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Work Domain Analysis of Australia's Air Power System: Purpose-related Functions of Combat; Transport; and Intelligence, Surveillance, and Reconnaissance Subsystems

Ashleigh Brady and Neelam Naikar

Joint and Operations Analysis Division
Defence Science and Technology Organisation

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ABSTRACT

Work domain analysis, the first dimension of cognitive work analysis, provides a structured description of a system that is independent of particular actors and situations, giving it utility across a range of applications. Documented in this report is a work domain analysis of Australia's Air Power system, focusing on the purpose-related functions of three key subsystems within the model—combat; transport; and intelligence, surveillance, and reconnaissance. This focus provides a preliminary understanding of some of the major functions of the system that must be supported to achieve the fundamental purposes of Air Power. The work domain model presented in this report has already demonstrated its usefulness through two significant applications. Firstly, the model contributed to the development of a narrative of the Royal Australian Air Force's doctrine and strategy, documented in the sixth edition of *The Air Power Manual* (AAP 1000-D). Additionally, the Air Power work domain model was utilised to assist with the formulation of the Royal Australian Air Force's forthcoming edition of *The Future Air and Space Operating Concept*. Further applications of this model could encompass organisational design, capability definition, and the generation of organisational narratives beyond doctrine and strategy.

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Executive Summary

Work domain analysis, the first dimension of cognitive work analysis (Rasmussen, Pejtersen, & Goodstein, 1994; Vicente, 1999), provides a detailed structural description of a system. The value of this structured approach lies in its ability to define the functional purposes, value and priority measures, purpose-related functions, object-related processes, and physical resources of a system in a way that is independent of specific actors or events. As such, work domain models are useful for addressing a variety of problems.

In this report, the preliminary results of a work domain analysis of Australia's Air Power system are presented, focusing on the purpose-related functions of three key subsystems within the model—combat; transport; and intelligence, surveillance, and reconnaissance. Describing the purpose-related functions of these key subsystems will afford a preliminary understanding of some of the major functions of the system that must be supported to achieve the fundamental purposes of Air Power. Later publications will document further results of this work domain analysis, ultimately providing a comprehensive representation of Australia's military Air Power capability.

The work domain model of Australia's Air Power system has already demonstrated its utility by way of two major applications. First, the model contributed to the development of the Royal Australian Air Force's doctrine and strategy. Specifically, the model was used to develop the narrative of *The Air Power Manual* (AAP 1000-D) by refining the way in which fundamental air power concepts, such as purposes, goals, values, functions, missions, and roles, are defined, characterised, and interrelated (Brady, Naikar, & Treadwell, 2013; Naikar, Treadwell, & Brady, 2014). Second, the model contributed to the formulation of the Royal Australian Air Force's forthcoming *Future Air and Space Operating Concept*. The Air Power model enabled the implications of emerging trends to be examined comprehensively, contributing to the generation of a picture of the future operating environment and its implications for system operation (Brady, Naikar, & Treadwell, in press). In the future, the Air Power model could be utilised as a tool for informing decision making at the strategic level, justifying decisions and rationalising resource requirements to the Australian Government, and identifying deficiencies and redundancies in the current Air Force with the intention of

defining future capability objectives. Additionally, the Air Power model could be utilised to inform the organisational redesign of the Royal Australian Air Force and as a means for generating a range of organisational narratives beyond that required for the communication of Air Force doctrine and strategy.

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Authors

Ashleigh Brady
Joint and Operations Analysis Division

Ashleigh has been a Research Scientist at the Defence Science and Technology Organisation (DSTO) since 2011. Her work at DSTO has focused primarily on the application and extension of cognitive work analysis to organisational design, doctrine and strategy development, and future operating concept development. Ashleigh obtained a BSc in Psychology and Psychophysiology from Swinburne University in 2008 and a BA (Hons) from Swinburne University in 2009.

Neelam Naikar
Joint and Operations Analysis Division

Neelam Naikar joined the Defence Science and Technology Organisation (DSTO) as a Research Scientist in 1996 and was promoted to Senior Research Scientist in 1999. Some of Neelam's major projects at DSTO have involved the extension of cognitive work analysis to support the acquisition of complex military systems and the application of AcciMap Analysis and the Critical Decision Method to enhance safety in these systems. Her research interests continue to encompass the development of theories and methods for work analysis. Neelam obtained a BSc (Hons) in Psychology from the University of New South Wales, Australia, in 1993 and a PhD in Psychology from the University of Auckland, New Zealand, in 1996. She is a member of the Board of Editors for Applied Ergonomics and the Journal of Cognitive Engineering and Decision Making and the author of Work Domain Analysis: Concepts, guidelines and cases.

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1. Introduction

This report is one of a series of publications that will document the results of a work domain analysis of Australia's Air Power system. The primary aim of this analysis is to provide a structured description of the functional purposes, value and priority measures, purpose-related functions, object-related processes, and physical objects of the Air Power system. As well as providing a comprehensive representation of Australia's military Air Power capability, the resulting work domain model can be used for a number of applications, including doctrine and strategy development, future operating concept formulation, organisational design, and capability definition.

The current report focuses on the purpose-related functions of three key subsystems in the preliminary work domain model of Air Power. These subsystems—combat; transport; and intelligence, surveillance, and reconnaissance—align with the Royal Australian Air Force's core Air Power roles. These core roles of control of the air; strike; air mobility; and intelligence, surveillance, and reconnaissance represent those fundamental and enduring functions of Air Power that can be conducted to achieve military objectives across the spectrum of conflict (Royal Australian Air Force, 2013).

By describing the purpose-related functions of key subsystems of Australia's Air Power system, this report will provide a preliminary understanding of some of the major functions of the system that must be supported to achieve the fundamental purposes of Air Power. The value of this structured description is based on the definition of Air Power functions in a manner that is independent of actors and events. As such, the purpose-related functions of Air Power are relevant across a broad range of situations, including those that cannot be predicted or anticipated. This feature of the work domain analysis framework is particularly significant because it supports actors in coping with novelty by providing a variety of ways for dealing with situations, in a manner that is consistent with the constraints of the work domain. Accordingly, the purpose-related functions of the Air Power model have potential applications across a broad and dynamic problem space.

The value of the work domain model presented in this report has already been demonstrated on the basis of its utility for Air Power doctrine and strategy development. Specifically, the model of Air Power was utilised to inform the development of a credible narrative of the Royal Australian Air Force's foundational doctrine text, *The Air Power Manual* (AAP 1000-D). The narrative of doctrine and strategy was improved by examining the logic, rigour, and coherence with which air power concepts were presented. In other words, the work domain model provided a basis for refining how pivotal air power concepts, such as purposes, goals, values, functions, missions, and roles, are defined, characterised, and interrelated (Brady, Naikar, & Treadwell, 2013; Naikar, Treadwell, & Brady, 2014). More recently, the work domain model of Air Power contributed to the development of the forthcoming edition of *The Future Air and Space Operating Concept*. Specifically, the Air Power model assisted with examining the implications of emerging trends for the constraints of the Air Power system. As part of a larger framework comprising the overarching concepts of the five dimensions of cognitive work analysis, the Air Power model led to the generation of a picture of the future operating environment

and its implications for system operation, ultimately enabling the future operating concept to be defined (Brady, Naikar, & Treadwell, in press). Further applications of the Air Power model could extend to organisational design, particularly the development of a flexible and adaptive organisational structure for the Royal Australian Air Force (Naikar, 2012).

Prior to presenting the purpose-related functions of the Air Power subsystems of combat; transport; and intelligence, surveillance, and reconnaissance, this report will provide a brief overview of work domain analysis and its main modelling tool, the abstraction hierarchy. The specific methodology used to conduct the work domain analysis of Air Power will also be described, focusing on the purpose-related functions level of abstraction. Following that, the purpose-related functions of the three subsystems will be presented. The report will conclude by discussing the potential future directions for applying the Air Power work domain model.

2. Work Domain Analysis

Work domain analysis is the first dimension of cognitive work analysis, a framework that defines the work demands of complex sociotechnical systems in terms of the constraints on actors[1] (Rasmussen, 1986; Rasmussen, Pejtersen, & Goodstein, 1994; Vicente, 1999). Together with work domain analysis, the four other dimensions of the framework—control task analysis, strategies analysis, social organisation and cooperation analysis, and worker competencies analysis—are concerned with capturing the different kinds of constraints within a system using specialised modelling tools. By focusing on constraints, cognitive work analysis reveals how work can be done in a system (formative approach) rather than how work should be done (normative approach) or is done currently (descriptive approach). The suitability of this formative approach for modelling work demands has been demonstrated across a diverse range of systems, including military (Bisantz, Roth, Brickman, Gosbee, Hettinger, & McKinney, 2003; Burns, Bryant, & Chalmers, 2005), medical (Hajdukiewicz, Vicente, Doyle, Milgram, & Burns, 2001), aviation (Ahlstrom, 2005; Borst, Suijkerbuijk, Mulder, & van Paassen, 2006), and process control (Jamieson & Vicente, 2001) systems.

The important and unique value of work domain analysis within the cognitive work analysis framework derives from its ability to deal with novelty (Vicente, 1999). Specifically, work domain analysis is concerned with identifying and representing the functional structure[2] of the physical, social, or cultural environment in which actors work (Naikar, 2013; Rasmussen et al, 1994; Vicente, 1999). By describing the structure of a

[1] The term *actor* is used to encompass a worker or automation (Vicente, 1999, p. 4).

