

# BEYOND THE PLANNED AIR FORCE

Thoughts on Future Drivers and Disruptors



ROYAL AUSTRALIAN AIR FORCE



*The Royal Australian Air Force will become the world's first 5th-generation Air Force. This is only a milestone on a journey that must continue for us. Air Force needs its people to innovate and embrace the possibilities of disruptions to guide us beyond the planned Air Force.*

*—Air Marshal Leo Davies*



# CONTENTS

Foreword.....	4
Beyond the Planned Air Force's Place in the Taxonomy of Guidance .....	6
<b>INTRODUCTION.....</b>	<b>8</b>
Aim.....	10
Scope.....	10
<b>THE 5TH-GENERATION NETWORKED AIR FORCE OF 2027 .....</b>	<b>12</b>
Multi-Domain Integration .....	13
Training and Education.....	14
Air Force Enterprise .....	14
<b>BEYOND THE PLANNED AIR FORCE .....</b>	<b>16</b>
<b>DISRUPTORS.....</b>	<b>18</b>
Technological Disruptors .....	20
Non-Technological Disruptors.....	32
<b>ENDURING FACTORS.....</b>	<b>34</b>
Foundations of the Air Force .....	35
Enduring Geo-strategic Factors .....	37
<b>CONCLUSION.....</b>	<b>42</b>

## Foreword

The Royal Australian Air Force is nearing its first centenary of service in providing air and space power for the security of the nation. The members serving in 2021 will not only be celebrating a century of distinguished service but will also be remembering those who have served before them and those who have made the ultimate sacrifice, all of whom have helped to lay the foundations for the modern Air Force.

It was only 18 years after that first tentative powered flight at Kitty Hawk that our Air Force came into being as a discrete organisation to deliver air power effects. At its inception, it already included World War I air combat veterans—airmen who, in their short flying careers, had seen their flimsy wire and canvas machines develop into air reconnaissance,

fighter and bomber platforms. A century later, we will be not only an Air Force with combat veterans of recent conflicts, but also a workforce privileged to be able to draw on its century-long history of operational, technical, logistical and managerial achievements.

Plan *Jericho* puts Air Force on the path to building a secure foundation for the future force. By 2021, we will have developed better integrated air and space capabilities for the delivery of air power, and we will also realise the force multiplying effects of joint integration. We will be well advanced to attract, train, and employ the workforce that will drive the Air Force into its second century of operations. With the final pieces of current planned acquisitions soon entering service, now is the time to begin considering the next generation



of needs and effects for Air Force to continue to succeed in an ever more demanding, complex and contested environment.

Our legacy must be that the future workforce makes that journey with the best guidance that we can offer from experience. This is what *Beyond the Planned Air Force* serves to do. From the standpoint of an Air Force that is setting off in a direction given by Plan *Jericho*, placing emphasis on the strategic vectors of *Air Force Strategy 2017-2027*, and which is developing into the world's first 5th-generation air forces, this volume envisages an Air Force beyond our known future structure.

We cannot conceive of this future force with the same clarity as for closer horizons but we must describe what we aspire to be, drawing

on our accumulated experiences as air power professionals. There will be challenges and opportunities along the way, with the potential to accelerate, impede or deviate us from our planned course. *Beyond the Planned Air Force* captures what we currently understand, and can predict, as being those potential future disruptors, to aid those who follow us to design and develop the future force as the horizon becomes closer and our current aspiration becomes the future reality.

**MA Green**

Air Commodore  
Director-General  
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## Beyond the Planned Air Force's Place in the Taxonomy of Guidance

Air Force's Plan *Jericho* was launched in February 2015, with the vision of developing 'a future force that is agile and adaptive, fully immersed in the information age and truly joint'. Shortly after his appointment in July 2015, Chief of Air Force (CAF), Air Marshal Davies, released his *Commander's Intent* which, in part, expressed his commitment to the ongoing implementation of the plan. In February 2017, CAF released the *Air Force Strategy 2017-2027*, providing a transparent basis for strategic decision-making within Air Force for the next ten years. Taken together, Plan *Jericho* and *Air Force Strategy 2017-2027* will guide Air Force through to 2027 and lay foundations beyond that.

As an element of a joint and integrated ADF, Air Force is equally committed to its responsibilities as expressed in joint doctrine, embodied in the *Australian Joint Operating Concept* (AJOC) and *Future Joint Operating Concept* (FJOC). From these documents, Air Force has developed its single-service *Air Force Operating Concept* (AFOC).

*Beyond the Planned Air Force* sits alongside all of the aforementioned documents, and other strategic joint and Air Force guidance as periodically released. Its intent is to inform and remind authors of doctrine, force designers, capability developers and acquirers, and air power practitioners of catalysts that may trigger the needs for future changes. It provides an inventory of potential 'disruptors',

factors which may act to accelerate, augment, impede or divert Air Force from its planned development trajectory. Consideration of these factors will permit them to be assessed for their potential to be included or mitigated in future force designs.

As such, *Beyond the Planned Air Force* complements, but is not bound by, the hierarchy of strategic guidance documents or their timeframes. It is intended to be reviewed periodically as new opportunities or disruptors emerge, and to serve as the stimulus for deeper, air-power focussed analysis of the disruptors it identifies. It also invites dialogue, not only among airmen, but also by way of feedback, that may be developed and included in subsequent editions.







# INTRODUCTION



*It is difficult  
to predict -  
especially the  
future.*

— Neils Bohr

The Royal Australian Air Force is a dynamic organisation, committed to assuring its future relevance by choosing to adopt a measured but relentless approach to its development. The Air Force consciously chooses to balance the discipline required to assure operations and the sustainment of high technology systems against the need for innovation in leadership, enterprise and force design, and education and training.

Air Force's enduring intent is to be a relevant and contemporary force, designed to prevail on operations under the Australian Government's strategic direction. To do so, it combines capabilities into an integrated and networked force that can seamlessly integrate with and contribute to a potent joint Australian Defence Force, able to lead on operations, as well as contribute to operations with allies and coalition partners.

External factors will act upon Air Force's chosen trajectory—accelerating, impeding, deviating or denying it. Unforeseen events may cause a dislocating change in circumstances, imposing a new and displaced starting point. An exploration of these potential disruptors will assist in the development of a robust capability to respond. Designing robustness into the force structure and flexibility into people institutionalises a capacity to adapt; it provides Air Force with resilience by design, which is an enduring feature of Air Force's posture.



## Aim

The aim of *Beyond the Planned Air Force* is to provide a future-learning analysis of opportunities and risks (disruptors) to support force designers, capability developers and air power professionals in developing future air power options for the defence of Australia.

