with an RAN observer and an RAN telegraphist/air gunner, in support of the Royal Navy's preparations for an attack on Taranto. Ultimately, the League of Nations settled for the imposition of economic sanctions, rather than military action, against Italy. British naval planners, however, continued to draw up options for war in the Mediterranean, including an attack on Taranto; the plan developed in 1935-36 was updated, especially at the time of the Munich crisis in 1938, and became the basis for the attack actually carried out two years later.

After Italy formally entered World War II on 10 June 1940, the Regia Marina had several clashes with the Royal Navy, including a large but inconclusive action involving several battleships off the coast of Calabria in July. Following these initial contests, the Italians rarely ventured out to directly contest control of the Mediterranean, but instead concentrated their ships at Taranto—one of the most heavily fortified anchorages in the world. The mere existence of the

Italian fleet posed an ever-present threat (or Persistent Effect) to Britain's vital supply lines through the Suez Canal. To counter this threat, Britain was impelled to utilise warships and resources badly needed elsewhere. The greatest need of British commander, Admiral Sir Andrew Cunningham, was to neutralise the Regia Marina at Taranto.

In August 1940, the newly completed aircraft carrier HMS *Illustrious* joined the carrier HMS *Eagle* in the Mediterranean Fleet at Alexandria. Arriving with the *Illustrious* to take command of the fleet's carriers was Rear-Admiral Lumley Lyster, Fifth Sea Lord and Flag Officer Carrier Training, who had been developing and refining the plan for a carrier attack on Taranto since the Abyssinian Crisis.

Lyster's plan, Operation *Judgement*, called for a surprise attack at night by his torpedo-bombers. A night attack was essential to the plan as the Fleet Air Arm's obsolete Fairey Swordfish biplane torpedo-bombers could not make more than 80 knots when burdened with their torpedoes. The anti-aircraft guns of the ships and harbour defences and the fighters of the Italian Air Force (*Regia Aeronautica*) made a daylight attack at this speed suicidal. Achieving surprise was also critical in ensuring that an alerted Italian fleet did not sally forth to give battle. This would not only make it more difficult for the aircraft to locate and hit their targets, but the Italian battleships would pose a very real threat to the vulnerable carriers.

Attacking ships at anchor in the shallow waters of Taranto harbour posed another considerable challenge. Special modifications were made to the torpedoes for use in the shallow waters within the confines of the harbour and tests were carried out that determined that the torpedoes needed to be dropped at a height of 30 feet. To achieve this at night and under fire presented the Fleet Air Arm with no easy task, but Cunningham and Lyster made the decision to proceed.

After the attack, the Royal Navy—in a single night and using obsolete aircraft—had succeeded in halving the Italian battleship fleet. The loss of the three battleships was keenly felt by the Italians

four months later when they were decisively defeated at the Battle of Cape Matapan, where the Fairey Swordfish again played a decisive role, after which the Regia Marina never again ventured into the Eastern Mediterranean.

Taranto changed many naval experts' thoughts regarding air power and the potency of surprise air-launched torpedo attacks on ships at anchor. Prior to Taranto it was widely believed that deep water was absolutely necessary to successfully drop torpedoes. Operation *Judgement* forever changed this notion. Ominously for the Allies, the Taranto raid was thoroughly studied by the Japanese. The officers of the Imperial Japanese Navy, particularly Admiral Yamamoto Isoroku and Captain Genda Minoru, studied the battle in minute detail in planning the strike on Pearl Harbor.

Northern Territory special reconnaissance unit

In mid-1941 Australia faced a difficult defence conundrum, with an increasingly aggressive Japan threatening conflict in the Pacific at the same time that Australia's military resources were heavily committed to a war in Europe. Since 1940 Australia had contributed troops and air combat squadrons to the forces garrisoning the British naval base at Singapore, as a hedge against any expansionist Japanese move into the Asia-Pacific region. Attention was also being directed to developing Australia's home defences.

As early as 1940, the importance of the sea approaches to Darwin had been recognised, both in terms of the city's defence and the continued logistics supply to the elements of the defence forces stationed there. The RAAF had constructed a series of airfields along Darwin's flanks to extend air cover over the shipping lanes and enable greater reconnaissance over the northern approaches to Darwin. Many of these were so isolated, however, that if one was to be captured by the Japanese, that fact could conceivably go unnoticed for days. There was no such thing as an Airfield Defence Squadron at the time, and most remote airfields had a presence of only two or three airmen. East Arnhem Land, with a coastline some 1 600km long, was a particularly sensitive area with lightly manned airfields at Milingimbi and Groote Eylandt.

Key Points

- Creation of bases to extend air power across Australia's north during World War II brought problems of ground protection which had not been previously addressed.

- Forming local Aborigines into the NTSRU represented one of the first efforts to provide for airfield defence.

- Thomson's attempt to utilise indigenous warriors' inherent military skills provides an excellent example of adapting to an environment and making effective use of available resources.

Into this climate of apprehension and uncertainty, a novel solution to coastline surveillance was proposed by a junior RAAF officer, Flight Lieutenant Donald Thomson, in the course of a lecture he gave to a group of senior officers of all three services at Melbourne's Victoria Barracks on 11 June 1941. Thomson was not a Defence regular, having only come into RAAF uniform in January 1940. In civilian life he was an anthropologist and zoologist, and had recently returned from research at Cambridge, England. He had also spent a considerable amount of time with indigenous communities in Cape York in the 1920s and 1930s. In 1935-37, the Commonwealth Government had commissioned him to establish friendly relations with the native people of East Arnhem Land after a serious incident in 1932 involving killings of a Japanese pearler crew and a Northern Territory policeman. Much of his war service so far had been spent with No 11 Squadron at Port Moresby, where he was involved in helping to establish a coastwatch network in the Solomon Islands, and at Air Force Headquarters in Melbourne, observing and reporting on the training of Independent Companies.

In his lecture titled 'Arnhem Land and the Native Tribes Who Inhabit That Area', Thomson raised concerns about the influence that attacking Japanese forces could potentially have among the Aborigines of Arnhem Land and recommended that prior contact be made with them to neutralise any such effect. He even suggested that the indigenous peoples could be organised to form a coast-watching system. As a result of his lecture, an ambitious and radical plan was conceived whereby employees on pastoral properties and local police personnel would form the basis of a volunteer guerrilla force in conjunction with the Aboriginal coast-watch network which Thomson had suggested. The Army's director of Special Operations, a Lieutenant Colonel Scott, became convinced that Thomson (promoted Squadron Leader in August) was the only man who could raise an indigenous unit and arranged to have him seconded to the Army.

On 12 February 1942—with war in the Pacific already two months old—Thomson left Darwin aboard the 43-tonne ketch *Aroetta* headed east for Arnhem Land to begin recruiting for the Northern Territory Special Reconnaissance Unit (NTSRU). Among his eight-man crew was an Aboriginal named Raiwalla from the Glyde River area, who was a fine hunter renowned throughout East Arnhem Land as a one-on-one spear fighter. With his assistance, Thomson found willing allies in two of the most respected and influential tribal leaders in East Arnhem Land: Bindjarpuma from the Arnhem Bay area, and Wonggu from Caledon Bay.

The NTSRU was organised along tribal lines into three sections led by Raiwalla, Bindjarpuma and Natjialma, one of Wonggu's sons. Each section was trained in reconnaissance, harassing and ambush tactics. No members were trained with rifles except for Raiwalla, the only enlisted man in the NTSRU, but they were instructed in the manufacture and use of Molotov Cocktails. The reason for not providing modern arms to the units was that Thomson feared that equipping the NTSRU in such a way would make the unit a target of the Japanese and he wanted it to remain inconspicuous. In any case, he believed that, even equipped with just traditional weapons and Molotov Cocktails, the unit could be effective in attacking small Japanese parties while leaving larger parties for conventional forces. The primary role of the NTSRU should be reconnaissance, and as an early warning system should the airfields come under threat.

Unfortunately for Thomson's plans, the Japanese air raids which began against Darwin and other military targets across the Top End from 19 February gave rise to a new and rival body. Interestingly, this organisation—the North Australia Observer Unit (NAOU, or 'Nackeroos' as they became known)—was under command of another anthropologist, Major William Stanner. Responsibility for early warning fell increasingly to Stanner's outfit, and in April 1943 the NTSRU was disbanded. Although its life was brief, the NTSRU remains one of the most remarkable units to have served in the defence of Australia. Though the RAAF airfields in the Top End were

considered essential to the defence of Darwin, their self-defence from ground attack presented a problem that had not been fully considered before. The NTSRU represented the beginnings of the solution.

After promotion to Wing Commander, Thomson went on to lead expeditions into Japanese-occupied Dutch New Guinea until a native attack on the second of these resulted in him suffering severe wounds which led to his discharge from the RAAF in October 1944; he was appointed OBE in 1945. During his time in command of the NTSRU he had recommended both Raiwalla and Natjialma for commendations, but it was not until 1992 that members of the unit received official recognition including medals and back-pay for their selfless service.

The RAAF in the loss of HMAS *Sydney*

The remains of the Royal Australian Navy's light cruiser *Sydney* (the second RAN warship to bear that name) were discovered on 16 March 2008 about 250 km off the West Australian coastline, at a depth of nearly 2.5 km. Just days earlier, the wreck of the German commerce raider HSK *Kormoran* was located some 22 km away. For half an hour in the late afternoon of 19 November 1941, these two ships had traded shell-fire and torpedoes with such damaging effect that both sank later that night—*Kormoran* with the loss of 78 men, *Sydney* with its entire complement of 645.

Key Points

- The finding of HMAS *Sydney II* is an event of significance to the Air Force as well as the Navy, on account of the loss of six RAAF men during the 1941 action.

- The RAAF also played a prominent part in the search effort to locate the missing cruiser in the week after the battle with *Kormoran*.

- The pilot of the air detachment was among the men from *Sydney* being considered in the effort to identify a corpse washed up on Christmas Island in 1942.

The finding of both ships 66 years after the action which claimed them brings closure to an enduring mystery. That sense of relief, while strongest among Australia's naval community, is shared across the nation. It is also felt within the Royal Australian Air Force, which had six of its uniformed members on board *Sydney* when it disappeared without trace. These were men from the RAAF's No 9 Squadron based at Rathmines on Lake Macquarie, north of Sydney. They formed a detachment which was embarked to operate and maintain the Walrus amphibian aircraft which the cruiser carried to undertake reconnaissance, gunnery spotting, and search and rescue work.

In the modified Leander Class ships of the RAN's light cruiser force, the Walrus sat on a catapult positioned amidships between the

ship's two funnels. When required for use, the amphibian took off from there; during recovery, it was lifted by crane from the water alongside and returned to its place high on the ship's superstructure. It is known that *Sydney*'s Walrus was sitting on its exposed perch at the start of the ill-fated clash with *Kormoran*. German eyewitnesses reported that the aircraft was on the catapult with its engine running, and propeller turning, apparently in preparation for launching.

At this point, *Sydney*'s commander, Captain Joseph Burnett, was still attempting to satisfy himself that the strange ship he had encountered was the Dutch freighter *Straat Malakka* that it claimed to be. Flying off the ship's aircraft would have seemed a prudent step to take, if Burnett had doubts about the stranger's identity and thought that he might need to order his ship into action. This makes it all the more puzzling that he reportedly drew almost abeam of *Kormoran* to starboard, and barely 1500 metres distant, before demanding that the mystery vessel's secret identifying code letters be displayed. This put *Sydney* at point-blank range when *Kormoran*'s captain chose the moment to drop his ship's disguise and open fire.

Within four seconds of firing two ranging shots, a salvo from *Kormoran* struck *Sydney*'s bridge and armament director tower— thereby almost immediately restricting the Australian ship's capacity to make effective reply. A full salvo from *Sydney* passed over the German raider and failed to score any hits. Two more salvos from *Kormoran* again smothered *Sydney*'s bridge and tore amidships, followed by two more which took out the cruiser's forward gun turrets. According to Lieutenant Fritz Skeries, the gunnery officer in *Kormoran*, it was apparently between the third and fourth salvos that a single 'lucky shot' hit the cruiser's aeroplane and set it ablaze, causing its motor to shut off.