[2] The concept of *functional* is used to signify action-relevance (Vicente, 1999), while the term *structure* is used to denote a relatively stable relational property of a system (Vicente, 1999). As such, work domain analysis can be understood as describing the action-relevant, relatively permanent relational properties of a system (Naikar, 2013). This report adopts Naikar's (2013) definition of *system*, which refers only to a sociotechnical system, rather than Vicente's (1999) definition, which also encompasses a work domain or actor.

system independently of specific events, tasks, and actors, work domain analysis is able to reveal the range of possibilities for action, even for situations that are novel or that have not been predicted (Vicente & Rasmussen, 1992). This feature of work domain analysis results in a generalised representation of the work domain under investigation, which can then be used to reason about a variety of situations in a way that does not violate the constraints of a system. This approach is particularly important for complex sociotechnical systems given that goals, work requirements, and work conditions are frequently changing.

The abstraction hierarchy is one of the main modelling tools of work domain analysis. As displayed in Figure 1, it comprises five levels of abstraction—functional purposes, value and priority measures, purpose-related functions, object-related processes, and physical objects—for modelling the functional structure of the environment of actors. These concepts span from purposive concepts, relating to the reasons for a system's existence or design, to physical concepts, relating to a system's resources. As a result, by moving up or down the model the view of the system is changed, such that examining the system at different levels of abstraction is like seeing it through different conceptual lenses (Naikar, 2013). Of particular significance for the current report is the third level of abstraction—purpose-related functions. This level captures those functions that a system must be capable of supporting in order to fulfil its higher level objectives.

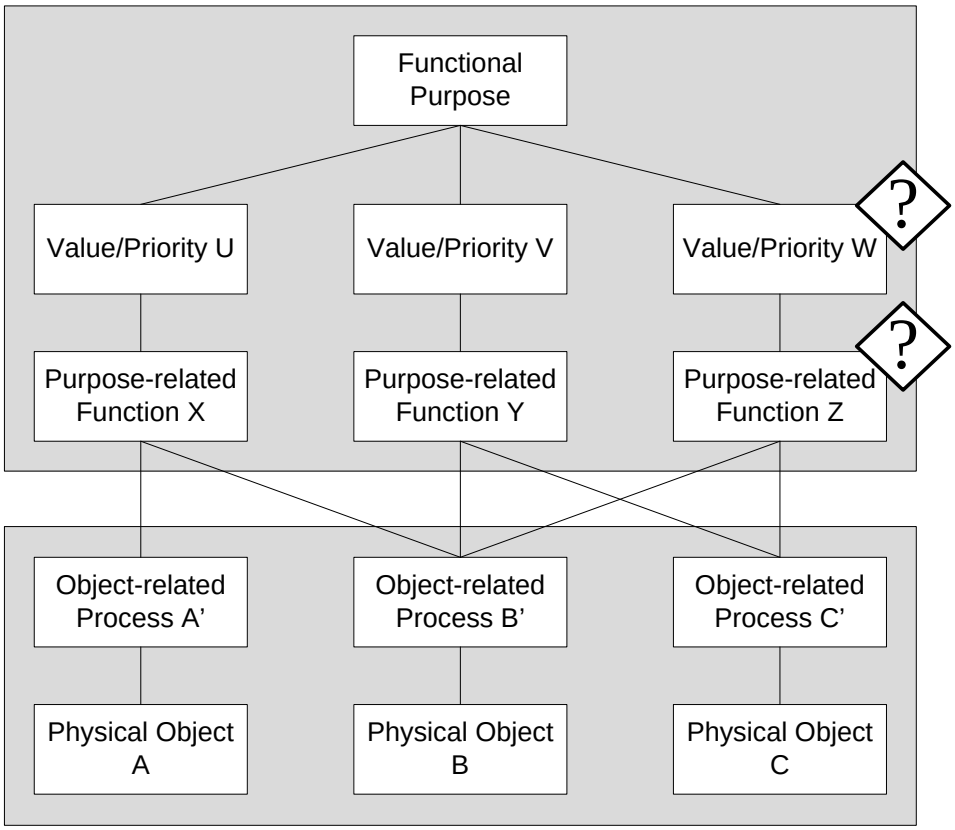

Figure 1 A generic abstraction hierarchy (Reproduced from Naikar, 2013)

As demonstrated in Figure 1, the abstraction hierarchy links categories of constraints using structural means-ends relations. Such relations are unique to work domain models and describe the properties of the environment that are necessary for achieving an end by connecting higher order objectives to physical resources (Naikar, 2013). That is, concepts at lower levels represent the structural means for achieving the ends at the higher levels, whereas concepts at higher levels represent the structural ends that can be achieved by means at the lower levels.

3. Methods

The work domain analysis of the Air Power system was performed using a methodology outlined by Naikar (2013). Summarised in the form of a series of questions, this methodology comprises eight analytic themes:

1. What is the purpose of the analysis?
2. What are the project restrictions?
3. What are the boundaries of the analysis or what is the focus system for the analysis?
4. Is it useful to develop multiple models?
5. Where on the causal-intentional continuum does the focus system fall?
6. What are the sources of information for the analysis?
7. What is the content of the abstraction-decomposition space?
8. Is the abstraction-decomposition space a valid model of the focus system?

In the current analysis, these structured guidelines provided a means for identifying and defining the purpose-related functions of the Air Power system in a way that was consistent with the fundamental concepts of work domain analysis.

In the following sections, the purposes, restrictions, boundaries, information sources, content, and validation of the Air Power model will be discussed. A comprehensive examination of the remaining themes will be provided in a later publication.

3.1 Purpose of the Analysis

The first analytic theme involves establishing the purpose of the analysis. This theme is of particular importance as the purpose of the analysis will significantly influence the composition of the resulting work domain model.

There are two essential considerations involved in determining the purpose of an analysis. The first concentrates on the objective that will be achieved with the analysis, and the

second focuses on how the work domain model will be used to achieve that objective. The general aim of the current analysis was to assist the Royal Australian Air Force in achieving their current and future (2030-2050) capability objectives. In order to achieve this aim, the purposes, values and priorities, and functions that Australia's Air Power system must be capable of fulfilling and the physical resources that this system must possess, now and into the future, were to be identified.

3.2 Project Restrictions

The second theme to consider when undertaking a work domain analysis involves project restrictions. This theme is important because, similar to the purpose of analysis, these restrictions have the capacity to influence how the analysis is conducted.

Typically, project restrictions are concerned with schedule, personnel, and finances. Schedule refers to the time available for both performing the analysis and applying the resulting model to a problem, while personnel concerns the number and experience of staff available. Finances relates to the amount of money that is available. For the current analysis, personnel availability dictated that only two researchers could contribute a portion of their time to the development and refinement of the purpose-related functions of the Air Power model. Personnel constraints also precluded multiple analysts from reviewing the same documents.

3.3 Boundaries of the Analysis

The third analytic theme concerns the boundaries of the analysis. This theme involves demarcating the system, or aspects of the system, that are to be the focus of the analysis. The demarcation can be determined by considering which organisational entity, physical entity, problem, or actor's perspective should be the focus of the analysis.

The boundaries of the current analysis focused on Australia's Air Power system. The analysis is limited to military capability and does not include civilian Air Power. Military Air Power incorporates the air capabilities of the three armed Services—Air Force, Army, and Navy—with these capabilities including both airborne and ground-based physical entities. The problem that defined the focus of the analysis was how to provide effective defence of Australia and its interests now and into the future. This problem was modelled from the perspective of Air Force Headquarters, the organisation responsible for providing strategic and policy guidance relating to Air Force capability to the Royal Australian Air Force, the Australian Defence Force, and the Australian Government (Royal Australian Air Force, 2013).

3.4 Sources of Information

The sixth theme to consider in the methodology concerns the sources of information for the analysis. Typically, the key information sources for work domain analysis are documents, field observations, and subject matter experts.

To produce a preliminary work domain model of Air Power, the sources of information were confined to documents. This approach was adopted in response to project restrictions which constrained analysts from utilising further information sources to generate the first iteration of the model. Such an approach still has considerable value given that it is possible to produce a reasonably comprehensive work domain model solely on the basis on documents (Naikar, 2013). Furthermore, Klein (2014) has suggested that the primary criterion of a good work analysis is the generation of insights. The Air Power model has already been utilised to generate useful insights in relation to the development of doctrine (Naikar et al., 2014) and a future air and space operating concept (Brady et al., in press), further substantiating the argument that a model based on documents is worthwhile. (Further details about these applications of the Air Power model are provided below.) In later iterations of the Air Power model, field observations and subject matter experts will be utilised as information sources to expand or refine the model.

Although the key information sources of a work domain analysis may reflect current work practices or current thinking about future work practices, work domain models are not limited by prevailing practices or thinking. Rather, work domain models take advantage of documents, field observations, or subject matter experts to establish the constraints that must be satisfied irrespective of current practices and thinking. That this outcome was achieved satisfactorily in the case of the Air Power model has been demonstrated through two major applications of the model, namely the development of the sixth edition of *The Air Power Manual* (AAP-1000D) in which the model led to 150 substantive recommendations for alterations to existing doctrine (Naikar et al., 2014), and the development of the forthcoming edition of *The Future Air and Space Operating Concept*, in which the model was utilised to provide an alternative concept to that being proposed by subject matter experts (Brady et al., in press). The fact that the work domain model led to changes in Air Force thinking, rather than confirming their thinking, indicates that the model was not limited by using information sources largely reflecting current work practices or current thinking.