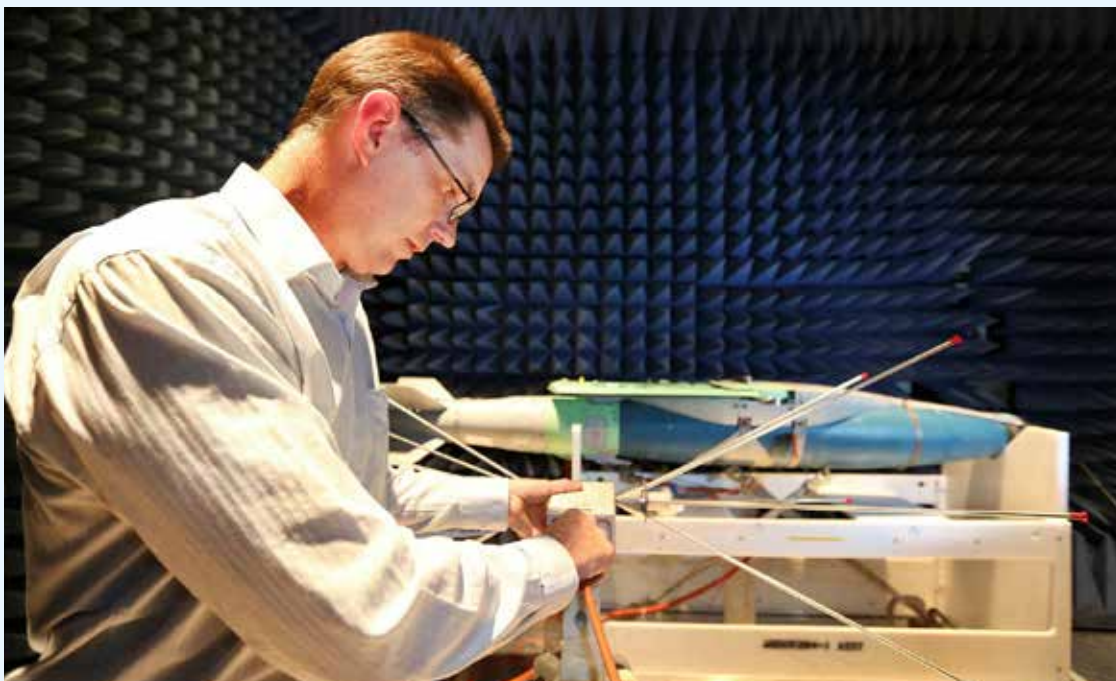
## Scope

*Beyond the Planned Air Force* provides security and military professionals with a catalogue of potential disruptors, to be used in the analysis, testing and experimentation of options for future force design and capability acquisition. It is not possible to predict with certainty which ‘impactors’ will

arise, but by considering the spectrum of possibilities responses can be developed and stronger vectors identified for exploration and development. That exploration is underway, and lies within the provenance of the Air Warfare Centre and VCDF Group to lead, with this document providing Air Force’s perspective on the strategic scope for exploration.

*Beyond the Planned Air Force* commences by positioning its analysis of drivers and disruptors, briefly describing the 5th-generation networked Air Force that should be delivered by 2026 under the 2016 Defence White Paper and *Integrated Investment Program*, but only to provide a baseline from which the future force will be developed. *Beyond the Planned Air Force* then looks further, outlining the characteristics of the force beyond 2026 to provide a broad





statement of Air Force's future aspiration. The disruptors are then listed and described. Some will be familiar, as they already exist and are anticipated to continue to evolve, potentially impacting upon Air Force's preferred developmental path. Others are currently conceptual but may be developed and fielded, with an attendant need to be assessed for their utility to, or impact on, Air Force. Regardless of their imminence or likelihood, drivers and disruptors may exist, and act, anywhere along the continuum from the strategic level, down to the tactical.

As it is not possible to definitively assert the list's completeness, the flexibility to adapt to circumstance, which is a hallmark of the Australian application of air power, must remain and be fostered. For Air Force, that means a capacity to be resilient through rapid adaptation technologically, operationally and, most importantly, in leadership and

professional practice. These thoughts conclude with some enduring precepts that will need to be considered regardless of which disruptors may eventuate.

*Beyond the Planned Air Force* informs a broad readership, from the air power professional to the layperson with an interest in national security and the role of air power. This document is oriented towards high-end warfare and the capabilities needed to succeed in that environment, with the understanding that lower-end capability requirements can be satisfied by selectively applying and adapting elements of the high-end capable force.

## 2

THE 5TH-GENERATION NETWORKED  
AIR FORCE OF 2027



The 5th-generation networked Air Force will be realised by the mid-2020s, delivered through the initiatives detailed in the 2016 *Defence White Paper*, the *Integrated Investment Program* and Air Force's *Plan Jericho*. It will be an integrated force, shaped to fight and win within a joint Australian Defence Force. Air Force will acquire, integrate and exploit air power systems functioning at the leading edge of technology. It will generate integrated air power effects, both kinetic and non-kinetic, across maritime, land, air, space and information domains. Air Force's personnel will continue to be highly educated and trained, capable of rapid innovation and motivated to perform.

## Multi-Domain Integration

Air Force has developed through a process of replacing redundant systems with new ones that provide enhanced capability to enable Australian military operations in the air, maritime and land domains. The future force requires a different, multi-domain integration (MDI) approach. For an effective military force to develop into a seamless joint force, options that function across and through all domains, including space and information, are required. The future force design requires an enterprise design process and capability development methodology that together creates a force that meets the needs of MDI.



Air Force announced Plan *Jericho* in February 2015. It integrates and delivers Air Force's on-going force and capability modernisation process through the implementation of a number of transformative initiatives. The culmination of Plan *Jericho* will be the realisation of a 5th-generation networked Air Force, providing new levels of potency, agility and capability advantage to maintain assured decision superiority into the future.

## Training and Education

The skill of the trained and educated workforce is a fundamental input to ensuring that Air Force delivers optimised air power options. Air Force is introducing live, virtual and constructive (LVC) simulation capabilities to support the integration of complex force elements through options testing and experimentation. LVC enhances integrated training, combining personnel and advanced simulators with the capabilities to support experimentation and analyse results.

Air Force will be innovative, agile and adaptive, able to readily identify emergent training requirements needed to successfully employ sophisticated air power systems. It will deliver training and education in air power to ensure that technical proficiency is developed into professional mastery.

## Air Force Enterprise

Under the emerging Departmental and ADF enterprise structure arising from the 2015 First Principles Review of Defence, the 'raise, train and sustain' function will continue to be an individual-service responsibility, even as Air Force functions in an environment in which MDI has become a reality. Guided by *Air Force Strategy 2017-2027*, Air Force will continue to adapt, with emphasis on the strategic vectors identified in that publication. The inherent flexibility of air power will permit Air Force to develop discrete air power response options, which can be employed in a stand-alone mode or seamlessly integrated into more complex ADF response options.

Air Force will require assured network security and availability, ensuring continuous communications and data exchange. Communication and information architectures will be designed in the knowledge that networks themselves may be subject to attack and must, therefore, be structured to degrade gracefully when exposed to such an attack. Network integrity will be assured by a dedicated, specialist workforce.





BEYOND THE PLANNED AIR FORCE

The 5th-generation Air Force will be an amalgam of advanced systems operated by a workforce imbued with technical proficiency and professional mastery of air power. In providing effective and responsive air and space power for the defence of Australia and its national interests, it will draw on the accumulated experience of more than 100 years of Australian military aviation. The future Air Force will be a multi-domain integrated force, consciously designed to induct, employ and sustain technologically sophisticated air and space power systems for employment in a joint operating environment.

Air Force beyond the planned Air Force will:

- value a skilled and adaptive workforce that is critical to achieving capability outcomes;
- be a balanced air force, offering Government appropriate options weighted to Government's strategic assessments but also able to operate across the broader spectrum of conflict;
- be integrated by design into joint military, national security and alliance systems and structures, for operations where Australia might lead a joint force in a multi-domain environment, and where Australia might contribute to allied or coalition operations;
- operate within the laws of armed conflict and rules of engagement while employing a mixture of inhabited and uninhabited systems, with varying degrees of system autonomy;
- embrace and sensibly assimilate complex technologies, whose rate of change and societal impact are increasing

exponentially, but only where they are judged operationally salient rather than simply 'on-trend'; and

- be designed as an adaptable, resilient and gracefully redundant system of systems, second to none.

Air Force's preferred future version of itself will be realised through its inherent flexibility—conceptual, doctrinal, organisational and cognitive. Part 4 provides a forecast of potential 'impactors' that might act on Air Force's preferred trajectory towards its desired future state—either positively or negatively. These factors must be carefully examined and assessed in order to be prepared to respond appropriately when they eventuate.





4

DISRUPTORS

*Beyond the Planned Air Force* highlights, for the designers of the future force, a number of potential disruptors to its preferred development trajectory. They have been chosen because they relate to four major factors that must be considered in future force design: integrated systems, technology, force and enterprise design, and people.