Nothing is known of what happened to the Walrus three-man crew, which would have normally consisted of the RAAF pilot, Flying Officer Ray Barrey, a naval officer who acted as observer, and a RAN rating who was telegraphist air gunner. The other RAAF members of the air detachment—three fitters, one armourer and a

photographer—were all maintenance and support personnel who would have taken their place at Action Stations among the ship's crew on or below deck. Whatever their individual part in the engagement, it is clear that the Air Force men shared the same fate as the rest of *Sydney*'s crew.

The disappearance of *Sydney* was not immediately noticed. The ship had previously advised that it expected to arrive at Fremantle, Western Australia, on 20 November, and it was not until the next day that it was reported as late. Even then there was no particular concern until the 23rd, when the ship was instructed to report by signal. Only on the following day were steps initiated to locate the missing cruiser. Among these measures was an air search by RAAF Ansons from the base at Gerraldton, north of Perth. The Commander-in-Chief of the Netherlands Navy in the East Indies was also asked to carry out an air search south of Java, where Sydney was last known to have been on 17 November when it handed over a troopship it had escorted to the Sunda Strait.

Efforts to find the missing cruiser took a different course after the first report was received that a British tanker had rescued survivors from a German ship approximately 120 miles off Carnarvon, Western Australia, on the evening of 24 November. It was now realised that a naval action of some sort had taken place. Ships already in the area were instructed to keep a lookout for other survivors and additional naval vessels were dispatched to assist in this work. The RAAF was also requested to send Hudson aircraft from Pearce to Carnarvon, to be better positioned to carry out a detailed aerial search at sea. Two Catalina flying boats with longer endurance were additionally ordered from Townsville to undertake a wide ocean reconnaissance. These were measures which soon led to the location of many more boatloads of German survivors, both at sea and ashore on the WA coast, but revealed nothing about the whereabouts of *Sydney*.

One tantalizing hint on this score emerged some two months later, but has only recently reassumed significance. When a Carley float containing the remains of a corpse washed up on Christmas Island

in early February 1942, it was first thought that this might be from *Sydney* but the idea was then discounted. In 2007, however, the grave containing the mystery corpse was located and the remains subjected to close forensic examination. It was subsequently concluded that the body definitely came from the lost cruiser, and based on indications that it had been dressed in overalls when found, the field of DNA matches was first thought to be narrowed to three engineering officers. Now, the investigators are seeking descendants of 13 men from *Sydney*'s crew, in the hope that DNA samples may enable a final identification to be made from these 'possibles'. Among the 13 names is Flying Officer Ray Barrey.[1]

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[1] This issue of Pathfinder was published in March 2008. It was subsequently determined that FLGOFF Barrey was not the mystery corpse and later investigations were widened to consider a larger number of *Sydney's* crew.

75 Squadron in the defence of Port Moresby

The air battle for Port Moresby, conducted by No 75 Squadron from 21 March to 8 May 1942, stands as one of the more remarkable feats in RAAF history. Seventeen days after forming at Townsville, Queensland, and converting to an all-new aircraft type, the unit deployed to mount a gallant defence of Port Moresby lasting 48 days that thwarted Japanese plans to capture this

> **Key Points**
> - Control of the Air can be achieved through a carefully balanced campaign of defensive and offensive action.
> - Freedom of manoeuvre to surface forces is denied without effective control of the air, and incurs penalties of complexity and friction.

crucial allied base and take control of its strategically vital airfields and harbour facilities. For nearly all of its six weeks on the front line 75 Squadron was the sole fighter unit in the area, being joined by American units only during its final week at Moresby. The epic effort by the squadron demonstrated what could be achieved through a carefully balanced campaign of defensive and offensive action.

When 75 Squadron was raised on 4 March, its prospects of success probably looked good despite the rush and improvisation surrounding its formation. Its first Commanding Officer was Squadron Leader Peter Jeffrey, who had outstanding experience in the Middle East flying the Curtiss P-40E Kittyhawk with which the new unit was equipped. These American aircraft were capable of speeds up to 582 km/h (365 mph) and were the best fighters then available to Australia. On 19 March, however, Jeffrey handed over command to Squadron Leader John Jackson (another pilot with Kittyhawk experience in the Middle East) and moved to raise a sister unit, No 76 Squadron. When 75 Squadron's deployment to Papua took place two days later, the unit's younger pilots had an average of nine days training on the Kittyhawks and had fired their guns only once.

The hasty formation and deployment of 75 Squadron was driven by the dire situation facing Australia in early 1942. By February of that year, the Japanese expansion into the South-West Pacific had reached as far as Lae, on the north coast of New Guinea, and appeared to be edging towards Australia. As if in preparation for an advance further south, on 3 February Japanese aircraft began to conduct damaging raids on the army garrison and defences of Port Moresby. These raids were particularly successful due to the lack of any allied fighter aircraft opposition in the area, and risked disrupting the operations of RAAF Hudson and Catalina units using the base. In order to provide some measure of air defence, the RAAF decided to deploy a fighter squadron at Port Moresby as soon as aircraft and pilots were available. On 17 March 1942 the first ground elements of 75 Squadron began moving north from Townsville. By 21 March the squadron's aircraft landed at Seven Mile Airfield, just north of Port Moresby. Within hours of arrival two pilots successfully intercepted and destroyed an enemy reconnaissance aircraft over the town.

Before the RAAF presence was known to the Japanese, Squadron Leader Jackson decided to launch an attack on the Japanese airfield at Lae early on 22 March. This raid was an outstanding success, with three bombers and nine fighters claimed destroyed on the ground and another two fighters claimed destroyed in the air. Two of the nine Kittyhawks taking part in the raid were downed, with Flying Officer Bruce Anderson killed and Flying Officer Wilbur Wackett having to embark on a 320 km trek in order to get back to Port Moresby.

Over the following weeks 75 Squadron aircraft were almost constantly in the air during daylight hours. Standing patrols, anti-strafing patrols and airfield cover patrols were conducted. The squadron also scrambled to intercept 32 incoming raids that varied in size and nature. Some consisted of bombers escorted by Zero fighters, while others were strafing attacks by fighters alone. No 75 Squadron also conducted reconnaissance and strafing attacks on enemy positions at Lae, escorted United States Army Air Force (USAAF) aircraft on bombing raids and on one occasion attacked a

submarine. In short, the unit conducted both defensive and offensive missions to best defend Port Moresby. Importantly, control of the air was always contested and never totally lost to the adversary, though the cost to the unit was very high: 12 pilots were killed in combat and 17 aircraft lost to enemy action.

On 30 April, 75 Squadron was joined by the Airacobra aircraft of the USAAF's 8th Pursuit Group. The arrival of the Americans was timely, as aircraft availability in 75 Squadron had become critical and was getting worse. By that time, despite an around-the-clock maintenance effort, only three Kittyhawks were serviceable. The last operational sortie of the squadron's Moresby deployment—an interception of a bomber raid on 3 May—was undertaken jointly with the American Airacobras and consisted of 75 Squadron's sole serviceable aircraft. On 7 May the unit was ordered back to Australia for replenishment and a well-earned rest.

The heroic action of 75 Squadron had significant impact on the air war over Port Moresby. Prior to their arrival, the Japanese faced no threat from allied fighters. No 75 Squadron's raid on the Lae airfield on 22 March demonstrated the need for the Japanese to dedicate more aircraft to defensive patrols rather than in support of raids on Port Moresby, while also increasing the requirement to provide escorts to their bomber formations. The losses they suffered further reduced the Japanese ability to conduct offensive operations.

One less noticeable effect, and one more difficult to quantify, is the impact that was generated by 75 Squadron on Japanese planning for the amphibious assault on Port Moresby. The presence of a persistent and effective allied fighter force meant that the Japanese needed the capacity to maintain control of the air over any invasion force launched against the allies. The Japanese amphibious fleet that threatened Port Moresby during the first week of May included the auxiliary aircraft carrier *Shoho* to provide air cover to the attacking troops. When the *Shoho* was sunk by US naval aircraft during the Battle of the Coral Sea, the Japanese were forced to cancel the

amphibious landings due to the aggregated threats of the air and maritime forces arrayed against them.

No 75 Squadron's achievements during their first operational deployment are truly remarkable. To have formed and deployed within 17 days is an accomplishment that has few equals. To have gone into action so quickly, and sustained such a high tempo of operations for so long, is outstanding. During its epic six weeks in the front line, the squadron claimed 35 enemy aircraft destroyed, four probably destroyed and 54 damaged. The squadron demonstrated that one small, highly professional unit can generate effects beyond the tactical environment and influence adversary operations and planning.

The battle of the Coral Sea: the RAAF contribution

The Battle of the Coral Sea (4–8 May 1942) was a pivotal action in the defence of Australia during the Pacific War. Fought over 1.5 million square kilometres of ocean, it was the first sea engagement contested principally by opposing groups of carrier-launched aircraft without the surface fleets coming within direct sight of each other. The RAAF, while not a large component of the Allied forces engaged at the Coral Sea, nonetheless made important contributions in the lead up to the battle and in shaping the course of the battle itself.

> **Key Points**
> - Surveillance and reconnaissance operations by airborne platforms deny freedom of manoeuvre to enemy forces.
> - Secure bases are essential to ensure uninterrupted air operations.
> - Forward defence helped to counter direct threats to Australia and its vital sea lanes.

The operation, codenamed 'MO', which the Japanese launched in the first days of May had twin objectives. It aimed, first, to consolidate the defensive barrier established by Japanese forces in the island chains across Australia's north, by seizing control of the last major base held by the Allies in New Guinea at Port Moresby. Secondly, it was to begin a process of isolating Australia by extending Japanese control over the groups of islands east and south-east of New Guinea, thereby severing vital sea-lanes between Australia and the United States, beginning with the southern Solomon Islands. Though limited in intent, the operation entailed large naval forces organised into six separate groups moving from widely separated starting points. Most importantly, the plan included the light carrier *Shōhō* as well as the 5th Carrier Division, centred around the two large modern aircraft carriers *Shōkaku* and *Zuikaku*, both veterans of the raid on Pearl Harbor.

The scale of these moves—when detected by the Americans while still in the preparatory stage during late April—were taken by the Allies as likely signalling an attempted invasion of Australia itself. An additional American task force led by the large carrier USS *Lexington* was immediately dispatched from Hawaii to reinforce the task force led by USS *Yorktown* which was already in the Coral Sea. As a consequence, the Allies were reasonably well-placed to respond when the Japanese launched the first phase of Operation MO with a move towards Florida Island in the southern Solomons.

Lying directly in the path of the first Japanese task force was the RAAF Advanced Operating Base (AOB) at Tulagi, manned by a combined force of No 11 Squadron, RAAF, operating Catalina flying-boats, and army commandos of the Australian 2/1 Independent Company. The Japanese planned to seize the Tulagi seaplane station, not only to deny its use by the Allies, but to use it as a base for their own maritime surveillance floatplanes. Despite heavy Japanese air raids from land-based bombers operating from Rabaul, No 11 Squadron continued to operate until the Japanese invasion force was within 35 miles of the island. These operations included the first offensive action taken by the Allies in the lead-up to the Coral Sea battle—a daring attack on the Japanese landings ships, carried out on 1 May by Flying Officer Bob Hirst and the crew of Catalina A24-14. The next day the Australian aircraft and personnel were safely evacuated, only hours before the Japanese arrived early on 3 May. Aircraft from USS *Yorktown*, alerted to the Japanese presence by RAAF surveillance and Australian coastwatchers, launched air raids which destroyed or damaged several of the Japanese surface vessels. More importantly, five of the six Japanese F1M2 'Pete' reconnaissance floatplanes which had arrived at Tulagi immediately after its seizure were also destroyed. The loss of these aircraft greatly diminished the later ability of the Japanese to locate and track the American aircraft carriers.