The following documents were consulted to produce a preliminary model:

- Australian Service doctrine, such as *The Air Power Manual* (AAP-1000D) (Royal Australian Air Force, 2007a), *The Future Air and Space Operating Concept* (Royal Australian Air Force, 2007b), and the *Australian Maritime Doctrine* (Royal Australian Navy, 2010)
- Australian Defence Force Joint doctrine, such as the *Foundations of Australian Military Doctrine* (Department of Defence, 2012) and the *Law of Armed Conflict* (Department of Defence, 2006)
- Allied Joint doctrine, including philosophical and application level doctrine

- Strategic and policy publications, such as the *Defence White Paper* (Department of Defence, 2009)[3]
- Operating reference manuals and training procedures for Australian Air Power resources
- Internal and external websites of Australian and allied armed Services, which provided the most up-to-date information pertaining to Air Power doctrine and capabilities.

Australian Air Force documents were particularly relevant for identifying constraints relating to the Air Power system. Information from other sources was valuable for understanding how particular terms are utilised within the military; for developing general domain knowledge; and for developing suitable explanations or definitions of the terms utilised within the model to describe the constraints of Australia's Air Power system.

The process of document analysis involved searching source documents comprehensively for constraint-based, actor-independent, and event-independent information pertinent to Air Power combat; transport; and intelligence, surveillance, and reconnaissance functions. Specifically, through the examination of documented Australian Air Force and military functions, the underlying constraints—or limits on behaviour—were identified for these three key subsystems. As representations of the limits on action, constraints or purpose-related functions remain relatively invariant or constant across a range of circumstances (Vicente, 1999). Hence, while the functions presented in Air Force and broader military documentation are typically fluid, being responsive to emerging global trends and stakeholder perspectives, the purpose-related functions of the Air Power system are independent of such influences. The aim of the document analysis was to uncover the fundamental functions of Air Power, often not explicitly articulated in Air Force and military documents. The focus on underlying functions meant that any conflicts in functions represented by the source documents did not impact upon purpose-related function development.

It is important to highlight that constraint-based information is not usually easily identified or inferred from source documents. As such, this process can be challenging, even for experienced analysts. Additional documents were reviewed until no new purpose-related functions were identified or until the definitions of these constraints stabilised. Bisantz (2014) has suggested that such an approach can be used as a measure of reliability.

[3] It is important to note that the most recent version of the *Defence White Paper* (2013) was not available during model development. Consequently, the previous edition of the *Defence White Paper* (2009) was utilised to support the development of the Air Power model. Due to the fact that a work domain analysis describes relatively stable concepts, the use of a superseded publication does not invalidate the results presented in this report.

3.5 Content of the Abstraction-Decomposition Space

To produce the abstraction hierarchy of Air Power, an abstraction-decomposition space was constructed to identify the levels of abstraction and decomposition[4] at which the system would be modelled. As demonstrated in Figure 2, the five standard levels of abstraction, which were established by Rasmussen (1986) and Rasmussen et al. (1994), were identified as providing a faithful representation of Air Power. The labels of these levels are functional purposes, value and priority measures, purpose-related functions, object-related processes, and physical objects. In addition, Figure 2 shows that three levels of decomposition were identified as relevant to Air Power—the entire Air Power system, the subsystems of the Air Power system, and the components of those subsystems. The grey shading indicates those cells that were populated with constraints to create the abstraction hierarchy of Air Power; these cells were assessed as providing the most meaningful or useful views of this system.

	Entire System	**Subsystems**	**Components**
Functional Purposes	*Functional purposes of the entire system*	*Functional purposes of the subsystems*	*Functional purposes of the components*
Value and Priority Measures	*Value and priority measures of the entire system*	*Value and priority measures of the subsystems*	*Value and priority measures of the components*
Purpose-related Functions	*Purpose-related functions of the entire system*	*Purpose-related functions of the subsystems*	*Purpose-related functions of the components*
Object-related Processes	*Object-related processes of the entire system*	*Object-related processes of the subsystems*	*Object-related processes of the components*
Physical Objects	*Physical form of the entire system*	*Physical form of the subsystems*	*Physical form of the components*

Figure 2 A skeletal abstraction-decomposition space of the Air Power system

As shown in Figure 2, the purpose-related functions of the Air Power system were defined at the subsystem level of decomposition. As such, purpose-related functions were identified for each subsystem of Air Power. While the current report focuses on three key subsystems (i.e., combat; transport; and intelligence, surveillance, and reconnaissance),

[4] The decomposition dimension of the abstraction-decomposition space, located on the horizontal axis, represents a system at different levels of detail or resolution (Naikar, 2013).

several other subsystems have been identified for the Air Power model. The purpose-related functions of these subsystems will be presented in a later report.

3.6 Validity of the Model

The final theme to consider in performing a work domain analysis concerns the validity of the model. That is, the model must provide an accurate and comprehensive representation of the focus system.

Although a number of different strategies are available for validating a work domain model, it is important to acknowledge the difficulty involved in doing so fully or completely. In practice, the ultimate test of value is based on the model's evaluated usefulness (Burns & Hajdukiewicz, 2004; Vicente, 1999), either for the purpose for which it was developed or for other applications (Naikar, 2013). A similar approach to validity is articulated by Campbell and Bolton (2005), who contend that cognitive models may be best assessed for validity from the perspective of their intended uses or application.

According to Naikar (2009, 2013) the usefulness of a work domain model can be established on the basis of its impact, or ability to influence practice, and its uniqueness relative to other approaches. The feasibility of work domain analysis, that is, whether it can be accomplished within specified schedule, personnel, and financial restrictions, is also an important consideration. Similarly, Pfautz (2014) acknowledges that the quality of work analyses are fundamentally defined by the availability of time and funding, further suggesting that any evaluation should consider the context and scope of an analysis, together with information about the application and the observed benefits achieved through analysis.

The validity of the preliminary work domain model of the Air Power system was established in two ways. First, the model was reviewed extensively by an experienced analyst and authority on work domain analysis. Review of an analysis for internal logic, consistency, and completeness by an experienced analyst is a means suggested by Endsley (2014) for the assessment of work analysis quality.

Second, the model was evaluated on the basis of its usefulness. To date, the utility of the Air Power model has been demonstrated via two major applications[5], the development of the sixth edition of *The Air Power Manual* (AAP-1000D) and the forthcoming edition of *The Future Air and Space Operating Concep*t. The capacity of the model to provide an accurate representation of Australia's military Air Power system can be illustrated with an account of how the model was used to recommend changes to existing doctrine in the development of *The Air Power Manual* (AAP-1000D).

[5] This work was undertaken for the Air Power Development Centre, which resides within the Royal Australian Air Force.

As illustrated in Figure 3, based on the Air Power model, the set of concepts that had been previously identified as air power characteristics in existing doctrine was altered. Specifically, when the original air power characteristics were mapped onto the abstraction hierarchy, the characteristics demonstrated a fit at different levels of abstraction, which highlighted the potential for duplication of concepts. This duplication was confirmed through further examination of the concepts. To illustrate, from a military standpoint, the concepts of responsiveness and penetration (which map onto the value and priority measures and purpose-related functions levels, respectively) may be conceived as properties emerging from the synergy of various characteristics, including speed and reach. Logically, air power characteristics map onto the object-related processes level (Figure 1), as they are derived from the special qualities of the air environment and the unique parameters of flight, thereby signifying the functional capabilities and limitations of the system. For this reason, as shown at the right of Figure 3, the set of air power characteristics was altered. Specifically, the concepts of responsiveness, versatility, and penetration were removed, and the concepts of precision and fragility (which map onto the object-related processes level) were added.