**Integrated Systems.** There is a clear trend towards a continuing increase in the complexity of air power systems, both individually and through integration. The rate of 'complexity change' is also expected to continue to increase. Irrespective of the complexity of individual systems, the pervasiveness of complex networked systems and the operational efficiency they bring will make them systems of choice. Networked and integrated systems are naturally complex. Beyond air power platforms, complexity in command and control will also be an enduring feature. Understanding how to manage and master complex systems and operations, as well as when to exploit complexity and when not to, will be a hallmark of successful 21st century operations.

**Technology.** The continual progress of technology, driven equally by military and civilian demands, creates a volatile aerospace technology baseline. Air Force is technology driven, and innovation will be an essential attribute for it to remain relevant. However, while pursuing technology, it must remain cognisant of the asymmetric warfighting approaches being developed by potential adversaries without the same level of access to technology or using readily available technologies in new ways. Air Force must

retain the flexibility to counter asymmetric actions across the spectrum of warfare.

**Force and Enterprise Design.** The complexity of future systems and the accelerating rate of technology change will be major drivers of enterprise and organisational change. The future Air Force organisation will need to have the built-in capacity to rapidly adapt in order to leverage emerging opportunities and to neutralise vulnerabilities in partnership with the larger ADF and Defence enterprise. Unforeseen disruption will mean that enterprise design to realise the future Air Force vision and the necessary joint and coalition relationships, is likely to be reactive and immediate in nature rather than achieved only through deliberate planning. Resilience through rapid adaptation is, therefore, an enduring and essential feature of the force and enterprise design.

**People.** Air Force is fundamentally a force reliant on people—skilled in the application and sustainment of technologically advanced systems, trained in a joint operating environment, and professionally competent in the efficient employment of air power. The attraction, training and retention of a skilled workforce will be critical to develop, operate and sustain technologically driven and advanced systems and processes. Further, an empowered and innovative workforce, skilled in the application of air power, will be central to an effective force and enterprise design process. Leadership and well-founded professional practice are the backbone of operational and enterprise adaptation, and resilience to disruption.

# Technological Disruptors

## Autonomous Systems

Autonomous systems will proliferate and become intrinsically entwined in the routine application of air power. However, Air Force is unlikely to become totally reliant on autonomous systems for its efficient performance, although the level of trust bestowed on these systems will increase over time as they demonstrate reliability in decision-making for operational effect. Autonomous systems will be embedded in manned platforms as well as operating as stand-alone capabilities; it is the incorporation of the command and control of such systems into an integrated model of decision-making across the operational spectrum where real advances will lie, not in the systems themselves.

1. **Integration.** The integration of autonomous capabilities into the Air Force and its system-of-systems will be a priority for the future force, although the process will be complex. Autonomous decision-making systems may significantly improve the command and control of the battlespace, enhancing the capacity of personnel by relieving them of mundane and repetitive tasks. Providing complete autonomy in the decision-making cycle, especially when weapon release is involved, will continue to be a keenly debated ethical topic. Air Force will likely retain designs to keep qualified humans involved in the decision-making systems at all times, even if it is only to write the software rules of engagement governing

the operation of an autonomous system and to monitor the execution of the autonomous system missions with options for human intervention.

2. **Autonomy, Networks and Command and Control.** Networks are almost certain to be the centrepiece of future command, control and management functions unless they are disrupted by an adversary to the point of liability, but even then low-technology networking will still be necessary for command and control. Technological advances will create extremely sophisticated disruptive capabilities that potential adversaries will employ to counter this critical capability. Autonomously enabled networks, with nodes that can switch on and off at will and also have robust anti-disruptive capabilities, will be developed as a counter-countermeasure. Air Force will need to protect its networks across the entire force and design in graceful degradation, as these will represent a high value target for future adversaries. Air Force will use autonomous systems to improve network management and act as an aid to decision-making through cognitive load-sharing.

## Uninhabited Systems

The political imperative to minimise risk to own forces and the operational desire for extended mission time are two of the drivers in the accelerated development of uninhabited systems. Their reliance on network connectivity for operational efficiency will be an ongoing vulnerability to their employment. Reduction in this risk factor will



require increased robustness of networks and improved autonomy in operations. This will bring about advantages in reducing decision-cycle times. Uninhabited systems are already critically important to non-lethal air operations. They will likely develop in ways not currently understood, providing the prospect of the creation of novel missions, including some based on 'swarming' concepts. Air Force is likely to operate a mix of inhabited and uninhabited systems, operating together, with the uninhabited systems being given increased autonomy in predetermined operations.

While the technology to operate uninhabited systems may be relatively easy to achieve, considerable effort is still required to mature their integration in high-end warfare scenarios.

1. **Uninhabited Combat Aerial Vehicles (UCAVs).** UCAVs are currently operational, although their mission set is restricted. The technological competence to successfully operate these systems is restricted to a small number of military forces. Over time, UCAVs will develop into robust, survivable systems with characteristics including high-maneuvrability and low-observability. They will proliferate and will likely operate routinely as adjuncts to inhabited systems in the strike role. The challenges of ethics and rules of engagement will influence the decision to employ UCAVs. UCAVs will likely be introduced primarily as a strike system, to be employed in non-permissive air environments where the risks to human operators are high. This will require granting increased autonomy to UCAVs, employed either independently or in conjunction with inhabited systems.

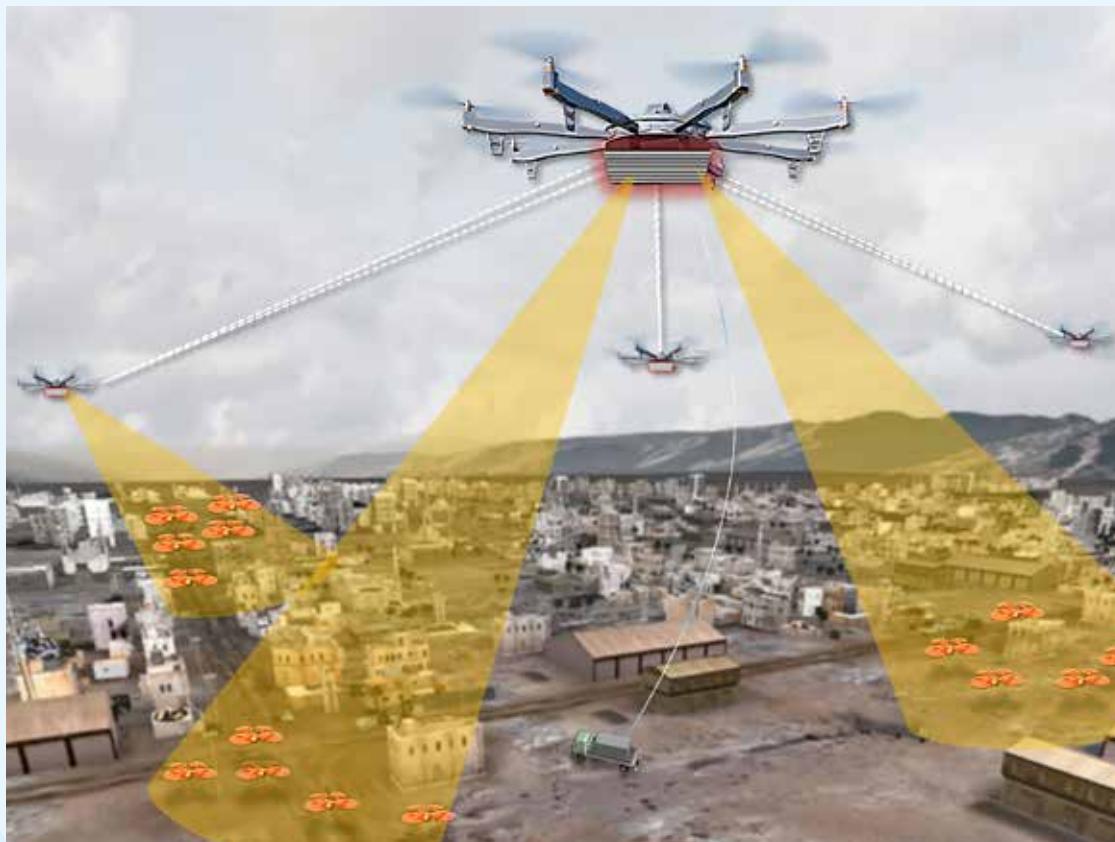


2. **Combat Mission Teams.** The teaming of uninhabited vehicles with inhabited platforms in a single mission will become technologically feasible. Such a 'team' may be employed to create an enhanced operational envelope and increase the intelligence, surveillance and reconnaissance (ISR) horizon of the mission package. Budgetary considerations dictate that emphasis will remain on driving down the cost of uninhabited systems. This could pave the way for the inception of 'swarm' tactics to overwhelm adversary air defences, which in turn would directly influence the development of future concepts of