As the Japanese and American fleets closed with each other in the Coral Sea, accurate reconnaissance was at a premium. Both

sides were engaged in a race to be the first to locate the enemy, particularly their carriers, and destroy them. Throughout the battle, Japanese and Allied carrier and land-based aircraft patrolled the skies, searching for any signs of enemy ships. RAAF Catalina squadrons played a pivotal role in this endeavour. Operating from Port Moresby, No 11 Squadron, along with the Catalinas of Cairns-based No 20 Squadron, provided vital information on the location of the Japanese forces in the Coral Sea throughout the battle. The loss of Tulagi and aggressive air operations by the Japanese made this an arduous and dangerous task. On 4 May, Catalina A24-18, commanded by Flying Officer Allan Norman, was attacked and shot down by Japanese aircraft, probably from the light aircraft carrier *Shōhō*; Norman and his crew were taken prisoner and later executed. The risk to aircrews, however, seemed justified, when on 5 May, Flight Lieutenant Frank Chapman and his crew in Catalina A24-17 sighted the *Shōhō* and her escorts. This sighting was quickly followed by a report from Flight Lieutenant Norm Fader and the crew of A24-12 that more enemy vessels were bound for New Guinea. Next day Squadron Leader Gough Hemsworth and his crew in A24-20 were shot down and killed after reporting the sighting of a strong enemy force heading towards the Jomard Passage. These three sightings confirmed the immediate threat posed to Port Moresby by the Japanese.

With the Japanese invasion forces located, they were successfully blocked from approaching New Guinea by a strong Australian-US force of cruisers and destroyers commanded by Rear-Admiral Jack Crace, RN, in HMAS *Australia*. The Japanese plans received a further setback on 7 May when, alerted to the presence of the *Shōhō* in the Coral Sea by RAAF and other Allied reconnaissance aircraft, and Australian coastwatchers, aircraft from the USS *Lexington* and USS *Yorktown* attacked and sank the Japanese light carrier. With no air cover available to support a landing at Port Moresby, the Japanese fleet turned back.

Despite this success, the threat posed by the main Japanese carrier division to the American fleet remained. Over 7-8 May, Japanese and American aircraft provided vital sighting reports that enabled each fleet to launch their torpedo and dive bombers against the opposing carriers. By the close of 8 May each side had lost an aircraft carrier and all of the remaining carriers had sustained damage and had lost most of their aircraft and crews. With the air groups badly depleted, the opposing fleets withdrew. In a final curtain call on 10 May, a Hudson of No 32 Squadron, RAAF, attacked and damaged a large Japanese submarine in the southern area of the battle zone. For the Allies, the RAAF had fired the opening and closing shots of the Battle of the Coral Sea.

As a direct consequence of the Coral Sea action, the Japanese carrier forces available to fight at Midway the following month were significantly depleted. Closer to home, the Japanese were forced overland along the Kokoda Track in their attempt to take Port Moresby. This resulted in the RAAF fighting for air superiority over Port Moresby and in the Battle of Milne Bay. Both of these operations will be the subjects of future *Pathfinders*.

The RAAF at the battle of Milne Bay

The Battle of Milne Bay, fought between Allied and Japanese forces in August-September 1942, was an important victory for the Allies. It was the first time that Japanese forces had been defeated on land, shattering the myth of Japanese invincibility built up after a succession of victories across South-East Asia. That the Allied forces at Milne Bay were predominantly Australian gave a boost to the morale of Australian servicemen and civilians alike. One of the main characteristics of the battle was the close liaison between the Army and RAAF, each arm contributing key capabilities to the eventual victory.

> **Key Points**
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> - Optimal integration of air and land power generates an effect in the battlespace far beyond what is possible through operating independently.
> - Ground based support is critical to the sustainment of air operations.

The Japanese intent in attacking Milne Bay was to establish an advanced operating base that could support their thrust along the Kokoda Track to Port Moresby and defend against Allied air and maritime forces operating in the regions of the Solomon and Coral Seas. The deep bay offered a well-sheltered anchorage, while the steep mountains that surrounded the area provided some security from land attack. Importantly, the flat ground between the mountains and the water was suitable for the construction of air bases.

Fortunately, the Allies were also well aware of Milne Bay's potential, and had been moving ground troops, engineers and aircraft into the area throughout July 1942. By 24 August, the Allies had three airfields at various stages of completion, initially named Nos 1, 2 and 3 Strip. The Australian Army deployed its 7th and 18th Infantry Brigades to the area, complemented by a force of American airfield engineers—in total a force of around 8800 personnel. The RAAF's commitment to the Milne Bay force was Nos 75 and 76 Squadrons

equipped with Kittyhawk fighters, a flight of Hudson reconnaissance aircraft from No 6 Squadron, No 37 Radar Station and No 8 Fighter Control Unit. A mobile torpedo unit was also pre-positioned to cater for a future deployment of No 100 Squadron's Beaufort torpedo bombers.

The preparations by the Allies proved well justified. On 25 August, Kittyhawks of 75 Squadron attacked a force of seven Japanese landing barges that were temporarily ashore on Goodenough Island, just 100 km north-west of Milne Bay. The raid was an unqualified success, with all seven barges destroyed (along with their cargoes) and the 353 marines of the Sasebo Special Naval Landing Force left marooned. On the same day a Japanese invasion convoy of two cruisers, three destroyers, two submarines, two transport ships and various smaller vessels arrived in the area. Immediate attacks on this convoy were conducted by 6, 75 and 76 Squadrons, with additional attacks conducted by Hudsons of 32 Squadron flying from Horn Island and USAAF B-17 Flying Fortresses based at Mareeba, North Queensland. Unfortunately bad weather made locating and targeting the ships difficult, and very early on the morning of 26 August, the Japanese were able to move into Milne Bay and begin landing troops on the northern shore.

Sunrise revealed that a beachhead consisting of a large number of troops, headquarters and supply dumps had been established between Waga Waga and Wanadala, a little over 10 km east of No 3 Strip near Gili Gili. With the elements of the 61st Battalion of 7 Brigade already in contact with the Japanese, the Kittyhawks of 75 and 76 Squadrons and Hudsons of 6 Squadron immediately began strafing troop concentrations and destroyed landing barges, vehicles, and other targets. Despite this significant blow, and the resistance put up by the Army's 7th Brigade, a Japanese force supported by two light tanks was able to advance west along a narrow strip of land between the Bay and Stirling Range towards No 3 Strip. By the night of the 27th, the Australian troops were defending the perimeter of the airfield, and it was here that the fiercest fighting took place. On

the night of 31 August the Australian troops repelled three massed charges and endured constant machinegun and sniper attacks.

Throughout this period and in the days following, the RAAF provided close air support to the troops in contact, and maintained attacks on command centres, artillery, supplies and reinforcements that the Japanese kept pushing forward into the battle. Much of the fighting was occurring in such close proximity to the Gili Gili defences that the Kittyhawks were coming into action almost before their undercarriages were fully retracted. The close liaison between RAAF and Army commands was vital in coordinating these air attacks.

Complicating the RAAF's efforts to maintain direct support to the Army were the persistent air raids conducted by Japanese fighters and dive bombers on the airfields. To assist, Allied aircraft from the broader region also conducted attacks on the Japanese forces. This included Beaufighters from No 30 Squadron in Townsville, and Beauforts from No 100 Squadron that carried out the first ever aerial torpedo attack by the RAAF just a day after deploying from Laverton, Victoria.

Of great significance to the air effort was the work carried out by the ground crews. Despite suffering attacks by Japanese aircraft, the work of the maintenance and support personnel at the Milne Bay airfields was magnificent. Repair and maintenance work was a continuous round-the-clock operation, rectifying damage caused not just by the enemy, but by the persistent rain that found its way into fuel systems and electrical systems, and mud that tore away undercarriage components and damaged flight controls during landings. Working out in the open, under fire, and with the most basic of tools, the ground crews consistently made sufficient numbers of aircraft available for fight on every day of the battle.

The turning point of the battle came when it was appreciated by the operational commander, Major General Cyril Clowes, that the Japanese were unable to transport any forces to threaten the flanks or rear of the Australian positions. The destruction of the landing

barges on Goodenough Island and in Milne Bay by the RAAF was a significant factor in limiting the Japanese to just one line of attack. Clowes was able to commit the full strength of his brigades to forcing the Japanese back to their initial landing point.

Over the night of 6-7 September the last of the Japanese troops were evacuated under the cover of a naval bombardment. They had failed in their attempt to take the Australian positions and suffered 1580 personnel killed, wounded or missing in action. The RAAF and Army had combined into an effective joint force that dealt a decisive blow on an enemy that had never before tasted defeat.

Vengeance vicissitude: RAAF dive bombers in New Guinea

Enduring controversy surrounds the RAAF's use of the US-produced Vultee Vengeance dive-bomber during the New Guinea air campaign in World War II. The period of the deployment was not long, nor was the aircraft's service conspicuously good or bad, but debate has continued to focus on whether the RAAF high command was wise to commit this particular aircraft type to that theatre at the time that it did, and the manner of its employment. These are issues with lessons that any evolving force might pause to think about.

> **Key Points**
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> - The procurement history of the Vultee Vengeance demonstrates the need to align force structure, doctrine and equipment.
> - The importance of meticulous planning to ensure adequacy of operational capability cannot be over emphasised.
> - Capability management is crucial for the optimum use of air power's inherent characteristics to contribute effectively to larger campaign aims.

The Vengeance was never seen as a war-winning aircraft. Its origins lay in the Vultee Aircraft Corporation's V-72 design from the late 1930s—a time when Germany's Ju-87 Stuka dive-bomber was being operationally tested in Spain's civil war. Built with private (not government) funding, the V-72 was intended for sale to foreign markets and found buyers in Brazil, China, France, Turkey and the USSR. After the fall of France in 1940, its order for the V-72 was taken over by Britain, making the RAF a major operator of the Vengeance—most notably in India and Burma. While Britain acquired more under Lend-Lease arrangements, the Americans themselves were not impressed with the Vengeance. They believed it was an inferior type and unsuitable for combat, and accordingly withdrew it from service with US Army Air Corps units.

Australia largely came to this aircraft by accident, rather than design. Indeed, the decision to buy the Vengeance was taken without regard to its role in the RAAF force structure or doctrine. In early 1942, with fears of a Japanese invasion of Australia at their peak, the Curtin Government was desperate to procure large numbers of additional aircraft to achieve the planned expansion of the RAAF to 73 squadrons. The External Affairs Minister, Dr H.V. Evatt, visited Washington in April to obtain assurances that America would supply Australia's needs. He cabled triumphantly that he had succeeded in obtaining an allocation of 475 aircraft, with some of these—'probably dive-bombers and fighters'—being made available quickly. It hardly mattered to Canberra that it would be taking American cast-offs.

Eventually the RAAF received some 342 Vultee Vengeance aircraft. Although the first of these were received at the end of May 1942, substantial numbers only began to arrive from April 1943—by which time, the crisis they had been meant to help avert had effectively passed. The RAAF proved to be in no great hurry to commit these aircraft to action either, although this, too, seems to have been as much a product of poor administration rather than actual intent. During September 1943, the commander of the US 5th Air Force in Australia, Lieutenant-General George Kenny, had requested that the RAAF make available a mobile strike force for operations in the New Britain Area. The RAAF responded by raising a force of two wings, No 77 Dive Bomber Wing and No 78 Fighter Wing, as part of 10 Operational Group.

The deployment of the three squadrons of 77 Wing proved to be an unacceptably tardy affair. Although 18 Vengeances of No 24 Squadron were immediately sent to New Guinea from Bankstown, NSW, the other two units—Nos 23 and 21 Squadrons—were not dispatched until late December 1943 and 18 January 1944, respectively. The protracted nature of the deployment was hardly an outstanding display of RAAF mobility, since it was caused by a lack of precise planning and transport capacity (although the Service was mainly dependent on American sea and air transport facilities).

Unfortunately, 24 Squadron's operational debut also proved less than auspicious. This was largely due to disarray within the unit caused by the fragmented manner of its deployment, but resulted in Kenny's forward commander, Brigadier General Ennis Whitehead, disgustedly reporting that 'we have never gotten a mission out of that unit' and complaining about the standard of 24 Squadron's training.