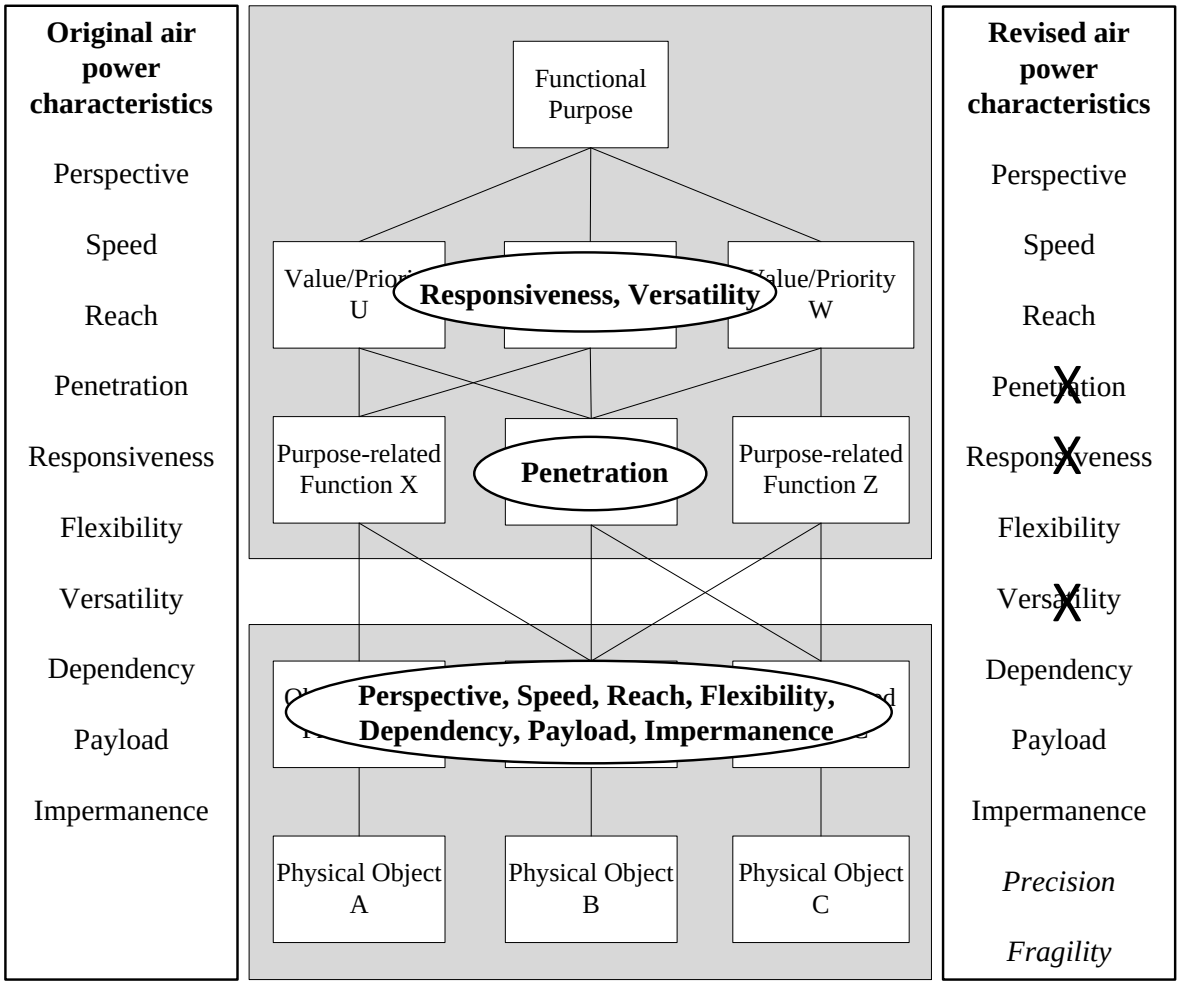

Figure 3. The original characteristics, their mapping to the abstraction hierarchy, and the revised characteristics.

4. Results

The purpose-related functions of the combat; transport; and intelligence, surveillance, and reconnaissance subsystems are presented below. Associated with these functions is a glossary which records the decisions made and the rationale for those decisions in defining each node. The glossary also provides an explanation for the inclusion of specific structural means-ends relations in the model. This glossary, organised by subsystem, is presented in Appendices A-C.

4.1 Purpose-related Functions of the Combat Subsystem

Six purpose-related functions were identified for the combat subsystem of Air Power. Presented in Table 1 are the definitions of these functions. The underlined terms are further defined in Appendix A.

Table 1 Combat subsystem purpose-related functions and definitions

Purpose-related Functions	Definitions
Target Destruction	The ability of the Air Power system to destroy a specified target. Specifically, the Air Power system must have the capacity to render a target so damaged that it cannot function as intended nor be restored to a useable condition.
Target Interference	The ability of the Air Power system to interfere with the capacity of a target to obtain information relating to its environment or to friendly forces. Specifically, the Air Power system must be capable of utilising non-lethal means to disrupt a target from achieving its goals for as long as necessary.
Target Containment	The ability of the Air Power system to restrict the movement of specified targets to a defined area. Specifically, the Air Power system must have the capacity to create operational barriers in order to control the manoeuvre options available to targets.
Target Deception	The ability of the Air Power system to deliberately convey false information to specified targets. Through misinformation the Air Power system is able to induce specified targets to react in a manner prejudicial to their interests.
Domain Penetration	The ability of the Air Power system to penetrate specified domains in order to achieve designated goals. Specifically, the Air Power system must have the capacity to bypass or breach obstructions in order to gain access to specified targets.
Asset Protection	The ability of the Air Power system to protect human and material resources from external dangers. Specifically, this function enables the Air Power system to safeguard important assets from harm or destruction.

4.2 Purpose-related Functions of the Transport Subsystem

A set of six purpose-related functions were identified for the transport subsystem of Air Power. The definitions of these functions are represented in Table 2. Additional information regarding these functions is provided in Appendix B, along with detailed definitions of the underlined terms.

Table 2 Transport subsystem purpose-related functions and definitions

Purpose-related Functions	Definitions
Asset Deployment	The ability of the Air Power system to deliver necessary human and material resources to designated locations.
Asset Recovery	The ability of the Air Power system to recover human and material resources from specified locations.
VIP Transport	The ability of the Air Power system to carry VIPs to domestic or international destinations in a secure and comfortable environment.
Air-to-Air Refuelling	The ability of the Air Power system to supply additional fuel to airborne aircraft. This function enables the Air Power system to extend its influence over large distances so that its endurance is limited only by aircrew fatigue and engineering factors.
People Rescue	The ability of the Air Power system to retrieve people and personal property from a threatened place, disaster area, or inhospitable environment and deliver them to a place of refuge. Specifically, the Air Power system must have the capacity to contribute to the rescue of people whose lives or health is at risk due to the effects of real or threatened occurrences or inadequate treatment resources.

4.3 Purpose-related Functions of the Intelligence, Surveillance, and Reconnaissance Subsystem

Five purpose-related functions were found to be relevant to the intelligence, surveillance, and reconnaissance subsystem of Air Power, as shown in Table 3. Further information about these functions, including definitions of the underlined terms, is presented in Appendix C.

Table 3 Intelligence, surveillance, and reconnaissance subsystem purpose-related functions and definitions

Purpose-related Functions	Definitions
Threat Detection	The ability of the Air Power system to establish the presence of targets with the potential to inflict harm on friendly assets and/or the civilian population and its infrastructure.
Target Monitoring	The ability of the Air Power system to survey the activities of specified targets. In particular, the Air Power system must have the capacity to survey the activities of adversaries, friendly forces, and environmental conditions.
Target Localisation	The ability of the Air Power system to determine the exact location of specified targets.
Target Identification	The ability of the Air Power system to establish the class and identity of specified targets.
Threat Prediction	The ability of the Air Power system to predict the intentions of specified targets.

5. Discussion

This report has identified and defined the purpose-related functions of three key subsystems of Australia's Air Power system—combat; transport; and intelligence, surveillance, and reconnaissance. The purpose-related functions associated with these subsystems represent some of the major functions that the Air Power system must be capable of supporting to achieve its purposes, independent of specific actors or events. This event-independence means that the purpose-related functions are relevant across a broad range of scenarios or situations, including those which are novel or unanticipated. As such, the purpose-related functions of the Air Power model have potential utility across a diverse range of applications.

As noted previously, the utility of the Air Power model has been demonstrated with its application to the development of the Royal Australian Air Force's doctrine and strategy, and the formulation of its future operating concept. The first application of the model was used to inform the philosophical content of the sixth edition of *The Air Power Manual* (AAP 1000-D), the Air Force's foundational strategic-level doctrine text, by providing a conceptual framework for refining how pivotal air power concepts (e.g., purposes, goals, values, functions, missions, roles) are defined, characterised, and interrelated (Brady et al., 2013; Naikar et al., 2014). The second application of the Air Power model assisted in the formulation of the Royal Australian Air Force's forthcoming edition of *The Future Air and Space Operating Concept*. Specifically, by providing a comprehensive means of evaluating the impact of emerging global trends on the constraints of the Air Power system, the

model contributed to the generation of a picture of the future operating environment, and implications for system operation, ultimately enabling the future operating concept to be defined (Brady et al., in press). On the basis of these applications, it may be claimed that the preliminary purpose-related functions of the Air Power model have demonstrated usefulness, having influenced the narrative of Australian Air Power doctrine and strategy, and the formulation of the Royal Australian Air Force's future operating concept. Further applications of the model could be used to assist the Royal Australian Air Force with its organisational redesign by informing the development of a flexible and adaptive organisational structure (Naikar, 2012).

The Air Power model could be further utilised within the Royal Australian Air Force as a tool for informing decision making at the strategic level, justifying decisions and rationalising resource requirements to the Australian Government, and identifying deficiencies and redundancies in the current Air Force with the intention of defining future capability requirements. The model could also be used to generate a range of authentic organisational narratives for purposes other than the communication of Air Force doctrine and strategy. These potential applications further demonstrate the value of the Air Power work domain model by highlighting its diverse utility. These prospective applications will inform future research.

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Appendix A: Glossary of Combat Subsystem Purpose-related Functions

This appendix presents an unclassified version of the glossary developed for the purpose-related functions of the combat subsystem of Air Power. Each function is defined in detail and is supported by a rationale and relevant documentation. It is important to highlight that supporting documentation has been sourced both from publications specific to the Australian context and from American, British, Canadian, and New Zealander contexts. Where supporting evidence from Australian publications has been excluded for classification purposes, equivalent evidence from public release allied Defence texts has been included.

TARGET DESTRUCTION

Definition of Target Destruction:

'Target Destruction' is defined as the ability of the Air Power system to destroy a specified target. Specifically, the Air Power system must have the capacity to render a target so damaged that it cannot function as intended nor be restored to a useable condition.

Destroy:
The Macquarie Dictionary Online (2013) defines 'destroy' as "to reduce to pieces or to a useless form". The capacity to 'destroy' is measured by the extent to which a target is damaged following destructive action such that it cannot function nor be restored to its intended condition. Such outcomes are desirable as they can reduce a target's ability to generate and project air or ground power against friendly forces. Kinetic weapons—such as air-to-air missiles, laser-guided bombs, and grenades—are currently utilised to achieve these outcomes.

- Function/Functionality:
  One direct outcome of Target Destruction is the removal of a target's functionality. As defined by the Macquarie Dictionary Online (2013), 'functionality' is "the purpose designed to be fulfilled by a device, tool, machine, etc." As such, the Air Power system must be capable of removing a specified entity's[6] primary function for Target Destruction to be achieved. This may include, for example, the flight functionality of an enemy fighter jet or the information exchange functions of a command and control centre.