operations. Combat mission teaming is also likely to be a preferred joint function designed to operate across traditional stovepipes: military, national and international. In turn, broadly based and connected combat mission teams will be a design driver for inclusive yet disciplined networked command and control as well as other support fundamental inputs to capability.

3. **UAV Tactical Delivery System.**

Considerable interest already exists in the use of uninhabited aerial systems for the delivery of commercial payloads. The potential military applications of



such systems are numerous. They may influence the way in which humanitarian aid and disaster relief are delivered, and be used in the support and sustainment of Special Force operations.

### Stealthy Systems

As a result of experience gained with current operational systems, stealth has come to be understood as relating to the management of the radar and infra-red signatures of combat platforms. However, the concept has the potential to become much more pervasive. Not only might physical measures be taken to disrupt, disguise or deny detection of systems, other intangible attributes might also be exploited. The 'cloaking device' of current science fiction may become future science

fact. Additionally, 'stealth' may grow to embrace all operational domains, to include, for example, obscurity and false attribution techniques developed for application in the information domain. To be engaged requires being detectable. Stealth will continue to foster a range of initiatives to deny this precondition.

### Weapon Systems

Developments in propulsion technology are already producing weapon systems that have extremely long ranges and which are faster than legacy systems. Extremely long-range air-to-air and air-to-ground weapon systems are expected to proliferate. As a consequence, Air Force may have to operate high-value assets such as air-to-air refuelling



and ISR platforms further away from their optimum on-station locations to ensure their safety. Air Force should consider inducting long-range weapon systems so that its own lethal reach is enhanced and the capability to protect its airborne assets is improved.

1. **Hypersonic Missiles.** The development of hypersonic missiles provides improved survivability of both the weapon and the launch platform. Their extreme speed and enhanced range make these missiles ideal for employment in contested air environments. Targeting these systems will be challenging; however, the problems are not insurmountable. Their long stand-off launch range and almost complete assurance of neutralising the target make them a valuable addition to the airborne missile arsenal. Air Force should assess acquisition of these weapon systems to match their proliferation and to increase the reach of its combat envelope.
2. **Modularised Weapons and Sensor Payload Systems.** Kinetic weapons are being developed to have greater component modularity for warheads, seekers and propulsion packages. They may also incorporate selectable weapon yield and adaptive software to improve counter-countermeasures. This development will lead to multi-role weapon systems providing enhanced counter-stealth capability and even precision strike in GPS-denied environments. When employed in conjunction with improved fire control systems, these weapons will provide all-weather strike capability that will be discriminating, proportional and

precise. They may change the concept of aerial strike.

### 3. **Directed Energy Weapons (DEWs).**

DEWs are systems that employ high-energy lasers, high-power microwaves and/or radio frequencies to incapacitate, damage, disrupt or destroy adversary capabilities and assets. When mature, they will have the capacity to create both lethal and non-lethal effects. As they will likely proliferate, actions must be initiated to protect own systems against DEWs. Although the power and cooling requirements currently limit the deployment of high-energy laser weapons, technological solutions to the challenge will be forthcoming. Once the developmental issues are overcome, they may be an option to counter the 'swarming' concept, due to the low-cost per shot of the system and its targeting of the electronic systems controlling the UAVs. Air Force should assess both the potential kinetic and non-kinetic applications of these systems. Similarly, high-power microwave and radio-frequency weapons should be assessed, since they have the potential to avoid unnecessary human casualties.

## **Command, Control and Communications (C<sup>3</sup>) and Sensor Systems**

Sensors employed in ISR missions already produce large amounts of data. There is a discernible trend towards significant increases in the quantity and diversity of data types being generated. Analysing data to develop information and situational awareness in a timely manner will increasingly require computer assistance. Air Force will continue





to employ emerging technologies to interpret information and improve its dissemination in order to ameliorate the challenges posed by the 'fog of war'. Information input may be incomplete, inadequate, conflicting, ambiguous and uncertain. In these situations, combined machine-human interpretation will be necessary to ensure adequate situational understanding. Quantum technologies being developed are expected to significantly improve sensor capabilities and create the ability to better discriminate targets from background clutter. This is likely to become a counter-stealth solution.

The increased volume of data produced by future sensors will have to be synthesised and made available to operators to enable effective decision-making through the C<sup>3</sup> system if it is to be converted to an operational effect. This will require very high transmission rates

that will likely be best satisfied by optical communication systems. Modulated laser links between communications satellites, enabling high data-transfer rates, will become a key enabler in the future battlespace.

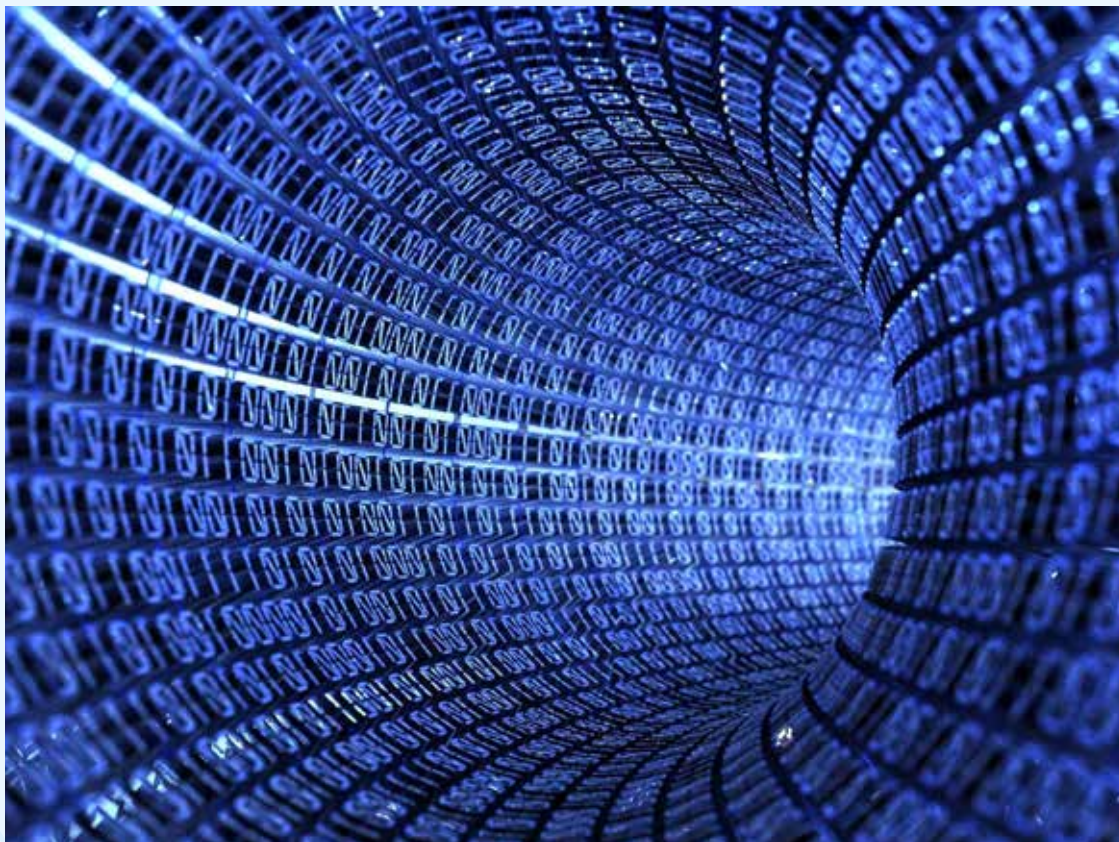
1. **Multi-Domain Surveillance.** Innovative technologies and tactics will continue to proliferate, in order to counter ISR sensors. Multiple sensor systems, operating in different parts of the sensing spectrum and in multiple domains, will enhance the probability of detection and surveillance of potential targets. Traditionally, this has implied hyper-spectral systems, sensing and synthesising in multiple areas of the electromagnetic spectrum. Future systems may sense and synthesise across multiple disparate domains, including: electromagnetic, environmental and human. Such systems offer resilience and