Whitehead had a point. No 24 Squadron did not record its first strike until 19 December 1943, with only intermittent operations being flown into mid-January 1944. On 16 January, the unit moved to Newton Field, Nadzab, from where it finally commenced daily operations three days later. The two remaining flying units of 77 Wing did not reach Nadzab until 10 and 21 February, respectively. The first strike by the combined squadrons was flown on 22 February. On 8 March the Wing flew its final mission (a bombing raid by 36 aircraft against Rempi village), after which it was returned to Australia and ultimately re-equipped with long-range B-24 Liberator bombers. In the six months of the Vengeance presence in New Guinea, the total of combat sorties flown by all squadrons of 77 Wing totalled 605. By comparison, the three Kittyhawk squadrons of 78 Fighter Wing had flown 784 dive bomber escort missions over the same period, in addition to mounting combat air patrols and escorting American heavy bombers and transport aircraft.

The Official Historian, George Odgers, states that there were three significant reasons for the withdrawal of RAAF Vengeance aircraft from operations. First, they were inefficient when compared to other advanced aircraft available to the 5th Air Force commander. Second, these modern aircraft were becoming available in large numbers which, thirdly, placed acute pressure on space available on a limited number of airfields. It was claimed that a fully loaded Vengeance required the full 6000 feet of the Newton runway to become airborne—an assertion with which an experienced Vengeance pilot disagrees. Another factor cited against the type was that it was susceptible to repeated engine failures in New Guinea. This seems highly questionable. Although the available records are incomplete,

there are only eight recorded incidents of forced landings or aborted take-offs during operations, only two of which are noted as 'engine failure'. In fact, 23 Squadron boasted of a 90 per cent serviceability record in February 1944, so the reliability and maintainability of the aircraft does not appear to have been a major issue. The more important consideration may well have been the difficulty of getting logistics into the theatre, with implications for sustainability.

The strategic situation in which the RAAF found itself in New Guinea is another factor that should be taken into account. After the defensive battles of late 1942 and early 1943 had been won by the Allies, planning was in progress for an advance along the north coast of New Guinea, ultimately to fulfil General Douglas MacArthur's pledge to return to the Philippines. Even though it was never intended by the Americans to take the RAAF with them to the Philippines—as Kenny actually advised the RAAF operational commander, Air Vice-Marshal William Bostock, on 27 September 1944—in reality the RAAF was not equipped to undertake such a strategic role anyway. Essentially, the RAAF in New Guinea was operating in a tactical role, and the Vengeance deployment must be seen from that perspective. No 77 Wing was deployed in an Army co-operation role, supporting the Australian 7th Division, while the 5th Air Force was planning strategic operations for which the Vengeance was inappropriate.

The RAAF's first peacekeepers

Since World War II, military operations other than conventional war have become more common. The world-wide upsurge in intra-state conflicts has placed increasing demands on the ADF to conduct peacekeeping and peace-enforcement operations, often under war-like conditions. Alongside members of the other services, the RAAF personnel have made major contributions to peacekeeping operations around the world, and continue to do so today.

The RAAF was part of the first UN peacekeeping mission in history

Key Points

- The RAAF contributed to the first UN military observer operations in history and continues to support peacekeeping in many countries.

- In a range of UN and regional peace missions, the RAAF has demonstrated its versatility and flexibility in responding to crises.

- Air Power plays a key role in ADF operations supporting government policy to promote security and stability within the region, and increasingly, across the globe.

in Netherlands East Indies (NEI), now Indonesia. On 17 August 1945, two days after the Japanese surrender, nationalists in the NEI proclaimed an Indonesian Republic and refused to accept the return of Dutch colonial rule. Sporadic fighting erupted on Java and Sumatra between Allied forces (who were trying to supervise the transition back to Dutch rule) and the Republicans. Two years later, the Dutch and Republicans still controlled separate enclaves.

In July 1947, the Dutch launched what they described as a 'police action' but which in reality was an invasion of Republican territory. The UN Security Council intervened to call a ceasefire and in August established a Consular Commission to monitor the separation of the two sides. The Commission was made up of the six UN Security Council member countries which had diplomatic representation in Batavia (now Jakarta). The Australian representative

on the Commission and its chairman was Group Captain Charles Eaton (Ret'd). When the Commission requested military observers, Australia responded promptly, sending a team of two Army officers, one Navy officer and a RAAF officer—Squadron Leader Lou Spence. They arrived in Surabaya on board a RAAF aircraft on 13 September, becoming the first ever UN peacekeepers deployed into the field.

After two weeks in country, Spence became ill and had to return to Australia. However, his report, co-written with Brigadier L.G.H. Dyke, argued that the ceasefire was unworkable and that a negotiated settlement between the two sides would not be possible. A further 60 Australians, many of them RAAF, would serve as UN peacekeepers in the NEI, reporting on the sporadic outbreaks of violence. In early 1949, in response to international pressure generated by the UN observer reports, Indonesia was finally granted its independence. Australia, with a significant contribution from the RAAF, had played a central role in the UN's first peacekeeping effort and in stabilising the SE Asian region.

The UN also maintained a presence in Korea from November 1947. In early 1950, two Australian officers—Major Stuart Peach and Squadron Leader Ronald Rankin—arrived in South Korea as UN observers. Rankin was a fighter pilot with operational experience in both the European and Pacific theatres in World War II. The two Australians spent two weeks inspecting South Korean units along the 38th Parallel, the dividing line between North and South Korea. Within days of their return to Seoul, North Korean forces crossed the 38th Parallel and invaded the South. Armed with Peach and Rankin's report, the UN deduced that the North was clearly the aggressor. The Security Council then passed a resolution to provide forces to oppose the Communist invasion. Having played a pivotal role in the Korean conflict, Peach and Rankin continued their UN duties until later that year. Their replacement in a volatile environment, as a part-time observer, was Wing Commander (later Air Vice-Marshal) Keith Hennock, RAAF.

Between March 1975 and January 1979, the RAAF maintained in Kashmir a detachment of one Caribou aircraft, with air and ground crews, as part of the UN Military Observer Group in India and Pakistan. The detachment's role was to move UN observers around an area of rugged mountain peaks and few roads. The observers monitored the ceasefire and prevented further violence between two hostile countries.

At the same time, another RAAF detachment was operating in a completely different environment. In July 1976, a detachment of four Iroquois helicopters from No 5 Squadron joined the UN Emergency Force (UNEF II) in the Sinai region. The detachment returned to Australia in 1979, but a larger detachment of eight RAAF and two RNZAF Iroquois returned to the Sinai between 1982 and 1986 as part of the Multinational Force of Observers (MFO). The role of both detachments was to monitor the ceasefire agreements between Egypt and Israel. Despite the uncomfortable desert conditions and the volatile political situation, the RAAF carried out its peacekeeping mission commendably and contributed to peace in the Middle East.

Since 1990, the number of ADF peacekeeping missions increased considerably. In 1992, the RAAF sent a Force Communications Unit of approximately 18 personnel to support the Australian-commanded UN Transitional Authority in Cambodia. Three years later, the Australian Medical Support Force sent to Rwanda in central Africa, included 51 RAAF personnel—some permanent and some reserve RAAF members. In 1992, the RAAF participated in Operation *Solace*, the stabilisation of Somalia after a period of civil war. RAAF transport aircraft flew the Australian National Liaison Team to Mogadishu and provided ongoing air logistic support to deployed Australian Army units in Somalia. RAAF specialists in movements and air traffic control provided valuable services on the ground at Mogadishu airport. At the end of the operation, RAAF and RNZAF C130 and RAAF B707 aircraft repatriated the ground force back to Australia.

Between 1999 and the present, the RAAF has participated in a number of UN missions in East Timor. The contribution included airlift of ground forces, organic airfield defence, support to air operations, maritime and land surveillance, medical assistance and aeromedical evacuation. Another UN mission currently supported by the RAAF is the UN Mission in Sudan. The RAAF contribution includes airlift of personnel and equipment by C130 aircraft, provision of UN staff officers and a commander of the Australian contingent (Squadron Leader Ruth Elsley).

Some regional peacekeeping missions supported by the RAAF have not been under UN authority. In 1997–98, RAAF medical personnel formed part of the Combined Health Element deployed to Bougainville to support peace talks to end the civil war on the island. Other RAAF personnel were members of the Peace Monitoring Group. When law and order deteriorated in the Solomon Islands in 2003 and again in 2006, RAAF aircraft deployed the Regional Assistance Mission to the Solomon Island (RAMSI). A RAAF Caribou detachment deployed to the Honiara allowed RAMSI elements to move quickly between islands.

RAAF contributions to peacekeeping missions around the world have demonstrated the professionalism of RAAF personnel and underscored the sound judgement and exceptional level of technical expertise accrued by the service since the 1940s. The contribution has also highlighted the breadth of capabilities in the RAAF, from the use of force to the provision of medical and logistic assistance.

Sir Donald Hardman's reorganisation of the RAAF

In 1952 Air Marshal Sir Donald Hardman of the Royal Air Force was appointed Chief of the Air Staff of the RAAF. The appointment was immediately controversial because a British officer had been selected over several able and experienced RAAF officers. Yet by the end of his two year tenure, Hardman was widely regarded, both within and outside the RAAF, as having served as an outstanding CAS. His major achievement and most enduring legacy was a thorough restructure of the Air Force along functional lines—an organisational framework that ably served the Air Force's needs for almost half a century.

Key Points

- Air Marshal Hardman's functional reorganisation of the RAAF into operations, support and training commands remained the basis for Air Force's organisation for nearly half of a century.
- A clear and congruent organisational structure is an essential enabler for Air Force to deliver vital air power capabilities to meet a diverse range of security challenges.

At the time of Hardman's appointment the RAAF was organised on a geographic basis that divided Australia into five area commands: Eastern, Southern, Western, North-western, and North-eastern Commands. This organisational structure had been developed in some haste during World War II and had been retained after the war by Hardman's predecessor and Australia's longest continuous serving CAS, Air Marshal George Jones. Although it had served Australia reasonably well during the massive wartime expansion of the RAAF, the war had also exposed some serious weaknesses in this type of organisational structure. Hardman had a reputation as a capable and effective organiser and he readily accepted the challenge of serving as Australia's CAS and implementing a fundamental reorganisation of the Air Force along functional lines.

The appointment of another British officer to the position of CAS originated in several approaches to the RAF by the Australian Prime Minister, Sir Robert Menzies, and several government ministers during 1950 and 1951. Menzies, a thorough anglophile throughout his political career, argued that there was no suitable Australian officer of sufficient age, ability or experience to lead the Air Force. The decision was not well received by the RAAF and the wider Australian community. It was understandably perceived as an affront to those senior Australian airmen who had so recently served with distinction in World War II. Nor was this first time in its relatively short history that the Air Force been subjected to the imposition of a British officer to lead or pass judgment on the RAAF. In particular, considerable rancor still existed over the lacklustre performance of the last RAF officer, Air Chief Marshal Sir Charles Burnett, who Menzies had thrust upon the RAAF at the start of World War II.

In selecting Hardman for the two year appointment to Australia, the British CAS, Marshal of the Royal Air Force Sir John Slessor, chose one the RAF's most able and experienced senior officers. Donald Hardman had joined the Royal Flying Corps in 1917 and by the end of World War I he was a decorated fighter ace and flight commander. After the war he earned a degree in economics at Oxford before rejoining the RAAF in 1921. He graduated from both the RAF and Army Staff Colleges and by 1939 had risen to the rank of Wing Commander. At the outbreak of World War II, Hardman fought with the British Expeditionary Force in France where he was mentioned in dispatches. He subsequently filled several key staff positions within the British Air Ministry. During the last two years of the War he commanded Allied transport operations in South East Asia and had attained the rank of acting Air Vice-Marshal. After the War he served in several important and high profile command and staff positions. At the time of his appointment to the RAAF he was serving as the Air Officer Commander-in-Chief Home Command.

As a forthright and outspoken proponent of air power, Hardman set out to change Australian attitudes to the Air Force and its

relationship to the Navy and Army. He challenged prevailing orthodoxy that Australia would be defended, first and foremost, by sea power. Aircraft, he argued, had accounted for more than half of the enemy shipping sunk in 1939-1945 and, therefore, the Air Force could take over the protection of the sea-lanes. He believed that the RAAF could do any job the Navy could do, and do it better. The Army, he argued, was simply spending '…a tremendous amount of money training people who [were] of little real use to Australia in a Cold War'. In Hardman's view the RAAF was '…the one force that could quickly strike for Australia's and the Commonwealth's defence in South East Asia'.