- Restored:
  A further outcome of Target Destruction is the ability to destroy a specified target beyond restoration. The concept of 'restore' has been defined as "to bring back to a former, original, or normal condition" (Macquarie Dictionary Online, 2013). As such, the Air Power system must have the capacity to destroy a specified target to the extent that its original condition and function cannot be reinstated.

Target(s):
The term 'target' has been defined as "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" (Department of Defence, Version 6.2.0, NATO definition). This broad definition captures an extensive range of physical objects and within the current context encompasses personnel, material, and capabilities.

- Personnel:
  The term 'personnel' is described as "those individuals required in either a military or civilian capacity to accomplish the assigned mission" (Department of Defence, Version 6.2.0, US Joint definition).

- Material:
  'Material' has been described as "things needed for doing or making something" (Princeton University, 2013), with 'thing' defined as a "material object without life or consciousness" (Macquarie Dictionary Online, 2013). Based on the above definitions, the concept of 'material' will refer to any object required for a particular function(s) that is devoid of life or consciousness. This may include, for example: major and minor equipment (e.g., land vehicles, radios, handheld weapons), expendable supplies and material (e.g., fuel,

[6] As defined by the Macquarie Dictionary Online (2013), an 'entity' is "something that has a real existence; a thing, especially when considered as independent of other things". Within the current analysis, the concept of 'entity' will be used interchangeably with 'target'.

ammunition, surgical dressings, cleaning materials, medicines), and facilities (e.g., access roads, rail links, warehouses).

- Capability:
  The Oxford Dictionary Online (2013) defines 'capability' as "the power or ability to do something". Based on this definition a 'capability' will refer to those abilities or characteristics which enable a target to achieve its desired outcomes or effects. For example, a target's capabilities may refer to its capacity for flight, as required by a fighter jet, or the capacity for real time information to be exchanged, as required by a command and control centre.

Rationale and supporting documentation:

- Target Destruction is a purpose-related function of the Air Power system. The Air Power system must be capable of rendering a target so damaged that it cannot function as intended nor be restored to a useable condition. Specifically, this function enables the Air Power system to permanently eliminate threats of a combative nature.

  - "A decision-maker may have no other choice than to destroy, degrade, and erode the capabilities of an adversary, for it forecloses to them to any courses of action that depended on their use, and thus limits the options they may pursue" (Butler, 2008, p. 27).

  - "Once destroyed, the opposing unit or force can no longer pose a threat" (Smith, 2002, p. 258).

  Currently, in order to achieve this end the Air Power system must have access to kinetic weaponry.

  - "For the RAAF [Royal Australian Air Force], the use of weapons with a kinetic effect is the primary means to affect an adversary target system and is likely to remain so in the foreseeable future" (Butler, 2008, p. 27).

- The Air Power system's ability to secure Australia and its interests from threats is fundamentally predicated on its capacity to destroy targets.

  - "The fundamental reason for creating any warfighting organisation is to provide the nation with an ability to apply force, sometimes lethal force, in support of its national interests. Our Air Force exists to apply force in and from the air" (Royal Australian Air Force, 2007b, p. 37).

  - "The primary role of military forces is to ensure national security and defend the nation's interests through the application of lethal force" (Kainikara, 2011, p. 3).

  - "The ADF [Australian Defence Force] is the only agency of the Government that is to apply lethal force in such operations to defend Australia's people, interests and way of life" (Royal Australian Air Force, 2007a, p. 41).

  - "Ultimately, however, the potential use of lethal force by states is why, at the most basic level, armed forces exist" (Department of Defence, 2009, p. 20).

- In accordance with policy formulated and adhered to by Australian and allied forces, the physical destruction of targets is never to be used as an end in itself[7]. Instead, the Air Power

[7] The law of armed conflict (LOAC) clearly prohibits the use of destruction as an end in itself (Australian Defence Force, 2006b, Chapter 5, p. 4). As such, the Air Power system is strictly forbidden from executing any attacks on a person or object which has the ability to inflict destruction that is unnecessary to achieving the military objective.

system must utilise destruction as an agent for generating effects beyond directly elicited physical outcomes.

- "The use of warfighting techniques may be essential to ensure security or compliance, but the aim will never be destruction or the application of lethal force for its own sake" (New Zealand Defence Force, 2004, Chapter 8, p. 4).

- "Attrition and destruction can demoralise and reduce adversary capabilities, thus changing force ratios, force the adversary to disperse, and enable freedom of action, creating new opportunities for more effective physical and psychological manoeuvre" (Australian Defence Force, 2012, Chapter 2, p. 28).

- "Destruction is a means to an end and an enabler of psychological effects. It can change decisions, produce shock and chaos, and wear down resistance" (Butler, 2008, p. 32).

- "It is the reality of contemporary offensive air operations that, for the moment, the inducement of effects is closely tied to the infliction of physical damage" (Butler, 2008, p. 50).

While destruction may overcome a target's physical means of continuing a conflict, it also has the ability to produce indirect psychological effects. Using minimal destruction as a means to induce psychological effects has the benefit of influencing the future behaviour of a target, thus reducing the likelihood of conflict in the long-term (Deptula, 2001, p. 30; Royal Australian Air Force, 2002, p. 153; United States Joint Defense Services, 2003, Chapter 1, p. 2).

- In order to uphold its legal and ethical obligations, the Air Power system must respect all domestic, international, and operational laws/directives in the application of lethal force. Specifically, the Air Power system must adhere to principles specified by the law of armed conflict (LOAC) and rules of engagement (ROE) when conducting operations involving the use of kinetic weaponry to achieve objectives.

  - "…all ADF and Air Force operations must be conducted with adherence to the LOAC as well as mandated ROE" (Royal Australian Air Force, in press, p. 40).

  - "Additionally, the conduct of all military operations is subject to domestic and international law at all times…" (Royal Australian Air Force, in press, p. 37-38).

  - "The people of Australia, the ADF and the Air Force have an enviable reputation for fairness, honesty, integrity and respect for the rule of law" (Royal Australian Air Force, 2007a, p. 48).

Additional definitions:

- *Domestic law:* "Domestic or municipal law encompasses those internal laws that govern the behaviour of persons within a state and in some cases may affect nationals abroad. An Act of Parliament such as the *Defence Force Discipline Act* 1982 (DFDA) is an example of a domestic law that binds Australian Service personnel within Australia and abroad. International law can also become part of a state's domestic law; the Australian Parliament's ratification of the 1977 Protocols Additional to the Geneva Conventions of 1949 (Additional Protocols) being just one example. In the absence of specific legislation, international law can still be regarded as part of domestic law; although certain legal conditions are required" (Royal Australian Air Force, 2004, p. 2).

- *Effect*: "The adverse physical, physiological, psychological or functional impact on the enemy as a result, or consequence of, own military or non-military actions" (Department of Defence, Version 6.2.0, Army definition).

- *Expendable supplies and materials:* All stores and supplies that are consumed in normal use or that lose their identity during periods of use, such as fuel, explosive ordnance, and spare parts (informed by Department of Defence, Version 6.2.0, NATO definition).

- *Facility:* "A building or place that provides a particular service or is used for a particular industry" (Princeton University, 2013).

- *Friendly forces:* The term 'friendly' generally refers to assets which belong to, or are allied or partnered with, one's own defence forces (informed by Macquarie Dictionary Online, 2013; United States Department of Defense, 2013), with 'force' described as a "group of people organised for particular duties or tasks" (Collins Dictionary Online, 2013). In the current analysis, the concept of 'friendly forces' encapsulates any RAAF, ADF, or allied assets.

- *Indirect effect:* An outcome that cascades from one or more direct effects of a designated action (informed by United Kingdom Ministry of Defence, 2009, Chapter 3, p. 8).

- *International law:* "Operations law is primarily a product of international law which is itself concerned with international law and order and security. While it defies precise definition, international law is equally applicable to individuals despite the fact that it governs relations between states. In international law the term 'states' refers to nations which are accepted as legitimate members of the international community" (Royal Australian Air Force, 2004, p. 1).

- *Kinetic:* "Relating to motion; caused by motion" (Macquarie Dictionary Online, 2013).

- *Law of armed conflict (LOAC):* "The international law regulating the conduct of States and combatants engaged in armed hostilities" (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Operations law:* "Operations law is that domestic and international law associated with planning and execution of military operations in peacetime or during armed conflict. It includes but is not limited to LOAC, air law, law of the sea, anti-and counter-terrorist activities, overseas procurement, discipline, pre-deployment preparation, deployment, status of forces agreement, operations against hostile forces, aid to the civil authority, border protection and civil affairs operations" (Royal Australian Air Force, 2004, p. 1).

- *Rules of engagement (ROE):* "Directions endorsed by Government and issued by commanders, which delineate the circumstances, and limitations within which military force may be applied to achieve military objectives" (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Threat:* "A potential event or intention that could adversely affect the security of a facility, asset or function" (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Weapon:* "An offensive or defensive instrument of combat used to destroy, injure, defeat or threaten an enemy. Examples: gun, bomb, or bomber" (Department of Defence, Version 6.2.0, ADF Joint definition).

TARGET INTERFERENCE

Definition of Target Interference:

'Target Interference' is defined as the ability of the Air Power system to interfere with the capacity of a target to obtain information relating to its environment or to friendly forces. Specifically, the Air Power system must be capable of utilising non-lethal means to disrupt a target from achieving its goals for as long as necessary.