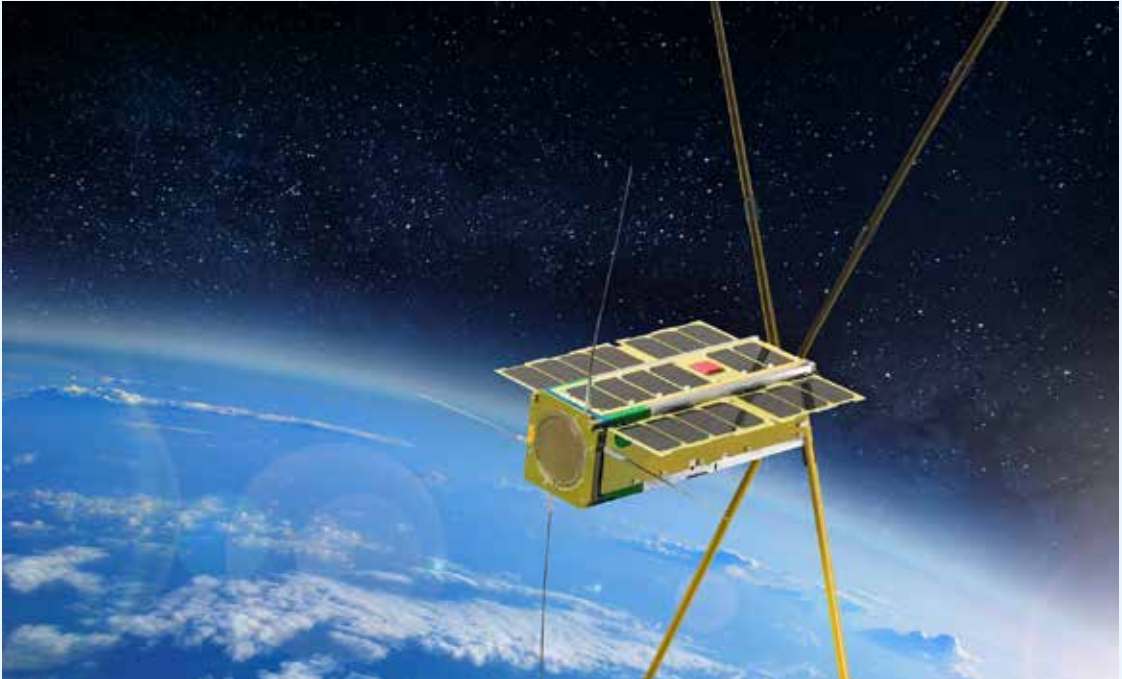
redundancy when used by own forces, but significantly complicate efforts required to neutralise them when employed by an adversary.

2. **Communications Security.** The future battlespace will be data intensive and secure communications will hold the key to decision superiority. Software-defined communication has a low probability of detection, although it reduces data transfer rates. Communications are progressing towards using free-space transmission within a network. When combined with quantum key dissemination, this offers potential for highly secure, high-bandwidth communications. Digital and software-

defined communications are maturing rapidly. Air Force may wish to exploit these advances, cognisant of the need to surmount the challenge of an adversary's employment of similar technologies.

3. **Electromagnetic Spectrum Operations.** The electromagnetic spectrum will continue to be contested and congested. Electronic emissions will become increasingly difficult to detect as emitters incorporate the ability to constantly change their characteristics. Radars that can constantly modify their waveforms will be difficult to identify and jam. The inability to identify emitters from their individual characteristics will increase uncertainty





for commanders and may compromise situational awareness. Exploitation of these capabilities, while investing in countering their use by potential adversaries, may emerge as a critical capability consideration.

4. **Virtual Presence and Networked Command and Control.** Entities in future conflict will have both a virtual and physical presence. Physical presence is easy to comprehend as it is the visible part of daily life; virtual presence is more esoteric but is nonetheless a real part of a networked system. One aspect of virtual presence is a quality of command across the network: IP-addressed commanders will have authority dependent on the breadth of their view and the degree of trust assigned to them. This authority may extend to command of other systems across the

network, even those inhabited by other commanders. Systems on a platform will be shared locally and time-shared across the network to enable situational awareness, decision-making and real and virtual effects. Developing protocols to enable such on- and off-board flexibility will be one of the most important aspects of networked command and control. Exploitation of the flexibility of the network must be tempered by the need to be disciplined in the use of force and also platform management. Virtual presence in the conflict space will have an effect on decision-making for both the aggressor and defender, and that effect is dependent on enabling and defending transparency on our side while making the network and its actors opaque to the other—the network interpretation of low observability or stealth. All of this is emergent and



needs a robust experimentation process to drive system and decision architecture if the network command and control is to be simultaneously trusted and exploited.

### Quantum Technology Systems

The harnessing of quantum technology will have a transformational impact on Air Force's decision-making, communications and force structure. Quantum technology manipulates the exotic properties of subatomic matter to achieve computing power unobtainable with traditional computer designs. Quantum computers will have faster computing times and the connection between two quantum systems will be far more secure than any currently available. Further, the precision characteristics of quantum sensors can be translated to almost fully secure position, navigation and timing systems. Quantum technology systems will enable a step-change improvement in sensor sensitivities. Air Force is aware that while quantum technology provides greatly enhanced capabilities to the overall employment of air power, it also requires extremely sophisticated technology enablers to be effective.

### Space Systems

Air Force will continue to be fundamentally dependant on space-based capabilities for its effective performance. Space is becoming an increasingly challenged domain, with the introduction of a range of offensive space capabilities such as anti-satellite, electronic warfare and cyber weapons, adding to an Earth-orbital space environment that is becoming increasingly cluttered by natural and non-natural space debris. Developments

underway will deliver improved space situational awareness and other systems that will mitigate potential loss of space capabilities. Conceptual development has already taken place addressing the replacement of some space capabilities through the relatively rapid launch of small or micro satellites, with short life spans and low-Earth orbits.

**Miniaturisation of Payloads.** The miniaturisation of payloads has increased the potential use of space to provide support to the employment of air power, especially in contested air environments. Their relative low weight simplifies launch and sustainment, enabling proliferation of smaller satellites. Miniaturised space payloads provide adaptive and ad-hoc communications that can be sustained for an effective period of time. The miniaturisation of sensor systems has the potential to rapidly and temporarily reconfigure air power platforms in order to fulfil different roles concurrently, such as communications relay and battlefield ISR sensors.