His views on air power were central to his rationale for a thorough reorganisation of the RAAF and his arguments drew upon the fundamental axiom that divided air power is weakened air power. It sacrificed economy of force and flexibility, and it denied the ability to concentrate at the decisive time and place. For Hardman, the Cold War had imposed the need for a new form of organisation that would enable the Air Force '…to operate almost anywhere in the world and possibly under the control of a foreign power'. He perceived that the existing RAAF structure made command and control unnecessarily complex through unclear divisions of responsibility between the Department of Air, the Air Board and RAAF Headquarters, and dispersed scarce resources between the various area commanders who could exercise little independent authority. The result, as one commentator observed, was '…apoplexy at the centre and anemia at the extremities.'

Drawing upon his experience of the RAF's functional command system, Hardman established three RAAF Commands. Home Command was responsible for control of all home defence and mobile (expeditionary) task force units. Training Command set training standards including national service training and recruitment into the Air Force. Maintenance Command controlled all equipment and servicing programs. All these Commands were given considerable autonomy over the resources placed at their disposal. At the centre,

he disbanded RAAF Headquarters and merged the Air Board into the Department of Air, creating a single and unified central authority from which all government, ministerial and Air Board decisions were issued to the RAAF.

Sir Donald Hardman forcefully and publicly voiced opinions on air power which few other senior airmen, and certainly no Australian, would have considered prudent and he set out to organise the Air Force in a fashion which would turn those opinions into policy. At the end of his two year tenure, Hardman returned to Britain and was promoted Air Chief Marshal and served out the remainder of his distinguished career as the Air Member for Supply and Organisation on the Air Council—the RAF's senior governing body. In Australia, he left behind a RAAF that was remarkably different from the one had taken over in 1952. By 1954, the Menzies government had declared that air power would be the first line of Australian defence. The expectations of the Air Force had at last rivalled, and even surpassed, those of the Army and Navy and it had adopted a command structure that would provide for the air defence of Australia for the next half century.

The RAAF in 'Konfrontasi'

In the 1960s the RAAF faced the prospect of becoming involved in a regional conflict in which Australian territory and interests were directly threatened for the first time since World War II. As a consequence, some RAAF fighter squadrons were held on five-minute alert status, and aircraft carried live ordnance while operating in a declared Air Defence Identification Zone—the first time this had happened since the Korean War ten years earlier. The RAAF response in these circumstances not only helped shape and deter the situation, but the RAAF itself was shaped by it.

> **Key Points**
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> - Confrontation presented the greatest direct threat to Australian territory and interests in the fifty years after the end of World War II.
> - Although full-scale conflict was avoided, air power was at the forefront of the Australian Government response.
> - The flexibility provided by air power undoubtedly helped to shape response and deter escalation of Indonesian military activity.

The cause of so much anxiety was the British decision to grant independence to Malaya, Singapore and Britain's territories of Borneo by incorporating them into a federation called Malaysia in September 1963. This was a step vigorously opposed by President Sukarno of Indonesia, who regarded the new entity as a neo-colonial creation. Rather than provoke all-out war over the issue, Sukarno embarked on a sustained program of political and military aggravation—including limited cross-border incursions—aimed at destroying Malaysia. This policy was termed '*Konfrontasi*' (Confrontation) by Sukarno's foreign minister, Dr Subandrio.

Because Australia (with Britain and New Zealand) had forces stationed in Malaysia as part of a regional stabilising force known as the Far East Strategic Reserve, Indonesia's policy carried risks of wider involvement if there was any miscalculation or escalation in the military levels it employed. Australia's air presence in the affected

region was sizeable, with three RAAF squadrons—No 2 (Canberra bombers) and Nos 3 and 77 (Sabre fighters)—stationed at the Butterworth base opposite the Indonesian island of Sumatra. This proximity placed Australian air elements in the immediate front-line in case of any serious outbreak of conflict.

The first deliberate incursion into Malaysian airspace to which the RAAF responded occurred on 17 July 1963 when two unidentified aircraft, thought to be Indonesian MiG-19s, were separately sighted near the Malayan coast about 100 km south of Penang. One of the intruders was pursued back across the Strait of Malacca towards the Indonesian town of Medan. Following this incident, Far East Air Force (FEAF) commanders extended radar surveillance at key bases, including Butterworth, to 24 hours a day and upgraded the readiness status of air defences.

From October 1963, the RAAF was required to keep two Sabres at 'Alert 5' status during daylight hours, requiring fighters to take off five minutes after an order to scramble, with the RAF's No 60 Squadron (operating Javelins) taking over this duty at night. Rules of engagement were initially complicated and only allowed RAAF fighters to engage Indonesian aircraft if a number of, not always well-defined, conditions were met. These rules were changed in October 1964, however, in response to continued Indonesian aggression, and thereafter any positively identified Indonesian aircraft operating in Malaysian or Singaporean air space was to be destroyed.

While the Sabres of Nos 3 and 77 Squadrons remained on alert for incursions by Indonesian aircraft, the Canberra bombers of No 2 Squadron prepared for possible strikes against Indonesian targets. Crews familiarised themselves thoroughly with potential targets, such as Indonesian air bases on Sumatra, and regular training flights included simulated low-level air strikes. The need for such operations seemed about to be realised in September–October 1964, after Indonesian paratroops and amphibious vehicles raided Labis and Pontian on the south-western side of the Malayan peninsula, and Australian troops became involved in operations to mop-up the

invaders. The Australian Government even felt compelled at this time to initiate a deployment of RAAF fighters to ward off any retaliatory strikes which the Indonesians might launch against Darwin (see *Pathfinder 48*).

The Labis-Pontian raids also brought to light a radar blind spot over the Strait of Malacca, behind Penang Island, which meant that Indonesian aircraft could approach Butterworth from Medan undetected by 114 Mobile Control and Reporting Unit (MCRU). This created a difficult air defence problem. Until a second MCRU could be established to close the radar gap, a radar-equipped Royal Navy destroyer had to patrol the Strait between Medan and Penang, and RAAF Sabres were required to mount armed dawn patrols to the west of Penang Island.

In conjunction with the armed incursions that were occurring on the ground and in the air, Indonesia was also applying political pressure which carried further implications for the RAAF. On 3 July 1964 the Australian Embassy in Jakarta was informed that two RAAF and eight RNZAF transport flights had been refused clearance to enter Indonesian air space, and a blanket clearance for C-130 courier flights from Darwin to Butterworth which also passed through Indonesian air space was withdrawn. In response, Australia's ambassador to Indonesia, Mr Keith Shann, supported by Chief of the Air Staff, Air Marshal Sir Valston Hancock, proposed to test Indonesian resolve by flying a combat aircraft from Darwin to Singapore via the standard route taking it over waters claimed by Indonesia but regarded by Australia as international. Government procrastination over granting approval, however, meant that the proposal was never implemented, and for more than a year RAAF aircraft were obliged to travel to Butterworth and Singapore via the Cocos Islands to avoid Indonesian air space.

By November 1964 the Australian Government was announcing a range of new measures which reflected its gloomy assessment of the strategic situation in the region, and sought to exercise a measure of deterrence. An increase of 4000 personnel to the RAAF's strength

(taking it to over 20 000) was announced in Parliament, along with plans to build new airfields at Tindal, south of Darwin, as well as Wewak in New Guinea in case problems developed across Indonesia's border with the then-Australian territory of Papua New Guinea. Proposals were also conspicuously debated to upgrade the airfield at Learmonth, Western Australia, to enhance the publicly-vaunted ability of new nuclear-capable F-111 bombers, ordered from the US in October 1963, to comfortably strike at targets as far away as the Indonesian island of Java.

In November 1965, a detachment of 77 Squadron was also moved to Labuan in Borneo to patrol the border with Indonesian Kalimantan. Pilots were authorised to carry out direct armed action against Indonesian Air Force aircraft known to be strafing villages on the Malaysian side of the border. This situation was fraught with danger of accidental encounters, since existing maps were inaccurate and pilots were forced to draw their own maps of the patrol area. Patrols were continued by a detachment of 3 Squadron until late December 1965.

Fortunately, Confrontation soon to come to an end. An attempted coup by Indonesian communists in September 1965 saw Sukarno removed from power and General Suharto installed as President. Tensions gradually eased, and a peace treaty was signed between Indonesia and Malaysia in August the following year. While it has since become history that matters never deteriorated to the stage where worst fears were realised, RAAF personnel in Malaysia had to contend with a tense war of nerves for the period that Confrontation lasted. The conflict has received little media attention and today is completely overshadowed by Vietnam. Of some 3500 Australians who served during Confrontation, there were only 23 fatalities, including four RAAF personnel.

RAAF neptunes and the Vietnam war

On 29 April 1965, the Australian Government announced its decision to commit an infantry battalion for ground combat service in the Vietnam War. In addition to the First Battalion, Royal Australian Regiment (1RAR), the force would include a troop of armoured carriers and a logistics supply company.

> **Key Points**
> - Providing multi-dimensional and layered defence for an expeditionary force is a complex joint operation.
> - Expeditionary operations need long range force protection.

One company of the battalion, along with elements of its Support and Administration companies and most of the force's vehicles, equipment and supplies, were to be moved to Vietnam a month later on board HMAS *Sydney* (III)—the former aircraft carrier that had been converted to service in the Royal Australian Navy as a fast troop transport. The remainder of 1RAR would follow early in June, on board a Qantas Boeing 707 jet operating from RAAF Base Richmond.

At this stage of the war, *Sydney* was a high-value asset of the Australian defence forces in that she had a unique sea-lift capability, and a successful attack on her would seriously delay or possibly cancel Australia's commitment to the war. *Sydney* and its cargo had to be protected at all costs. Based on this assessment, the decision was taken in the Defence Department to provide multi-layered protection for the deployment, with both sea and land-based air power playing a major role in the operation.

At that time, the RAAF's maritime patrol force consisted of two squadrons of Neptunes: 10 Squadron based at Townsville, and 11 Squadron based at Richmond. On 21 April, WGCDR Geoff Michael AFC, the CO of 10 Squadron, was briefed about Operation *Trimdon*—the deployment of 1RAR to Vietnam—and ordered to begin planning the air support required. There was no specific threat

identified, however the worst case scenario would be an attack on *Sydney* by a submarine of a nation that was allied or sympathetic to North Vietnam. The tone of the briefing was reflected in the RAAF Operations Order which stated 'a wartime situation is to be assumed throughout the operation'. Continuous air support was required all the way to the destination, the Vietnamese port of Vung Tau. All Neptune aircraft involved in Operation *Trimdon* would carry live torpedoes and depth charges on all sorties. Aircraft captains were briefed that attacks were authorised on any target that 'was acting in a hostile manner' – although what constituted a 'hostile manner' was not defined.

RAAF support to Operation *Trimdon* commenced on 28 May, when three Neptunes of 11 Squadron deployed to RAAF Townsville and two to Lae, in Papua New Guinea. That same day, support personnel and equipment were deployed to Lae by C130A aircraft. One 10 Squadron Neptune joined the others at Lae on 29 May. These aircraft shadowed the *Sydney* task group during passage through the Coral Sea, around the island of New Guinea and through the Vitiaz Straits between New Guinea and New Britain. At least one Neptune remained on station at all times approximately 200 km ahead of the task group. Passive sonobuoys dropped in the water listened for any submerged submarines while the Neptune crews used radar and visual lookouts to detect any submarine on the surface or at snorting depth. The escorting destroyer HMAS *Duchess* provided close-in protection using sonar and radar. The detection of a possible hostile submarine required the RAAF crew to warn *Sydney*'s captain who would then coordinate an appropriate response using all the assets available. Unless contact with a possible threat was made, all aircraft had to maintain radio silence.

By 2 June, approximately half-way between New Guinea and the Philippines, *Sydney* was joined by the destroyer escort HMAS *Parramatta*. Three Neptune aircraft began flying support sorties from Agana airfield on the island of Guam. Two of these aircraft flew to Naval Air Station (NAS) Sangley Point in the Philippines on 4

June to join five other RAAF Neptunes which had just completed an exercise in the Philippines area. Together, these aircraft and crews provided protection to *Sydney* for the remainder of its voyage to Vietnam.