Interfere:
The term 'interfere' is defined as "to come between or in opposition; hinder; obstruct" (Collins Dictionary Online, 2013). Within the current context, 'interfere' will refer to the ability of the Air Power system to partially or entirely prevent targets from accessing information relating to their own environment or to friendly forces. This may be achieved, for example, by jamming an enemy[8] target's sensor systems so that information relating to friendly force movements is actively withheld or by corrupting information resident in an adversary's computer networks.

Target:
The term 'target' has been defined as "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" (Department of Defence, Version 6.2.0, NATO definition). This broad definition captures an extensive range of physical objects and within the current context encompasses personnel, material, and capabilities.

- Personnel:
  The term 'personnel' is described as "those individuals required in either a military or civilian capacity to accomplish the assigned mission" (Department of Defence, Version 6.2.0, US Joint definition).

- Material:
  'Material' has been described as "things needed for doing or making something" (Princeton University, 2013), with 'thing' defined as a "material object without life or consciousness" (Macquarie Dictionary Online, 2013). Based on the above definitions, the concept of 'material' will refer to any object required for a particular function(s) that is devoid of life or consciousness. This may include, for example: major and minor equipment (e.g., land vehicles, radios, handheld weapons), expendable supplies and material (e.g., fuel, ammunition, surgical dressings, cleaning materials, medicines), and facilities (e.g., access roads, rail links, warehouses).

- Capability:
  The Oxford Dictionary Online (2013) defines 'capability' as "the power or ability to do something". Based on this definition, a 'capability' will refer to those abilities or characteristics which enable a target to achieve its desired outcomes or effects. For example, a target's capabilities may refer to its capacity for flight, as required by an enemy fighter jet, or the capacity for real time information to be exchanged, as required by a command and control centre.

Information:
The Royal Australian Air Force (2007b, p. 66) defines 'information' as "unprocessed data of every description which may be used in the production of intelligence". This may pertain to facts, data, or instructions in any medium or form, for example: documents and papers; electronic data; intellectual information collected by individuals; and physical items from which information regarding design, components, or use could be derived. As specific to Target Interference, the Air Power system must

[8] The concepts of 'enemy' and 'adversary' are synonymous within the Air Power model.

have the capacity to disrupt a target's ability to collect information pertaining to its environment and friendly forces.

- Environment:
  The term 'environment' is described as "the surroundings or conditions in which a person, animal, or plant lives or operates" (Oxford Dictionary Online, 2013). In the context of the current analysis, the Air Power system must be capable of obstructing a target's ability to collect information relating to the external conditions in which it operates (e.g., air, land, maritime). This could include, for example, information pertaining to terrain (e.g., hydrological data, elevation data), atmospheric conditions (e.g., temperature, wind speed), and existing infrastructure (e.g., roads, bridges). The Air Power system's capacity to obstruct a target's ability to collect this type of information is essential due to its ability to hinder the development of an adversary's situational understanding.

- Friendly forces:
  The term 'friendly' generally refers to personnel and other assets which belong to, or are allied with, one's own defence forces (informed by Macquarie Dictionary Online, 2013; United States Department of Defense, 2013), with 'force' described as a "group of persons organised for particular duties or tasks" (Collins Dictionary Online, 2013). Within the current analysis, the Air Power system must have the capacity to disrupt a target's ability to collect information relating to any RAAF, ADF, or allied personnel or other assets (e.g., airborne early warning and control aircraft, combat aircraft, ground-based surveillance systems/platforms). This information could, for example, pertain to ADF movements, unit capabilities and intentions, or the personal details and work functions of individual personnel.

Rationale and supporting documentation:

- Target Interference is a purpose-related function of the Air Power system. The Air Power system must be capable of interfering with a target's capacity to obtain information relating to its environment or to friendly forces. Specifically, the Air Power system must have the ability to incapacitate a target's electromagnetic devices—such that the target is prevented from achieving its goals—by using non-lethal means to prevent unnecessary suffering, injury, or destruction to the civilian population and its infrastructure.

  - "Non-lethal weapons have the potential to enhance the ADF mission by contributing to the basic goal of any military operation, which is the establishment of a stable and enduring peace after victory has been achieved" (Casagrande, 1995, p. 10).

  - "As demonstrated in the Gulf War, military commanders can minimize casualties on both sides by employing 'soft kill' techniques which interdict and disrupt vital civil and military information networks, thus incapacitating opposition" (Canadian Department of National Defence, 1998, Chapter 1, p. 2).

  - "NetA [network attack] can also offer the commander the ability to incapacitate an adversary while reducing exposure of friendly forces, reducing collateral damage, and saving conventional sorties for other targets" (United States Air Force, 2005, p. 20).

  - "Specific effects IO [information operations] can achieve include…hindering an adversary's ability to strike by incapacitating their information-intensive systems" (United States Air Force, 2005, p. 30).

- Due to the nature of modern warfare, many defence forces and their platforms rely heavily on electromagnetic devices for the collection, analysis, and dissemination of information.

- "Military forces, like many elements of society, are becoming increasingly reliant on their ISs [information systems]. Many of today's Intelligence, Surveillance and Reconnaissance (ISR) sensors, command and control (C2) systems and weapon platforms, such as combat aircraft, warships and missiles, are already fully dependent on the integrity of ISs to function" (Westwood, 1997, Chapter 1, p. 4-5).

- "Today, nearly every weapon system relies on radar for detection, tracking, or targeting" (Air Power Development Centre, 2012a, p. 1).

- "Like naval combat systems, air power is becoming increasingly dependent on sophisticated computer systems, both within the cockpit and in support areas. Attacks against communications, navigation, avionics, and command and control systems…could be devastating" (Casagrande, 1995, p. 16).

- "Today, electromagnetic (EM) devices are increasingly used alone and in networks by both civilian and military organizations and individuals for intelligence, communications, navigation, sensing, information storage, and processing, as well as a variety of other purposes" (United States Joint Defense Services, 2007, Chapter. 1, p. 1).

Despite improving the accuracy and timeliness of information processes, the dependence on electromagnetic devices to achieve numerous functions has created a significant vulnerability for all users. The temporary incapacitation of electromagnetic devices has the ability to render affected systems and platforms ineffective or wholly unemployable, therefore reducing a target's ability to generate and apply combat power. As such, the Air Power system must have the capability to take advantage of this vulnerability, without inflicting permanent damage. This is principally achieved by denying a target's electromagnetic devices access to information.

- "…reduce an enemy's ability to gain information from radar and the operational advantage can shift firmly in one's favour" (Air Power Development Centre, 2012a, p. 1).

- "IO are used to deny adversaries access to their C2 information and other supporting automated infrastructures" (United States Joint Defense Services, 2006a, Chapter 1, p. 11).

- "One example of NetA includes actions taken to reduce an adversary's effectiveness by denying the adversary use of their networks by affecting the ability of the network to perform its designated mission" (United States Air Force, 2005, p. 20).

- "…defensive EA [electronic attack] is primarily used to protect against lethal attacks by denying adversary use of the EMS [electromagnetic spectrum] to guide and/or trigger weapons" (United States Joint Defense Services, 2007, Chapter 1, p. 4).

- "For example, denial can be done by traditional noise jamming techniques designed to block communications channels or radarscope presentations" (United States Air Force, 2011c, p. 11).

It should be highlighted that whilst the Air Power system must have the capacity to deny a target's electromagnetic devices access to information, the Air Power system must also be capable of retaining effective use of its own electromagnetic devices. This is particularly important because the Air Power system must have access to information pertaining to the adversary (e.g., location, capabilities, intentions) in order to effectively incapacitate the adversary's electromagnetic devices and reduce its combat capability. To retain friendly use of electromagnetic devices, the Air Power system must guard against intentional and unintentional interference.

- Although non-lethal weaponry provides the Air Power system with a reversible, temporary means of applying military force, the nature of such weaponry and the environment in which it is employed complicates compliance with legal constraints.

  - "[Non-lethal weapons] may offer alternatives to the more direct use of physical force with the possibility of reduced collateral damage and thus greater public acceptability of any attack however, additional legal constraints may limit their availability" (United Kingdom Ministry of Defence, 2002, Annex 2A, p. 2).

  - "Especially in the area of CNO [computer network operations], where the application of different domestic and international laws may be unclear, close coordination among the operational, legal, and law enforcement communities is essential" (United States Joint Defense Services, 2006a, Chapter 3, p. 4).

  - "Another country's legal basis and limitations for military activity in the information environment may differ" (United States Joint Defense Services, 2006a, Chapter 5, p. 2).

  Due to the difficulties surrounding the use of non-lethal weapons, the Air Power system must be cognisant of the legal considerations that must be taken into account during all stages of operations involving the use of non-lethal weaponry. In order to ensure compliance with its legal obligations the Air Power system must have access to appropriate legal advice.

Additional definitions:

- *Achieve:* "To bring to a successful end; carry through; accomplish" (Macquarie Dictionary Online, 2013).

- *Allies:* Two or more nations that have formal agreements in place for the cooperative achievement of broad, long-term objectives that further the common interests of all parties (informed by Department of Defence, Version 6.2.0, US Joint definition).

- *Asset:* A valuable or useful source of supply, support, or aid (informed by Macquarie Dictionary Online, 2013; Royal Australian Air Force, 2007a, p. 114, 2007b, p. 36).

- *Civilian infrastructure:* Any fixed or permanent installations, fabrications, or facilities that are not used to achieve military objectives (informed by International Committee of the Red Cross, 1949, 1977; and definition of 'infrastructure' from Department of Defence, Version 6.2.0, ADF Joint definition; Macquarie Dictionary Online, 2013).

- *Civilian population:* All persons who are not members of the armed forces (informed by International Committee of the Red Cross, 1949, 1977).