**Improved Global Positioning System (GPS).** A key capability offered by space systems is the position, navigation and timing data delivered by the GPS and similar satellite constellations. By 2030, a new GPS constellation that is more robust and less prone to jamming is expected to be in place. The system will have the ability to update encryption codes while air power systems are still airborne. The developmental system will create an operating environment permitting airborne platforms to be supported by a GPS with almost complete assurance.



### Training and Education Systems

Improved understanding of an individual's cognitive abilities may lead to more efficient training methodologies. Pervasive computing will close the gap between training and its application, while natural language interaction in the human-machine interface has the potential to reduce training requirements. The cost-intensive nature of collective training will be reduced through intensive simulation support, delivering the same benefits as achieved through large-scale exercises. Seamless integration of simulated entities is already being realised, permitting the employment of systems and capabilities that may otherwise not have been possible because of safety and security concerns. It may be possible to move further, in creating simulation as a service wherein the applications and data reside in a pervasive

network rather than in individual simulators. The advantages that may be realised through such a move are enormous. Primarily, it may permit the incorporation of virtual and simulated entities into the lowest unit-level training activities, which will almost immediately enhance operational preparedness.

The increasing connectivity of systems and its effect on human cognition and decision-making, aided by machine-based intelligence and decision-making, will place a premium on not just training systems designed to exploit that environment but also education. The benefits of the 20th- and earlier 21st-century concept of a 'classical education', alongside that of a vocational one, may be required to give human decision-makers the background to contextualise decisions in complex technical environments.

To assure the robustness of Australia's security posture, Air Force has a professional responsibility to advise on national strategic matters, both as a complement to national preference and sometimes to challenge it. In this, Air Force remains committed to educating a small cadre of the force to strategic excellence as part of its larger professional responsibility.

### Technology and the Human Interface

Air Force has always sought to be at the leading edge of technology. By doing so, it has experienced capability step-changes brought about by technological advances. These advances have, at times, delivered exponential capability enhancements in the efficacy of air power. The translation of technology into capability requires an effective technology-human interface. For Air Force,





this means the interface of technology with a technically skilled workforce, which is also well educated in the application of air power—professional mastery at all levels. This professional mastery encompasses a deep understanding of doctrine and an ability to engage in strategic thinking and concept development, while continuing to maintain appropriate levels of technical proficiency in the employment of air power systems.

The future Air Force will be increasingly reliant on the awareness it derives from networks. It will require a workforce skilled in the configuration and manipulation of networks and the interpretation and dissemination of information derived through and from them.

The exponential rate of technological advance makes it reasonable to envisage a future Air Force in which autonomous systems are commonplace. Artificial intelligence, in combination with integrated decision-making systems will further improve decision-cycle speeds. All these improvements in the application of air power will be the product of skilled networkers.

1. **Smart Algorithms.** The next capability step-change may be the Air Force transitioning from platform-centric operational concepts to the use of smart algorithms. The full potential of uninhabited systems will only be understood and realised through concept testing and



evaluation undertaken with simulation technologies that are in the developmental stage. This will be the first stage towards implementing autonomy in a limited and controlled manner. A primary challenge to increasing the autonomous capabilities of uninhabited systems will be the development of policies and guidelines for making ethical and moral command decisions within the existing command chain. This will be achieved only through detailed human coding of the logic rules limiting the actions of an autonomous system.

2. **Decision-Making Cycle.** Integration of autonomous systems, artificial intelligence and the human-in- or on-the-loop decision-making cycle will be a significant challenge for the future Air Force. Since the Air Force will likely have access to a relatively small workforce, the challenge may be exacerbated. The introduction of systems with tailored degrees of autonomy could be the first step in mitigating this challenge. The operational workforce may require different and enhanced skill sets to efficiently employ sophisticated technology. This may also involve modifying the traditional relationship between the workforce and decision-makers. Routine operations that are fully bounded within calculated risks and limitations may be controlled by autonomous systems. The human-technology interface will continue to develop, progressively favouring increased autonomy in non-controversial operations.
3. **Artificial Intelligence (AI).** The combination of advanced algorithms and AI should enable computers to learn and make

independent decisions to perform functions that were not explicitly programmed by the human designer. The future Air Force will continue to favour a human-technology interface, especially in making complex decisions. If realised, AI-enabled decision-making will be a significant step-change, especially in enterprise design. Air Force should be aware of this possibility and be prepared to adapt to the change it would cause. Eventually, machine learning and AI may create certifiable systems that will autonomously decide and implement military decisions, as 'human-out-of-the-loop' systems. The ethical and moral issues relating to the military application of AI and complete autonomy will have to be addressed before the technology matures.

## Non-Technological Disruptors

### Demographic Challenges

The foregoing has focussed on potential disruptors that are predominantly technological in nature, and which may present opportunities or challenges for the future Air Force. However, people with adequate technical and professional mastery of air power have always been and will remain pivotal to the success of the Air Force. It is the workforce that adapts the technological advances and devises ways that negate the potentially negative impacts of disruptive technologies. Attracting and retaining the workforce with the appropriate level of competence required to develop, operate,

and sustain the future Air Force may present its own challenges.

Demographic trends in Western countries point to a stagnation in population growth. In the recent past, Air Force was seen by some as a preferred employer because it offered ready access to sophisticated technology. The proliferation of technology in the commercial sector has significantly broadened the options available to those seeking employment in the technology sector, to the detriment of the recruitment by Air Force. Attracting and retaining the right people in the necessary numbers will likely remain a challenge that needs to be addressed.

### Energy Needs

Air Force will likely remain reliant on hydrocarbon fuels to power aircraft, although propulsion advances may continue the trajectory of increasing fuel efficiency. Australia's geography will continue to make the security of access to energy markets a crucial operational planning consideration.

The requirement to be structured for expeditionary operations, either offshore or to forward-located austere, domestic bases, places a premium on assured energy supply. Future developments in portable, renewable and dense energy technologies should be monitored and assessed for their application to the support of Air Force operations.

### Climate

Climate patterns are becoming more unpredictable, generating more extreme weather events, at times and in locations different from historical patterns. Should this trend continue, Air Force may be required to operate in conditions, or respond to climate triggered events, that are increasingly severe and challenging to the efficient conduct of operations.



5

ENDURING FACTORS



## Foundations of the Air Force

Air Force is built on four enduring foundations—concepts of operations, capabilities, enterprise design and people. It develops concepts of operations that, when efficiently applied, contribute effectively to achieving national security objectives in a constantly changing strategic environment. It develops capabilities that enable the realisation of the preferred concept of operations through exploitation of technology and doctrine. Air Force's enterprise design should reflect Australian society and be attuned to developing innovative and efficient operational practices. People are of paramount importance to the functioning of Air Force and, therefore, it must attract, recruit, develop and retain the 'right' people now and into the future. The future Air Force will continue to build on these foundations.

Air power is born of technology and continues to be technology-enabled and driven. Air Force will embrace technology in order to provide the nation with quality air power. Therefore, technology remains superimposed on Air Force's four enduring foundational factors. The human-technology interface is critical to the effectiveness of Air Force in all aspects of air power—its acquisition, application and sustainment.

### Concepts

Air power concepts of operations cannot be developed in isolation. In the 21st century, they are a function of multi-domain integration, with the application of air power aimed

at achieving national objectives through contribution to a joint, integrated force. However, some elements of the air campaign, such as obtaining and maintaining control of the air, may have to be planned in isolation, even though they contribute directly to the success of the joint/integrated campaign. The development of Air Force concepts of operations carefully considers and factors in the disparate needs of the integrated force. Air Force concepts are designed to harmonise with the concepts of operations of forces functioning in other domains.

### Capabilities

The current conflict-war continuum will likely endure into the future, spanning operations from the delivery of humanitarian assistance to wars of national survival. In between these extremes lie variations of warfare that employ, to varying degrees, conventional capabilities, asymmetry, irregular tactics and capabilities that range from simple to complex technologies. The complexity of this spectrum will continue to increase. Air Force is, and will be, challenged to maintain the range of capabilities required to deliver air power across this complex spectrum of possible operations.