On 4 June, the *Sydney* task group rendezvoused with the aircraft carrier HMAS *Melbourne* and its two support ships for the next part of the voyage. During this most dangerous stage, *Melbourne*'s Wessex helicopters were deployed in a screening role using dipping sonar while its Gannet fixed-wing aircraft flew mid-field anti-submarine patrols during daylight and Sea Venom fighters flew sorties at dawn and dusk. Neptunes kept up the deep field patrols night and day.

As *Sydney* approached the coast of Vietnam on the night of 7–8 June, a Neptune kept watch for any hostile small craft that tried to approach the ship. With *Sydney* safely arrived and unloading at anchor in the port of Vung Tau, the last Neptune headed for RAAF Butterworth, which was the closest military airfield outside of Vietnam. Their mission over, the Neptunes returned to their home bases by 12 June, and support crews were flown home from Sangley Point and Agana by two RAAF C130A aircraft soon after.

The result of Operation *Trimdon* was that 1RAR arrived in Vietnam on time. No attacks on *Sydney* were attempted and no hostile vessels were observed. Were the resources used in protecting *Sydney* and her cargo justified? Certainly the countries that were supporting the communist side in Vietnam had conventional submarines that were capable of interfering with the Australian deployment. Perhaps the presence of an aggressive, in-depth defence deterred any potential aggressor. Of more lasting importance, however, was the recognition that any expeditionary force deployed from Australia required the provision of a comprehensive layered defence to provide warning and weapon coverage against air, surface or underwater threats.

Later voyages of HMAS *Sydney* to Vietnam were also provided with screening aircraft. Two voyages in 1966 were escorted by RAAF Neptunes as well as aircraft from *Melbourne*. For the voyages undertaken in 1967 and 1968, HMAS *Sydney* embarked its own

flight of four Wessex helicopters from either 725 Squadron or 817 Squadron to provide screening.

HMAS *Sydney* and the Neptunes have gone but the requirement to maintain sea control remains. Ships such as the new Landing Helicopter Dock (LHD) give the ADF the capability to deploy an expeditionary ground force over long distances and then sustain it during operations. However, such an expeditionary force will need protection from air, surface and sub-surface attack. Networked air power provided by sophisticated attack aircraft, air defence ships, maritime reconnaissance aircraft, unmanned aerial vehicles (UAVs) and ship-borne helicopters will be a major component of this protection in the future.

Helicopter operations in Vietnam

The Vietnam conflict of 1962–1975 saw the clash of a technologically superior force against an equally determined but unsophisticated enemy. The employment of air assets such as the iconic Bell UH-1 Iroquois series of helicopters to mount airmobile operations on a massive scale changed not only the battlefield in Vietnam, but all future battle-spaces.

The British success in using helicopters to deal with a Communist insurgency in Malaya may have been one of the factors

> **Key Points**
> - As used in Vietnam, the helicopter provided unprecedented troop mobility and supremacy on the battlefield.
> - The vulnerability of the helicopter to ground fire, demonstrated in Vietnam and currently elsewhere, ensured that gains were won at a high cost.
> - The utility of the helicopter weapon, and its drawbacks, remain the same irrespective of which service owns or operates the aircraft.

that saw these aircraft so rapidly introduced into the Vietnamese theatre. There were, however, significant differences between the two campaigns. The British used the helicopter as a means, whereas the US in Vietnam used it as an end. In Malaya the overall strategy was to hold ground, while in Vietnam the helicopter took the war to the enemy in no uncertain terms but the ground was never held. American airmobile tactics were underpinned by a grander strategy focussed on world-wide Communism.

To assist their ground forces, the Americans committed close to 50 assault helicopter companies (AHC) with about 1500 Iroquois, or *Hueys* as they were more commonly known, and another 20 or so assault support companies (about 400 CH-47 *Chinook* helicopters) as well as a multitude of other helicopter types. Each AHC comprised 20 lift aircraft (the *Slicks*), 8 gunships (UH-1Cs), and the air mission commander in the Command and Control (C&C) ship with two others for spare and maintenance support. At any

one time at the height of the war, about 1000 helicopters would be moving American, Australian, Thai, Korean, Philippino and South Vietnamese troops by company sized groups of 100 or so men, and equipment, from pick up zones to landing zones and back again.

From 1966, the Royal Australian Air Force also provided a helicopter unit to give support to Australian ground troops. The UH-1B, D and later H models operated by No 9 Squadron met most of the requirements of the Australian Task Force based at Nui Dat, although the RAAF was frequently stretched in finding enough pilots to keep the unit fully manned. This shortage was met by attaching some New Zealand officers to the squadron, and—from February 1968 until April 1969—some Royal Australian Navy pilots as well.

Quite separate to the Navy personnel serving with 9 Squadron was the contribution of the RAN Helicopter Flight Vietnam (RANHFV). From October 1967 the RAN provided a contingent of personnel only (no aircraft) comprising eight pilots, four observers, four aircrewmen, maintainers and supporting staff—a total of 46 all ranks. This contingent was relieved at yearly intervals, so that ultimately four groups were rotated through by late 1971, when Australian forces were swept up in the general exodus of foreign support for the South Vietnamese regime.

The RANHFV was tucked away within the US Army's 135th AHC, itself part of the huge 1st Aviation Brigade, forming part of that AHC's Experimental Military Unit, inevitably dubbed the EMUs. Initially, the 135th was stationed at Vung Tau (the base used by the RAAF squadron), but later it moved to Blackhorse near Xuan Loc, then Bearcat (north-east of Saigon) and finally Dong Tam in Dinh Tuong province. The Navy flight was fully integrated into the organisation of the 135th AHC. The officer in command of the RANHFV was the Company Executive Officer, and his pilots took C&C, as well as Platoon and Gunship lead positions. Observers went into operations positions at battalion and group level, while the aircrewmen became gunners and crew chiefs across the AHC.

While not technically 'under command', the RAN personnel inevitably assumed this status whenever they found themselves flying as part of an American crew, in an American aircraft, with US or Vietnamese commanders directing operations. It happened just as often, however, that when flying as C&C or *Slick* or *Gunship* lead, an Australian found himself in command of a mission involving American and Vietnamese forces.

In these operations the helicopters functioned purely in the trooplift role, taking troops to and from landing zones (LZ) to specifically engage the enemy based on intelligence derived in most cases over the previous evening. If the LZ was 'hot' (with enemy present), it was considered a plus because time had not been wasted in finding the enemy. Support was also generally available from other troops in the pick up areas, with artillery and air strikes available instantly on tap. The helicopters also carried out efficient medivac of injured personnel.

AHC flying rates were predicated on 1500 hours per month for the 15 aircraft required every day, but in 1968–69, the 135th AHC flew 3600–4100 hours a month for a yearly total of over 35 000 hours, much the same as all assault companies. The effect of this rate of effort was that in-house maintenance often suffered. The 100-hour inspections had to be done overnight, and repairing battle damage was similarly rushed. The frequency of aircraft losses placed a high strain on the supply chain and meant that replacements were not found quickly. In the 135th the normal complement of 31 helicopters was reduced to 17 in 1969, which meant that providing 15 aircraft every day eventually became difficult. Pre-flight inspections never became merely a matter of course in the company, but if the aircraft could be started, it was generally flown—such was the demand and the response.

The superiority that the US and South Vietnamese forces gained from airmobile deployment of troops produced formidable successes at the tactical level. Although often won at huge cost, the allied successes were so overwhelming that the North Vietnamese normally

withdrew rather than fight to the conclusion of any engagement. The enemy retired to fight another day, while the US and ARVN were airlifted back to their enclaves.

It is inconceivable that this sort of war could be fought again. Over 7000 *Hueys* went into Vietnam, and of these, 3300 were destroyed through enemy action or accident; nearly 2200 helicopter aircrew were among the 58 000 Americans who lost their lives in the conflict. The 135th AHC lost 13 killed and 22 wounded in action during 1968-69 alone. Overall, the RANHFV lost five killed and had 22 wounded—about the same as the RAAF's much larger No 9 Squadron operating sixteen aircraft.

What are the lessons for today? Helicopters are probably the most effective quick reaction tool in a land force commander's inventory, but they are only a means of taking the fight to the enemy, not an end by themselves. Moreover, using helicopters in situations entailing a high risk of combat means that inevitably there will be losses— possibly heavy losses. Any ADF commander faced with circumstances similar to Vietnam will need to decide the extent to which he can afford to sacrifice airmobility assets in order to achieve his campaign aims.

Precision airdrop:
the future of aerial resupply

Since barely a decade after manned flight began, high priority military stores and equipment have been delivered by air. In early 1916 the Australian Half Flight in Mesopotamia attempted to sustain the British force besieged at Kut el Amara by this means, and during World War II aerial re-supply featured significantly in a number of campaigns. The concept was fundamental to the Berlin Airlift, and became almost commonplace in Korea and Vietnam where units were

> **Key Points**
> - Airdrop of supplies is still essential for operations today.
> - JPADS will allow precision delivery of stores and supplies to manoeuvre forces whilst improving aircraft survivability.
> - Improving the Air Force's airdrop capability will enhance surface forces' ability to conduct operations.

often isolated in mountainous or jungle terrain. Aerial re-supply was less visible for much of the Cold War, in the absence of a large-scale conflict, although it was still used in the many regional wars fought in the period. In the kind of operations increasingly undertaken today in places such as Afghanistan, with units once more operating in dispersed and isolated mode, aerial re-supply is receiving renewed emphasis.

Aerial re-supply, or airdrop as it is called today, is the delivery of supplies and equipment to surface forces from an aircraft in flight. Airdrop supplements traditional logistics by delivering ready-to-use supplies and equipment to forces in the field. Traditionally there are three basic types of airdrop. First is **Free Drop,** which is the delivery of non-fragile items without the use of parachutes or other retarding devices. Items delivered by free drop require careful preparation to prevent damage from landing shock such as flexible containers or padding.

Second, **High Velocity Airdrop,** uses airdrop containers to deliver supplies. The containers have Energy Dissipater Material (EDM) attached to the underside of the load and a stabilising device, such as a ring slot parachute, attached to the top of the load. The stabilising device minimises the oscillation of the load and creates just enough drag to hold the load upright during descent so that it will land on the EDM. The design rate of descent for high velocity drop is 21 to 27 m/sec (70 to 90 ft/sec).

Third, **Low Velocity Airdrop,** delivers supplies using a parachute. Loads are prepared by either packing in airdrop containers or by rigging them to platforms or skidboards. The load is attached to cargo parachutes, which retard its descent and minimise landing shock. The design rate of descent for low velocity drop is 8 m/sec (28.5 ft/sec) or less.

To drop supplies with any degree of accuracy using traditional airdrop methods an aircraft must make its approach at or below 2000 feet above ground level at 120–150 knots over a suitable drop zone. At this height and speed, aircraft are vulnerable to small arms fire, man portable air defence systems and other surface-to-air missiles. Larger aircraft are more vulnerable because of the longer time required to dispense their larger load.

The Joint Precision Airdrop System (JPADS) aims to provide a safe, rapid and accurate high altitude delivery system to re-supply surface forces. Currently, JPADS can deliver up to 20 000 lbs of supplies (efforts to increase this to 60 000 lbs are already underway) with an accuracy of 100m circular error probable (CEP) and can be launched from up to 35 000 feet with a range of about 45km. The system consists of a steerable parachute, steering actuators, an airborne guidance unit and mission planning equipment. Some versions also have active in-air collision avoidance systems that facilitate simultaneous deployment of multiple packages. The JPADS is guided to a drop zone by either the airborne guidance unit using pre-set coordinates or guided to a ground beacon. Some variants can also be flown using a manual controller.

These evolving airdrop delivery systems provide several advantages over current delivery methods across the spectrum of conflict. Being able to airdrop from high altitude allows the delivery aircraft to fly above normal enemy ground fire increasing its probability of survival. The high altitude of the drop and the types of parachutes used by JPADS ensures that the aircraft can carry out the airdrop from a safe stand-off distance, away from enemy ground threats located near the drop zone.

The improved accuracy of delivery means that the size of the drop zones can be significantly reduced thereby increasing the number of possible drop zones. Improved accuracy also increases the probability of the cargo reaching its intended target and reduces the need for sequential drops or very long drop zones. JPADS can transmit its current position back to the aircraft, which could be relayed to the ground forces providing them with the exact landing location.