- *Destruction:* "The fact or condition of being destroyed" (Macquarie Dictionary Online, 2013).

- *Disrupt:* "To interrupt the progress of" (Collins Dictionary Online, 2013).

- *Goal:* "The object of a person's ambition or effort; an aim or desired result" (Oxford Dictionary Online, 2013).

- *Incapacitate:* "Prevent from functioning in a normal way" (Oxford Dictionary Online, 2013).

- *Injury:* "A term comprising such conditions as fractures, wounds, sprains, strains, dislocations, concussions, and compressions. In addition, it includes conditions resulting from extremes of temperature or prolonged exposure. Acute poisonings (except those due to contaminated food) resulting from exposure to a toxic or poisonous substance are also classified as injuries" (Department of Defence, Version 6.2.0, US Joint definition).

- *Lethal:* “The method of attack which is intended to cause physical damage to personnel, material or capabilities” (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Long:* “Having relatively great duration in time” (Collins Dictionary Online, 2013).

- *Necessary:* “Needed to achieve a certain desired effect or result” (Collins Dictionary Online, 2013).

- *Non-lethal:* Not resulting in or capable of causing permanent physical damage to personnel, material, or capabilities (informed by Collins Dictionary Online, 2013; Department of Defence, Version 6.2.0, ADF Joint definition).

- *Situational understanding:* “The accurate interpretation of a situation and the likely actions of groups and individuals within it. Note: Awareness, analysis, knowledge, comprehension and judgement facilitate understanding, which enables timely and accurate decision making” (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Soft kill:* “Efforts using other than explosive or kinetic systems to destroy or neutralise a target. They may include electronic measures” (Department of Defence, Version 6.2.0, Navy definition).

- *Suffer:* “To undergo or feel pain or distress” or “to sustain injury, disadvantage or loss” (Macquarie Dictionary Online, 2013).

TARGET CONTAINMENT

Definition of Target Containment:

'Target Containment' is defined as the ability of the Air Power system to restrict the movement of specified targets to a defined area. Specifically, the Air Power system must have the capacity to create operational barriers in order to control the manoeuvre options available to targets.

Restrict:
The Collins Dictionary Online (2013) defines 'restrict' as "to confine or keep within certain, often specified, limits or selected bounds".

Movement:
The term 'movement' is described as "the act or process or result of moving" (Macquarie Dictionary Online, 2013), with 'move' defined as "to go or pass to another place or in a certain direction with a continuous motion" (Merriam-Webster Dictionary Online, 2013).

Target(s):
The term 'target' has been defined as "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" (Department of Defence, Version 6.2.0, NATO definition). This broad definition captures an extensive range of physical objects and within the current context encompasses personnel, material, and capabilities.

- Personnel:
  The term 'personnel' is described as "those individuals required in either a military or civilian capacity to accomplish the assigned mission" (Department of Defence, Version 6.2.0, US Joint definition).

- Material:
  'Material' has been described as "things needed for doing or making something" (Princeton University, 2013), with 'thing' defined as a "material object without life or consciousness" (Macquarie Dictionary Online, 2013). Based on the above definitions, the concept of 'material' will refer to any object required for a particular function(s) that is devoid of life or consciousness. This may include, for example: major and minor equipment (e.g., land vehicles, radios, handheld weapons), expendable supplies and material (e.g., fuel, ammunition, surgical dressings, cleaning materials, medicines), and facilities (e.g., access roads, rail links, warehouses).

- Capability:
  The Oxford Dictionary Online (2013) defines 'capability' as "the power or ability to do something". Based on this definition, a 'capability' will refer to those abilities or characteristics which enable a target to achieve its desired outcomes or effects. For example, a target's capabilities may refer to its capacity for flight, as required by an enemy fighter jet, or the capacity for real time information to be exchanged, as required by a command and control centre.

Barrier:
The term 'barrier' has been described as "anything that prevents or obstructs passage, access, or progress" (Collins Dictionary Online, 2013). For the purposes of the current analysis, 'barriers' may be either fixed or moving and are used to prevent access to specific areas, facilities, or routes by physical presence, firepower, or obstacles/obstructions[9].

[9] According to the North Atlantic Treaty Organization (NATO), the term 'obstacle' is preferred in the land environment and the term 'obstruction' is preferred in the air and water environments (Department of Defence, Version 6.2.0).

Rationale and supporting documentation:

- Target Containment is a purpose-related function of the Air Power system. The Air Power system must be capable of restricting the movement of specified targets through the use of operational barriers. By controlling the manoeuvre options available to adversaries, the Air Power system is able to operate unhindered by adversary forces, thus increasing the system's ability to achieve its goals.

  - "Operational barriers, obstacles, and minefields….degrade the maneuver of enemy forces. Because of their size and the pattern of placement, they virtually dictate the maneuver options…" (United States Joint Defense Services, 2011a, Chapter 2, p. 3).

- To better understand the role of Target Containment within the Air Power system, the fundamental concepts relating to this purpose-related function were explored through raw data analysis. From this process it was first determined that the Air Power system must have the capacity to block target movement in order to control or direct adversary manoeuvre. Blocking the movement of targets may be used to completely arrest further movement or to canalise targets.

  - "The first priority for obstacles is to…block key avenues of approach, especially at major choke points" (United States Army, 1985a, Chapter 4, p. 74).

  - "Employment of cluster munitions against land-based targets can increase the effectiveness of attacks….They also allow joint forces to channel the enemy into kill zones or deny access to an area" (United States Joint Defense Services, 2011b, Chapter 2, p. 3).

  - "Joint forces can use obstacles to delay, channel, or stop the movement and maneuver of adversaries or for protection against an enemy's assault or against unauthorized access to facilities and bases" (United States Joint Defense Services, 2011a, Chapter 1, p. 2).

  - "Attacks on enemy lateral LOCs [lines of communications] can channel movement…" (United States Air Force, 2011b, p. 23).

  When creating operational barriers for the purpose of blocking movement, it is important to ensure that friendly force movement is not unduly impeded. Any damage to assets or delays to Air Power schedules caused by friendly barriers has the ability to severely impact the achievement of allocated goals.

  - "Obstacles should not impede our own mobility; or, if they do, they should be…with a self-destruct time coordinated to future maneuver plans" (United States Army, 1985a, Chapter 4, p. 56).

  - "The use of scatterable minefields should be carefully planned and executed so that friendly mobility during future operations is not impeded" (United States Army, 1985a, Chapter 1, p. 14).

- An intrinsic aspect of Target Containment is the ability to impact the manoeuvrability of opposing forces both physically and psychologically through the use of operational barriers.

  - "Proper use of obstacles in depth wears the enemy down and significantly increases the overall delay. At each new obstacle, he incurs losses and is forced to stop and react. This wearing down effect is psychologically significant. The desired effect is to degrade the enemy soldier's will and induce a feeling of hopelessness" (United States Army, 1985a, Chapter 2, p. 41).

- "[Mines] can also be emplaced individually or in groups to demoralize an enemy force" (United States Joint Defense Services, 2011a, Appendix C, p. 1).

Though the primary intent may be to physically restrict the movement of a target, as the statements above suggest, the psychological impact of barriers may also affect a target's ability to manoeuvre as intended.

- The Air Power system is required to respect domestic, international, and operational law/policy directives when creating and employing operational barriers. Specifically, the ADF and its allies are legally and ethically obligated to act in accordance with the principles of the LOAC and ROE when using lethal weaponry or obstacles/obstructions to restrict target movement.

  - "The creation and employment of countermobility barriers, obstacles, and mines must comply with the law of war, international law…and policy" (United States Joint Defense Services, 2011a, Chapter 3, p. 16).

  - "Obstacles frequently modify terrain through demolition, excavation, and other means. Some obstacle actions, such as destroying levees, setting fires, felling trees in forested areas, or demolishing bridges, may have immediate impacts on civilians and often will have long-term effects on them and the environment and are governed by the law of armed conflict" (United States Joint Defense Services, 2011a, Chapter 3, p. 16).

Additional definitions:

- *Adversary:* "A party acknowledged as potentially hostile to a friendly party and against which the use of force may be envisaged" (Department of Defence, Version 6.2.0, Navy definition).

- *Block:* "To deny access to a given area, or to prevent an advance in a particular direction" (Department of Defence, Version 6.2.0, Army definition).

- *Canalise:* "To limit the movement of individuals, groups, or organisations to a specified direction" (Department of Defence, Version 6.2.0, Army definition).

- *Containment:* "The geographical restriction of the freedom of action of enemy forces" (Department of Defence, Version 6.2.0, Navy definition).

- *Firepower:* "The amount of fire which may be delivered by a position, unit, or weapon system" (Department of Defence, Version 6.2.0, NATO definition).

- *Fix:* "A tactical task in which actions are taken to prevent the enemy from moving any part of its forces from a specific location, and/or for a specific period of time, by holding or surrounding them to prevent their withdrawal for use elsewhere" (Department of Defence, Version 6.2.0, Army definition).

- *Lethal weapon:* An object that can be used to cause permanent damage to personnel, material, and capabilities (informed by definitions of 'lethal' and 'weapon from Collins Dictionary Online, 2013; Department of Defence, Version 6.2.0, NATO definition).

- *Manoeuvre:*
  1. "A movement or series of moves requiring skill and care" (Oxford Dictionary Online, 2013).
  2. "A large-scale military exercise of troops, warships, and other forces" (Oxford Dictionary Online, 2013).

- *Obstacle:* “A natural or man-made object that creates a physical impediment to or hazard for the movement of vehicles, personnel or formations” (Department of Defence, Version 6.2.0, NATO definition).