Air Force will deliver air power effects, now and in the future, through the conduct of its enduring roles—four core and three enabling. The need to deliver these roles will continue to shape and influence the design of the Air Force organisation and force-structure development. The core roles are: control of the air, strike, ISR and air mobility. The enabling roles are: command and control, force protection and force generation and

sustainment. The terminology used to describe these roles may change, as will the systems employed to achieve them, but their essence will endure.

### Enterprise Design

Air Force delivers air power effects by creating an enterprise that is designed with in-built flexibility to optimise the conduct of its enduring roles. The current organisation combines the doctrinal underpinnings distilled from past experiences and present day realities with the forecast future trends in air power capabilities. In doing so, it is able to develop, while remaining attuned to the

potential operational environment. Essential to the robustness required in the organisation to withstand and overcome the challenges of a dynamic security environment are agility and innovation. Enterprise and structural agility, while critical to the success of Air Force, cannot be built in short order, but can be adapted rapidly. The foundations, however, are products of conscious long-term design that includes the capacity for short-term adaptation.



## People

People are the core of Air Force. This has always been the case and will continue to be so. While exponential changes in capability have been brought about by cutting-edge technology, it is the innovative adaptation and application of this technology by people that creates and sustains the Air Force. The current workforce, that of the 5th-generation Air Force, and the Air Force beyond that, will all need to be technical masters of networking and system design while also being professional masters of air power. The workforce must be skilled and innovative in order to harness the inevitable future changes to the operating environment. Air Force must be prepared to benefit from the flattening of its hierarchical structure, empowering its workforce to act, informed by an increased access to the information domain.

## Enduring Geo-strategic Factors

The future Air Force will be directly impacted by the enduring factors that influence the political, economic and societal developments within Australia as a nation. While some of these factors are truly beyond the control of Air Force, others can be studied, forecast and mitigated to manage their impact on the delivery of air power.

Australia's geo-strategic environment will be volatile in the next few decades as a result of: changes in the distribution of power, both globally, and particularly in the Indo-Pacific region; the continuing threat of terrorism;

increasing modernisation of regional military forces; and the proliferation of weapons of mass destruction and ballistic missile technology.

## Political Factors

1. **Rising Asia.** The clear trend is that relative global wealth and power are shifting to the Asia-Pacific. This is a strategic disruptor to the world's system of governance and presents a complex set of interconnected risks and opportunities impossible to foresee. It is fair to assume that increasing wealth in the Asia-Pacific will result in a natural increase in expenditure on defence and security, and a firming of national postures; wealthy nations have more to protect and border disputes in Asia are unresolved and ongoing. Irrespective of risk, on the opportunity side Australia does have preferences in exploiting the rise of the Asia-Pacific for its own and the larger international good, and Air Force is committed to playing its part in strategic analysis. The role of Australia's military in regional engagements, is shaped by Government direction in the *2016 Defence White Paper* and related classified Departmental documents.
2. **The US Alliance.** A strong and enduring strategic alliance with the United States remains Australia's most important defence relationship. Australia's military response to crises arising beyond its region will almost always be in conjunction with US military initiatives. Within the Australian region, the US military will act as a force multiplier for Australian military forces. Air Force will continue to align

its doctrine, force structure design and concepts of operations with those of US military forces to ensure interoperability.

**3. Five- or X-Eyes Community.**

Australia's membership of the Five-Eyes intelligence community—comprising Australia, Canada, New Zealand, United Kingdom and United States—provides it with shared information on combat systems technology and intelligence inputs. The objective is to achieve the information superiority that is vital to decision superiority. Air Force leverages the cooperation that is achieved in integration and interoperability through this membership. Emergent relationships might change the membership to an X-Eyes community over time, where X may be a larger or smaller number. However, the privileged nature of membership will be a chosen and enduring feature for those in the community.

- 4. Multinational Coalition Operations.** Air Force provides Australia with sophisticated military capabilities and response options. However, the ADF does not have the capacity to unilaterally protect Australia's national interests, especially if the threat originates outside the region. Further, Australia is committed to maintaining a rules-based world order that is necessary for global peace and prosperity. Therefore, Air Force will participate in multinational exercises in order to ensure that it can seamlessly integrate with multinational operations far away from home when necessary.

- 5. Domestic Defence Industry.** Major capital acquisition projects for Defence will involve commercial collaborative arrangements between domestic and international companies. The Australian aerospace industry will be involved in sourcing sensitive technology from overseas. Air Force will continue to promote innovation in domestic industry when seeking to induct affordable and timely solutions to ameliorate challenges to its modernisation. Air Force necessarily functions at the leading edge of technology and will continually strive to support domestic industry in its quest for self-reliance. In the long term, these initiatives will deliver a strategic advantage to Air Force.

**6. Weapons of Mass Destruction (WMD).**

Australia's security posture does not support Australian ownership or use of WMD. Australia's current posture is that of an engaged non-proliferator. However, strategic and technical disruption may pressure that posture to change, which would be an unfortunate turn of events and not preferred, but a reality nonetheless. The gravity of such a decision makes it solely the responsibility of Government. However, Air Force remains sensitive to its professional responsibility to thoroughly analyse the future strategic environment and make recommendations as to risk and response. For Air Force, professional judgement about the risk and utility of WMD lies mainly in considering the strike and force protection roles.



## Economic Factors

1. **Middle Power Status.** Australia is part of the Asia-Pacific, which is one of the most economically vibrant regions in the world. Currently there is a potential power-shift towards the region, balanced by the US as the sole super-power. The geopolitical and economic tensions inherent in this situation place a premium on Australia's strategic decision-making. In this context, Australia will continue to be a responsible middle-power and will choose to play a consequential role in trying to maintain a relatively peaceful security environment in the region and globally. Towards this end, it will deploy affordable and

balanced military capabilities as directed by Government. Such a move would be either to ensure or help build a stable regional security environment that is complementary to the power-shift to Asia and supportive of Australia's interest. Air Force will continue to maintain a posture that underlines its ability to project power rapidly in response to emerging security challenges. It will also further strengthen its relations with key coalition partners.

2. **Integrated Investment Program.**

Air Force's funding for capability investments will be derived from the Government-approved forward plan for