JPADS can also be used for individual re-supply, the precision emplacement of unattended ground sensors and small munitions deployed from military aircraft. Being self-guided, a JPADS container can be delivered in or above weather that would normally preclude a successful drop due to lack of visual contact with the ground.

Security of ground forces is also improved due to reduced aircraft noise through increased stand-off range. Improved accuracy and confirmation of delivery translates to reduction in time spent searching for lost stores because of inaccuracies. Moreover, even after the drop, if the intended drop zone proves untenable, the stores can be manually steered to prevent them falling into enemy hands.

This means that the JPADS is like a stand off weapon, in that it allows the aircraft to remain outside the weapon engagement zone both vertically and horizontally. Further, as drop zones need no longer be marked for visual identification by aircrew, along with increased stand off ranges, they become far more ambiguous to identify, making the location and timing of a drop far more difficult to predict and therefore more secure. This ambiguity is further enhanced by dropping in inclement weather or at night. JPADS could allow for

time sensitive airdrop with standardised loads dropped on request to allow a land commander to maintain his operational tempo. The introduction of JPADS would also allow, for the first time, accurate re-supply of manoeuvre forces as they could request re-supply in a way similar to how close air support is currently requested. With further refinement in guidance and reduction in the CEP, it would even become possible to deliver critical stores to a ship at sea.

While airdrop is far more expensive than either ground or sea transportation in terms of dollars per kilogram delivered, having an effective and accurate airdrop option will expand the combat capabilities of our ground forrces. JPADS will ensure that air power will be able to provide a truly responsive, flexible and versatile aerial re-supply capability.

RAAF EXPERIENCE IN COMBAT SAR

In Australian military tradition, coming to the aid of your comrades, especially under combat conditions, ranks a high priority and contributes to esprit de corps. Among World War I aviators, this tradition took the form of pilots landing their aircraft alongside those of fellow pilots who had been shot down, in an attempt to rescue them. Some succeeded gloriously; some failed. In Palestine on 20 March 1917, LT Frank McNamara of No 1 Squadron AFC landed his Martinsyde G100 in the

> **Key Points**
> - Australian airmen have been involved in rescuing personnel trapped in enemy territory since World War I.
> - The experience continued throughout World War II, Korea and Vietnam.
> - The RAAF is required to contribute air power support to personnel recovery efforts following an accident or hostile action.

desert, rescued his squadron mate from charging Turkish cavalry and was awarded the Victoria Cross. Combat Search and Rescue (CSAR) has evolved and improved way beyond the ad hoc methods used in World War I. These are some of the examples of RAAF experience in CSAR.

In World War II, the RAAF started to develop its CSAR capability by forming units that specialised in this role. No 1 Rescue Flight (later renamed No 1 Rescue and Communication Squadron, and even later No 8 Communications Unit) was located at Goodenough Island in November 1942, with detachments at various Allied bases around New Guinea. This unit used Walrus, Dornier Do-24 and Catalina flying boats in the CSAR role.

From December 1944, the number of units specialising in CSAR greatly increased. Air-Sea Rescue Flights (ASRFs) were formed at Madang, Darwin, Cairns and at Morotai Island, Netherlands East Indies (NEI). Each was equipped with at least two Catalina aircraft. Some of these units were also equipped with motor launches that

could be used to recover personnel when alighting on the water was not possible.

On 31 March 1945, Beaufighters from 31 Squadron were attacking Japanese targets in the Haroeke Straits near Ambon, NEI. The crew of one aircraft bailed out and climbed into a dinghy in the middle of the strait. Approaching to alight near the survivors, a Catalina of 113 ASRF was met with groundfire from both sides of the strait. Covering fire from both of the Catalina's blister guns and from two other Beaufighters kept the enemy occupied long enough for the flying boat to land, recover the Beaufighter crew and take off again. The Catalina recovered to Morotai, damaged by gunfire and with one wounded crewmember.

By April 1945, CSAR had evolved to the point where it was part of the planning of an air operation. Air-Sea Rescue Catalinas provided CSAR cover for many of the bombing missions flown by RAAF aircraft as part of Operation *Oboe 1*—the amphibious landings at Tarakan, Borneo. In these operations, the Catalina held in a safe area within visual range of the target, observed the attack and provided assistance to any of the attacking aircraft in distress.

In the Korean War, CSAR was generally provided by helicopters flown by the American services. At least two RAAF pilots were recovered by this method. On 15 March 1951, 77 Squadron Mustangs were attacking North Korean forces along the north bank of the Han River, while the UN forces held the south bank. WOFF Charles Howe's aircraft was struck by groundfire and began to lose power. He crash-landed his aircraft on an island in the middle of the Han River, which was not occupied by either side at the time. He was rescued shortly after by an American helicopter.

On 20 March 1951, two 77 Squadron Mustangs were patrolling north of Seoul when SGT Cecil Sly's cockpit began to fill with smoke and the engine lost power. Sly bailed out at low level but, once on the ground, found himself surrounded by well dug-in Chinese troops. His section leader in the other aircraft called for more Mustangs to provide a protective ring of fire around the RAAF pilot, who

had taken cover in a dry river bed near his crashed aircraft. A US helicopter attempted a rescue about half an hour later, but was driven off by the intensity of the enemy fire. More Mustangs came on the scene, dropping napalm on the area where most of the groundfire was coming from. The pilot of a US T-6 observation aircraft, who was directing the close air support, was wounded by groundfire and had to return to base. After Sly had been on the ground for about two hours, a second rescue helicopter flew in at low level, picked him up and flew to a major military airfield.

During the Korean War, six RAAF pilots successfully abandoned their aircraft over enemy territory but were captured. The rescues attempted were not successful because either the location of the downed pilot was unknown, or the pilot was captured within minutes of landing.

The RAN, however, had better luck with CSAR. In October 1951, HMAS *Sydney* II had embarked a US Navy Sikorsky S-51 helicopter and crew to provide CSAR services. On 26 October, five RAN Fairey Fireflys conducted a strike on a railway tunnel when one of the aircraft was hit by anti-aircraft fire and force-landed in a paddy field. Enemy forces surrounded the two-man crew but were kept at a distance by strafing fire from the remaining four Fireflys, three RAN Sea Furys plus two 77 Squadron Meteors. Seventy minutes after leaving *Sydney*, the rescue helicopter landed, under a hail of bullets, close to the two survivors and extracted them to the safety of Kimpo, the nearest military airfield.

In the Vietnam War, CSAR for RAAF operations was again generally provided by US services. An example of this was in March 1971 when Canberra A84-228 was struck by a surface-to-air missile over South Vietnam. The pilot and navigator successfully ejected and landed in an area of mountainous jungle held by the Viet Cong. After spending the night hidden in the jungle, both crewmembers were located and winched from the jungle by a USAF Iroquois which homed onto their emergency radio beacons.

In a war with many helicopter-borne forces, CSAR was often provided by friendly aircraft that happened to be in the area. An example of this occurred in February 1970, when FLTLT Chris Langton was flying a USAF OV-10 Bronco aircraft on a Forward Air Control (FAC) mission near the Cambodian border. His mission was to coordinate the air support for the helicopter extraction of a US Army patrol that was in close contact with communist forces. When the controls of his aircraft froze, FLTLT Langton was forced to eject at low level. While some A-37 Dragonfly aircraft put down covering fire to pin the enemy down, a LOH-6 helicopter that had been part of FLTLT Langton's support team, picked him up. Within seconds, groundfire struck the engine and the aircraft crash-landed in the jungle. Unhurt, the crews of both aircraft remained hidden in the undergrowth for 20 minutes until a rescue Iroquois winched them to safety.

The Air Power Manual (AAP 1000-D) states: 'The Air Force does not have a dedicated SAR capability, and contributes to Joint Personnel Recovery by providing air power support to other agencies and forces conducting recovery operations. In CSAR, the Air Force can contribute C2, ISR and air operations to protect rescue forces from enemy threats.'

Joint personnel recovery and combat search and rescue: A doctrinal view

Joint Personnel Recovery (JPR) includes support to civil search and rescue (SAR), combat search and rescue (CSAR), military SAR (MilSAR), combat recovery (CR), special recovery operations (SRO) and care after recovery (CAR). The concept of JPR is by itself not new, but like a number of other operational concepts the advent of air power impacted search and rescue missions by increasing the reach and flexibility with which they could be carried out. With its speed of response, the enhanced coverage

> **Key Points**
> - Air power has enhanced Joint Personnel Recovery capabilities by its reach, speed of response and information dissemination capacity.
> - Combat Search and Rescue is a highly visible and important part of JPR that has a moral dimension to it.
> - CSAR operations by itself are dangerous missions and require elaborate planning and efficient execution to be successful.

of its sensors, sophistication of survival equipment and extended reach that surmounts geographical barriers, airborne platforms can rapidly search large areas, reach areas inaccessible by land or sea and effect timely recovery. Time is critical in JPR and the responsiveness of air power and its reach, information dissemination capabilities and provision of command and control infrastructure has placed airborne assets at the vanguard of search and rescue operations, in both benign and hostile environments.

This is not to suggest that JPR using land or maritime assets has become redundant. The choice of the asset to be employed would depend on a number of factors, primarily the environment, accessibility and the urgency of the situation. History and current operations include instances where JPR (although not designated as such) has been carried out by land and sea. For example, in February 1942, the submarine, USS *Searaven*, rescued members of 28 Squadron RAAF from Timor at night because they had been

stranded after their exit plan to rendezvous with an RAAF flying boat failed.

Australia, as a signatory to the International Civil Aviation Convention 1944, the International Safety of Life at Sea Convention 1974, and the International Search and Rescue Convention 1979, is responsible for SAR over a vast area that includes the East India, South-West Pacific and Southern oceans, covering 47 million square kilometres. Although the state and territory police are the SAR authorities, the Federal Government, through the Australian Defence Headquarters, is responsible for the provision of SAR for all military and visiting military forces. This responsibility is exercised through the Navy, Army and Air Force depending on the context of the distress situation.

Combat search and rescue is the recovery of isolated personnel, usually behind enemy lines, from an environment in which a threat to their well-being is posed by hostile forces. By virtue of their mission profiles, combat aircrew and Special Forces groups are perhaps the ones at the highest risk of being behind enemy lines. Consequently a highly visible and important part of CSAR operations is the recovery of aircrew who have been forced to abandon their aircraft and Special Force groups who operate in side adversary territory.

By their very nature, the majority of Combat Search and Rescue operations are conducted in a hostile environment and are primarily aimed at maintaining the morale of combat forces by ensuring that all possible efforts will be undertaken to recover anyone in distress. It also has a by-product of denying the enemy information that could otherwise be obtained by the capture and interrogation of the individual or group in danger or their exploitation for political propaganda purposes.

Although the ADF does not have a dedicated CSAR capability, the inherent flexibility of air power can be leveraged to assist the CSAR efforts of partner forces. For example, a helicopter can be used in conjunction with Special Forces to create an ad-hoc, but capable, CSAR force on a case-by-case basis. All operational planning and

execution must take into account the CSAR requirements and therefore it is necessary for the ADF, and especially the Air Force, to be aware of the issues involved in CSAR operations.

It is to be expected that CSAR operations would be opposed by enemy activity and the assets being normally unarmed make these operations very high risk. In recent operations, CSAR missions have suffered as much as 10 per cent attrition. Operational security therefore, is of paramount importance in the planning and execution of these missions. It is also incumbent on the planners to ensure that CSAR operations are given priority in terms of protection, which may involve the use of combat assets to provide covering fire for the rescue aircraft, vehicle or ship. Proper planning before the mission is essential to ensure that the rescue operation is conducted with the appropriate coordination and concentration of necessary force. High level command of these operations will determine the necessary allocation of forces balanced against the need to avoid detriment to other operations. The basic air power tenet of centralised control and decentralised execution is very clearly applicable here. Unplanned rescue operations can rapidly spiral out of control and become extremely resource-intensive, limiting operational options in a smaller, resource-constrained force.