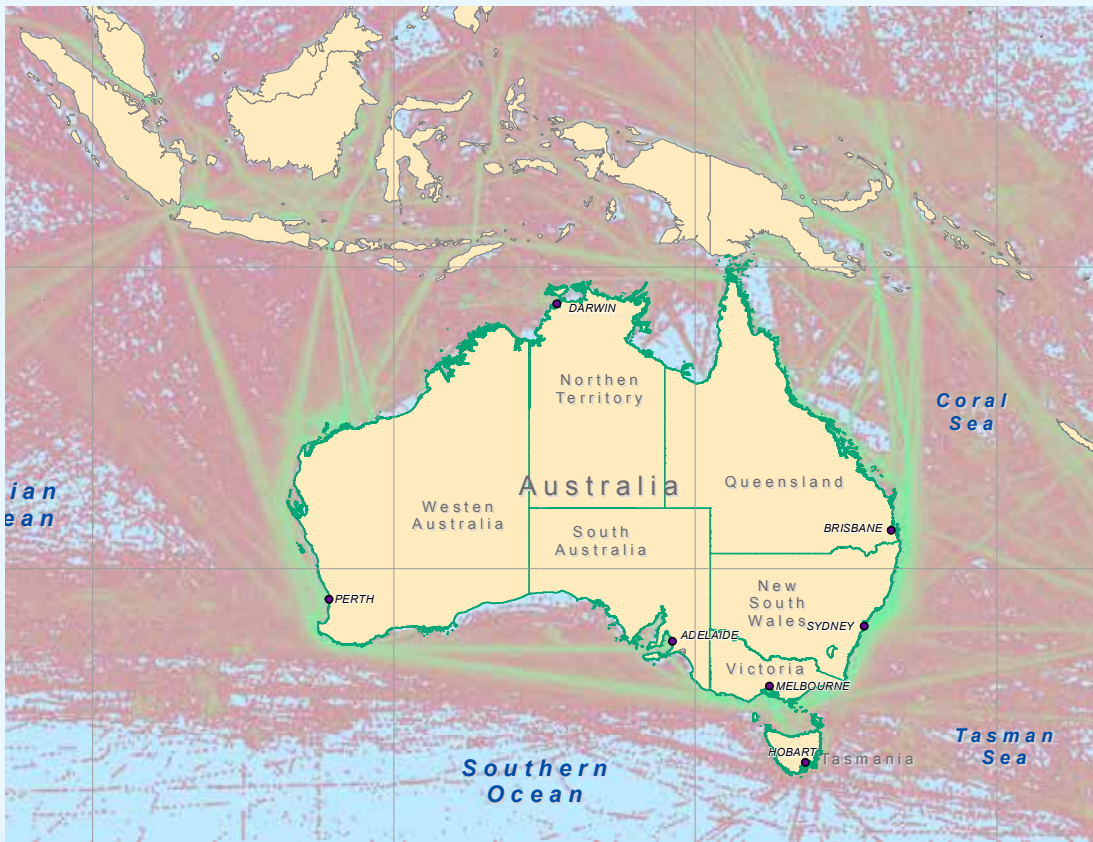
capability acquisitions, currently called the *Integrated Investment Program*. Air Force needs will be balanced against the broader integrated force requirements for resources and will form part of Government's consolidated investment in the ADF's capability development.

### 3. Multi-Domain Lines of

**Communications.** Australia's security is underwritten by unfettered access to sea lines of communications and the protection of its seaborne trade. Its prosperity is dependent on interaction with the global economy through the exploitation of sea, air, space and cyber

lines of communication. Air Force will play an active role in the protection of Australia's communication links.

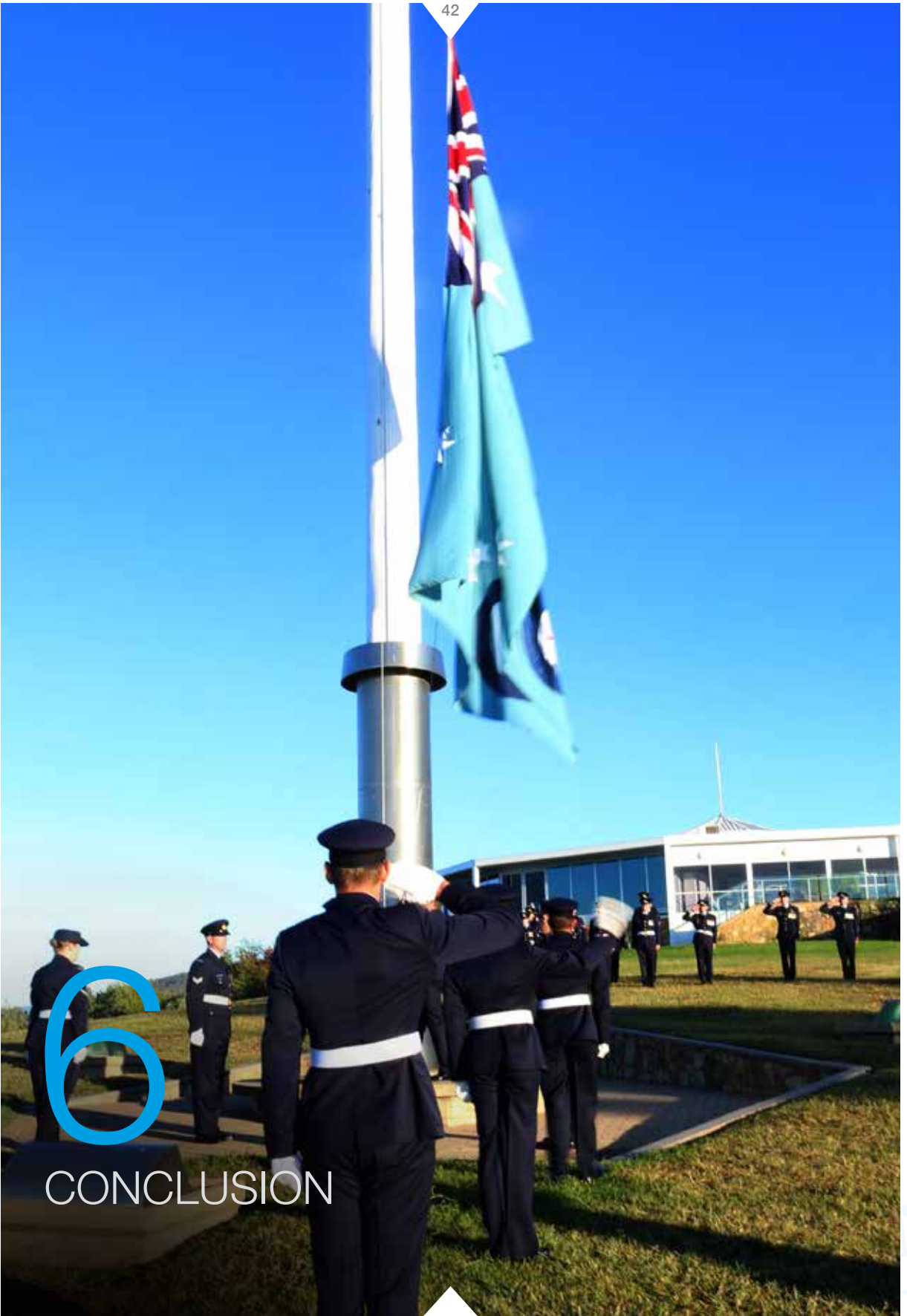
4. **Energy Security.** An assured supply of energy is critical to Australia's security. The nation must have the ability to meet its energy needs for the long term. Air Force recognises the importance of creating resilience in energy availability through the protection of access to reliable energy supplies and to alternative sources.



### Societal Factors

1. **Demography.** The Australian labour market will continue to become increasingly competitive. Air Force requires its workforce to be innovative and skilled in specialist areas. The ability of Air Force to attract people with the right qualifications will depend on its ability to ensure an attractive career path for its people. Air Force recognises that the workforce is at the foundation of its ability to deliver air power for the nation.
2. **Training and Education.** The future security environment will evolve rapidly and at times without notice. The Air Force of the future will be an adaptive system of systems, capable of recognising the emergence of change-triggers, and with the built-in ability to respond effectively. Training and education of its workforce assumes critical importance in the Air Force achieving this status. The Air Force workforce must have the necessary professional mastery to assure its future effectiveness.





6

CONCLUSION



The Air Force to be delivered by Plan *Jericho* and the 2016 *Defence White Paper* and the one that lies beyond, will be designed to deliver both adaptive and innovative solutions to emerging challenges, in both the organisational and operational environments. They will have to keep pace with disruptive changes and maintain the ability to respond to unforeseen risks, while continuing to deliver air and space power to the integrated force.

Information collection, exploitation and dissemination to ensure decision superiority will remain a fundamental principle for the effective application of air power.

In recognising, accepting, and designing for agility in the face of these challenges, Air Force will continue to be a world-class fighting force and be perceived as such both domestically and globally. It will continue to provide the Australian Government and people the most rapid and responsive aerial military options, across the spectrum of operations. Air Force will remain the sole organisation responsible for the generation, application and sustainment of integrated Australian military air and space power.

Air Force will retain and continue to develop the capacity to project air power anywhere in the world, across all domains, to protect Australia and its national interests.