While the rescue of combat forces in distress or downed aircrew is of the ultimate importance, CSAR missions, especially in very hostile situations, should only be undertaken after the probability of success has been carefully assessed. The advantages of recovering one's own personnel can be very quickly overwritten by the loss of the rescue package with even greater number of personnel in danger. The decision to mount a rescue operation would therefore have to be done at an appropriately high level, and must take into account the negative political, diplomatic and public opinion fall-outs that can accompany the capture of combatants and the possibility of their becoming hostages.

The culmination of CSAR is the eventual rescue of the survivors. Not all air power assets that can contribute to the SAR effort are capable

of conducting the rescue part of the operation. This is particularly so in the case of maritime SAR, wherein the airborne search platform by itself may not be able to effect the rescue, but has powerful search capabilities and the endurance necessary to remain in the physical proximity and in contact with the survivor, airdrop necessary supplies and coordinate the eventual rescue.

CSAR is a necessary capability, particularly for an all-volunteer military force, wherein there is an implicit moral obligation to rescue personnel in distress. However, the resource requirements to have a standing capability could be unsustainable and resource-debilitating for smaller forces. In these circumstances, the inherent flexibility of air power and the capability of the force to operate jointly will have to compensate for the lack of dedicated and assigned assets. A clear understanding of JPR, especially CSAR, will form an intrinsic part of the professional mastery of military personnel.

Flying safety: the RAAF record

To defend Australia and its national interests, the Australian Defence Force is regularly called upon to operate in high risk environments. Air Force's role as the primary provider of Australia's air power capability requires it to undertake hazardous operational missions that require dedicated preparation and training. Integral to Air Force's professional mastery of air power is the requirement to establish and maintain the fine balance between flying safety and mission achievement in the conduct of all operations, exercises and training.

Key Points

- The capability and professional credibility of Air Force as the primary provider of Australia's air power is dependant upon our flying safety practices and culture.

- Failure to maintain flying safety not only unnecessarily endangers the lives of personnel, but can have serious repercussions for Air Force command and administration.

- The Air Force's current flying safety culture has been hard-won over many years and requires constant attention to preserve and maintain.

The Royal Australian Air Force (RAAF) is one of the best smaller air forces in the world. Fundamental to that status is the emphasis our professional values and organisational culture places on flying safety. As a result, Air Force is a world leader in the flying safety records of all the current platforms in its inventory. The flying safety cultural norms of the RAAF today, however, should not and cannot be taken for granted. As one of the oldest air forces in the world, the RAAF's culture is the product of its history and close association with the development of the civil aviation industry in this country.

Military aviation in Australia began at the Central Flying School (CFS) at Point Cook. In the early days of powered flight, the nascent aeronautical and mechanical technology made flying a particularly perilous affair as airframes and engines frequently failed. Shortly after flying operations commenced at Point Cook in March 1914, Captain

Henry Petre suffered Australia's first military flying accident when his Deperdussin monoplane crashed. During the course of World War I, eight flying courses were conducted at Point Cook after which the pilots were dispatched to England for further training. The advanced training conducted by the Australian Flying Corps' training wing in Britain was more demanding of both students and aircraft and resulted in a high accident rate that claimed the lives of at least 25 Australian airmen.

Following World War I, the Australian government established an independent air force on 31 March 1921. Barely a week after the formation of the RAAF, the first fatal crash occurred at Point Cook. This tragic beginning was, unfortunately, to be the first of many accidents during the inter-war period that was characterised by poor flying safety. During April and May 1927, two flypasts to mark the visit by the Duke of York were marred by very public air disasters that claimed the lives of five airmen. When the RAAF's own internal investigation essentially exonerated all involved, the government established an independent Air Accidents Investigation Committee. This body was the first official air safety organisation tasked with investigating accidents and promoting air safety in Australia. Air Force's safety record, nevertheless, did not appreciably improve and between 1921 and 1937 the RAAF suffered a total of 56 flying fatalities. As continuing progress in the reliability and airworthiness of aircraft had little impact on the RAAF's accident rate, it became increasingly clear that a major cause of the poor safety record was to be found in the Air Force culture.

The early culture of the Air Force was a product of World War I as nearly all of its first members were veterans of that conflict. As a group, Air Force's most senior leaders were all relatively young men who shared the common bonds and intense camaraderie common among war veterans. Most had proven themselves in combat, with the majority of officers of Squadron Leader rank or higher possessing at least one decoration for flying prowess or valour. Their collective and individual experiences made them reluctant to either

give or receive criticism from their colleagues and peers. They, and the succeeding generation of pilots that they trained, created an organisational culture that emphasised 'spirited' individualism which accepted unnecessary risks and tended to turn a blind eye to cavalier attitudes towards safety and lapses in discipline.

The costs to Air Force were high. For the small Air Force establishment the most obvious of these costs was the loss of a significant number of promising airmen to death or injury. The high mortality rate also raised serious questions regarding Air Force's basic competence in its core business of flying. Successive Australian governments had cause to doubt the professional expertise of the Air Force's leaders and twice during the inter-war years invited senior Royal Air Force (RAF) officers from Britain to review the state of Australia's air defences. The second such review, by Marshal of the Royal Air Force Sir Edward Ellington, paid a great deal of attention to Air Force's safety record and was scathing in its criticism. As result, Air Vice-Marshal Richard Williams, the Chief of the Air Staff, was relieved of his post in 1939 and the Australian government appointed a British officer, Air Chief Marshal Sir Charles Burnett, in his place.

The demands of World War II resulted in a vast increase in the quantity and tempo of flying training. Burnett's appointment, however, had little impact on flying safety and over 300 instructors and trainees were killed in fatal accidents in Australia during the war. Of greater consequence for the future development of air power in Australia, Burnett's highest priority was the air defence of Britain and he threw his full support behind the Empire Air Training Scheme. The dispersal of Australian airmen across RAF squadrons deprived the RAAF of any sense of national and organisational identity. It also greatly limited the opportunities for senior RAAF officers to gain experience in command and opportunities to engage in the higher strategic level development of air power.

In the decades following World War II, the RAAF worked hard to overcome the legacy of its formative years. The post-war years witnessed the development of more professional training institutions

and curricula for development of aircrew and ground staff. As airborne platforms became increasingly complex and costly, and required a growing number of specialists to fly and maintain, air safety became a whole-of-organisation responsibility. Tragic and costly accidents during the post-war decades periodically gave renewed emphasis on improving flying safety and the organisational and procedural reforms necessary to achieve it. Most importantly, Air Force embraced the promotion of flying safety as a core organisation value.

The past decade has seen a significant increase in operational tempo at a time when Air Force has reduced in size. The future holds little prospect for a respite in operations and the next decade will see Air Force introduce an entirely new generation of weapons systems. The level of risk accepted for military operations will often exceed that allowed by civil authorities and must be carefully managed in light of the military situation. ADF Boards of Inquiry into some recent air accidents have highlighted that periods of increased operational commitments and the burdens imposed by the introduction of new weapons platforms are those most likely to lead to compromises in air safety. Our current culture of flying safety has been dearly won with lives of RAAF personnel and deserves to be safeguarded by all Air Force members as one our most precious assets.

Air power in Russia's Georgian campaign August 2008

For five days in August 2008, Russian and Georgian military forces were engaged in a brief but bloody conflict that ended with a ceasefire agreement. The conflict was triggered by a large-scale Georgian invasion of the breakaway region of South Ossetia on 7 August, to which Russia responded with an overwhelming show of force, deploying large elements of armour, infantry and air forces. Although Georgia has argued that their offensive was a move in response to severe provocations,

> **Key Points**
> - Threat libraries in self protection suites of airborne platforms should be upgraded with every change in national security perceptions.
> - Adequate surveillance and reconnaissance capabilities are critical to the conduct of a fast moving campaign.
> - Cyber warfare countermeasures are as important as combat capabilities to victory.

including the shooting down of Georgian unmanned systems, its strategy was significantly flawed from the beginning, being based on inadequate threat assessment and an underestimation of the vehemence of Russian response.

The importance of the Russian response lies in the fact that this was the first military offensive by the Russian military beyond its own borders since the collapse of the Soviet Union. Its severity and bluntness not only surprised the international community, but also highlighted the new found resolve within the Russian polity to display its power projection capabilities. The Russian campaign was spearheaded by its 58th Army, which along with armour, artillery and air defence units also has 120 combat aircraft and 70 helicopters integral to its composition.

Early in the conflict itself, Russia established air superiority and ensured that their initial deployment and subsequent lines of communications and supplies were not in any way threatened. The

Russian campaign, ostensibly aimed at liberating South Ossetia, was also aimed at crippling Georgian military capabilities by destroying as much of the heavy equipment as possible, along with bases and fixed installations—even those not involved in the conflict directly. Disruption of the on-going Georgian military infrastructure build-up, meant as a precursor to joining NATO, was the main objective.

The military infrastructure was targeted by successful air attacks on the Georgian bases at Kojori, Senaki, and Gori; the facilities at the Black Sea port at Poti; airfields at Marneuli and Vaziani; and the Tbilaviamsheni aviation plant where Sukhoi Su-25 'Frogfoot' fighter aircraft were produced.

The most significant factor that emerges from the campaign is the ease and rapidity with which the Russian air forces established air dominance and the effectiveness with which they neutralised the Georgian air-defence network and command and control systems. The second factor is the shooting down of Russian attack aircraft by surface-to-air missiles. The numbers (seven according to Georgia and four admitted by Russia) are unimportant. What matters is that this was a demonstration of the effectiveness of even very shoddily maintained and obsolete air defence systems in countering ground attack aircraft that do not have sufficient electronic self protection. In this particular instance it could have been a case of Russian aircraft threat libraries not recognising the Georgian air defence radar as hostile since they are also of Russian origin.

If this is indeed true, it is a salutary lesson for all air forces to take on board in the current security environment, wherein the international arms market is insecure and prone to arms proliferation and secondary distribution of sophisticated weapon systems. Threat libraries in the self protection suites of airborne platforms have to be updated regularly and in relation to the potential adversary.

The Russian air forces' lack of reconnaissance assets was clearly demonstrated by their having to send a Tupolev Tu-22M3 'Backfire' strategic bomber on a tactical reconnaissance mission. Even though a number of Uninhabited Combat Aerial Vehicles have been routinely

displayed by the Russians at international airshows over the years, there is obviously a lack of adequate assets within the military forces. The loss of manned aircraft could well have been avoided if this was not the case.

In the ground attack missions that the much-vaunted Su-25 'Frogfoot' aircraft carried out, their inadequacies became apparent. They lacked sophisticated aiming devices and did not have sufficiently long-range missiles that could be launched outside the enemy air defence envelope. They also did not have any 'smart' weapons and lacked electronic counter measure systems. From a strategic assessment, it is clear that the military aviation industry in Russia has not been able to keep abreast of emerging technology trends, despite their superlative demonstrations at numerous airshows.

The drawbacks of the Georgian air defence network and air combat capabilities were sharply demonstrated. The need to electronically integrate and coordinate the entire air defences of a theatre became very apparent to even the casual observer. Another aspect of the brief conflict that should be taken note of is the Russian use of cyber warfare that completely crippled the Georgian government website domains. In advanced nations, reliant more heavily on computer networks for its day-to-day functioning, this could have a devastating effect. Computer systems security and cyber countermeasures are as important as combat capabilities to ensure victory in contemporary conflict.

When the campaign is analysed holistically, although the Georgian forces were tactically and strategically outmatched by the Russian forces, there are three major observations that emerge as factors that hindered the effectiveness of Russian air power. First, The Russian air-land integration was completely below par, with ground forces resorting to the age old technique of marking their forward position with smoke prior to close air support missions. The fault lay with inadequate interoperability of communications systems and the lack of tactical reconnaissance assets that could plug into the theatre level surveillance system. Second, integrated fire control systems were

almost non-existent and therefore, joint fires could never be called upon. Third and perhaps most crucially, the identification friend-or-foe (IFF) systems did not work, since Georgia also used military hardware identical to the Russian forces. Although the break up of the Soviet Union that resulted in the formation of the many independent republics in central Europe was more than 14 years ago, the Russian military had not altered the IFF system, perhaps in a mistaken belief that they would not have to go to war with the states of their erstwhile empire.

The Russians achieved their aim, but at a cost that the military should not have had to pay if the much touted modernisation had been carried out in alignment with strategic and operational objectives.

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