- *Obstruction:* “A natural or man-made object that creates a physical impediment to or hazard for the movement of vehicles, personnel or formations” (Department of Defence, Version 6.2.0, NATO definition).

- *Route:* “The prescribed course to be travelled from a specific point of origin to a specific destination” (Department of Defence, Version 6.2.0, NATO definition).

TARGET DECEPTION

Definition of Target Deception:

'Target Deception' is defined as the ability of the Air Power system to deliberately convey false information to specified targets. Through misinformation the Air Power system is able to induce specified targets to react in a manner prejudicial to their interests.

Convey:
The term 'convey' has been described as "to communicate; impart; make known" (Macquarie Dictionary Online, 2013).

False:
The Collins Dictionary Online (2013) defines 'false' as "not in accordance with the truth or facts".

Information:
The Royal Australian Air Force (2007b, p. 66) defines 'information' as "unprocessed data of every description which may be used in the production of intelligence". This may pertain to facts, data, or instructions in any medium or form, for example: documents and papers; electronic data; intellectual information collected by individuals; and physical items from which information regarding design, components, or use could be derived. Within the current context the Air Power system must have the capacity to convey false information to selected targets, including that relating to the presence, location, classification, identity, capabilities/limitations, and intentions of friendly forces.

- Presence:
  The concept of 'presence' is defined as "the state or fact of being present" (Macquarie Dictionary Online, 2013), with 'present' described as "being in a specified place" (Collins Dictionary Online, 2013). By adopting these definitions, the concept of 'presence', within the current context, will refer to the Air Power system's ability to falsify information pertaining to the general existence of friendly forces. This may be achieved, for example, by utilising emission control measures to minimise an enemy target's detection capabilities.

- Location:
  The ability to 'locate' is described as "to set, fix, or establish in a place, situation, or locality", with 'location' defined as a "place or situation occupied" (Macquarie Dictionary Online, 2013). Based on the fact that an enemy's localisation of friendly forces may contribute to friendly destruction or degradation, the Air Power system must have the capacity to convey false information relating to the exact location of friendly forces. This may be accomplished, for example, by creating electromagnetic signatures in false locations to represent actual capabilities.

- Classification:
  The act of 'classifying' something is defined as "to arrange or distribute in classes" (Macquarie Dictionary Online, 2013). The establishment of category or class can provide important knowledge, such as whether an entity is friendly, hostile, or unknown. Therefore, the Air Power system must have the capacity to falsify information relating to the class of its personnel and material. This may be achieved, for example, by imitating enemy target signals in order to pose as enemy assets.

- Identity:
  The term 'identity' has been described as the "individual characteristics by which a person or thing is recognised" (Collins Dictionary Online, 2013). In order to establish 'identity', an entity must be capable of perceiving the individual characteristics of an individual or object in sufficient detail. As such, the Air Power system may falsify friendly force identity by

altering or hiding identifying characteristics. For example, using camouflage nets to cover vehicles and face paint on personnel may interfere with accurate identification.

- Capabilities/limitations:
  The Oxford Dictionary Online (2013) defines 'capability' as "the power or ability to do something". Based on this definition, capabilities are considered to be those individual abilities or characteristics which facilitate achievement of desired outcomes or effects. For example, by concealing or exaggerating the level of damage sustained by friendly forces following an attack, the Air Power system is able to deceive selected targets in relation to remaining friendly force capability.

  In contrast to capability, the concept of 'limitation' has been defined as "something that limits a quality or achievement" (Collins Dictionary Online, 2013). For the current analysis, friendly force limitations will be defined as any restricting/limiting factor (e.g., payload weight) which interferes with its ability to achieve desired outcomes or effects. As limitations represent areas of vulnerability, the Air Power system must have the capacity to deceive selected targets with respect to friendly force limitations.

- Intentions:
  Within Defence, an 'intention' is defined as "an aim or design (as distinct from capability) to execute a specified course of action" (Department of Defence, Version 6.2.0, US Joint definition). Within the current context, the Air Power system must have the capacity to deceive selected targets in regards to the goals of friendly forces and the methods and means that friendly forces will use to achieve them.

Target(s):
The Department of Defence (Version 6.2.0, NATO definition) defines 'target' as "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system". This broad definition captures an extensive range of physical objects and within the current context encompasses personnel, material, and capabilities.

- Personnel:
  The term 'personnel' is described as "those individuals required in either a military or civilian capacity to accomplish the assigned mission" (Department of Defence, Version 6.2.0, US Joint definition).

- Material:
  'Material' has been described as "things needed for doing or making something" (Princeton University, 2013), with 'thing' defined as a "material object without life or consciousness" (Macquarie Dictionary Online, 2013). Based on the above definitions, the concept of 'material' will refer to any object required for a particular function(s) that is devoid of life or consciousness. This may include, for example: major and minor equipment (e.g., land vehicles, radios, handheld weapons), expendable supplies and material (e.g., fuel, ammunition, surgical dressings, cleaning materials, medicines), and facilities (e.g., access roads, rail links, warehouses).

- Capability:
  The Oxford Dictionary Online (2013) defines 'capability' as "the power or ability to do something". Based on this definition a 'capability' will refer to those abilities or characteristics which enable a target to achieve its desired outcomes or effects. For example, a target's capabilities may refer to its capacity for flight, as required by an enemy fighter jet, or the capacity for real time information to be exchanged, as required by a command and control centre.

Rationale and supporting documentation:

- Target Deception is a purpose-related function of the Air Power system. The Air Power system must be capable of conveying false information to specified targets so as to induce desired behaviour. By deceiving specific decision-makers the Air Power system can lead adversaries to react in a manner inimical to their own interests.

  - "Electronic deception can be used to shape or influence the adversary commander to form inaccurate impressions about friendly forces, waste intelligence assets, or fail to use other resources to best advantage" (Australian Defence Force, 2013, Chapter 5, p. 6).

  - "MILDEC [military deception] must target the adversary decision maker capable of taking the desired action(s). The adversary's intelligence, surveillance, and reconnaissance (ISR) system is normally not the target; rather, it is the primary conduit used in MILDEC to convey selected information to the decision maker" (United States Joint Defense Services, 2006c, Chapter 1, p. 4).

  An important factor in achieving the deception goal is to target the key decision-maker(s) capable of selecting and generating the desired action. Therefore, the deceptive information must be conveyed in a way that ensures it will reach its intended target.

- In order to convey false information to specified targets, the Air Power system must be capable of releasing indicators that can be detected and gathered by a target's ISR assets. Consequently, the Air Power system must be capable of using its own ISR capabilities to accurately assess and identify the collection capabilities available to, and favoured by, a specified target. In addition, the Air Power system must understand how target decision-makers perceive friendly capabilities and intentions and how they are likely to react to the deception.

  - "Those indicators that the adversary cannot collect will not require portrayal" (United States Joint Defense Services, 2006c, Chapter 4, p. 8).

  - "When determining the adversary's detection and collection capabilities, deception planners need to be aware of and consider the possibility of adversaries acquiring intelligence from commercial surveillance and reconnaissance systems" (United States Joint Defense Services, 2006c, Chapter 4, p. 4).

  - "The adversary may have access to data collected from assets he does not control" (United States Joint Defense Services, 2006c, Chapter 4, p. 4).

  - "If it is known that the adversary places a higher value on information received from certain intelligence sources than from others, then emphasize those indicators that are collected by the valued sources" (United States Joint Defense Services, 2006c, Chapter 4, p. 8).

  - "Deception planners identify any preconceptions that the adversary leadership may have about friendly intentions and capabilities. With the intelligence analysts, the deception planners seek to identify any COAs [courses of action] that the adversary may adopt or have under consideration" (United States Joint Defense Services, 2006c, Chapter 4, p. 4).

- In order to successfully induce certain desired actions, or inactions, false information must not only be detected and gathered by specified targets, it must also be plausible.

  - "Credibility is key to influence operations" (United States Air Force, 2005, p. 9).

  - "Multisensor deception can increase the adversary's confidence about the 'plausibility' of the deception story" (United States Air Force, 2011c, p. 11).

- "Sufficient forces and resources should be committed to the deception effort to make it appear credible to the adversary" (United States Air Force, 2005, p. 11).

The portrayal of a credible and realistic deception story is central to the Air Power system's ability to induce targets to react in a desired manner. In order to react in a way that will achieve the deceptive goal, the target must first perceive the deception as truth. Thus, the Air Power system must be capable of conveying various indicators to multiple sources, as the believability of deceptions increases in line with the number and type of sources that are deceptively manipulated (United States Joint Defense Services, 2006c, Chapter 4, p. 8).

- The maintenance of public support is crucial for democratically accountable governments, as it will influence the options that can be taken, including military action. As such, democratic governments must remain responsive to public expectations by providing clear, timely, and accurate information. The Air Power system is ethically barred from deceiving the public through the reporting of false information.

  - "In order to gain and maintain public support, national and international governments need to show a degree of transparency in their actions…" (Australian Defence Force, 2007a, Chapter 1, p. 5).

  - "…if false information were ever intentionally used in PA [public affairs] operations, the public trust and support for the Air Force could be undermined and PA operations would be degraded" (United States Air Force, 2005, p. 12).

  - "Public affairs operations can document displays of force or training operations but they cannot use false information to simulate force projection" (United States Air Force, 2005, p. 12).

- The Air Power system is legally and ethically obligated to act in accordance with principles of the LOAC when using deception measures to meet military objectives. In order to respect international and operational law/policy directives, the Air Power system must refrain from using prohibited deceptions (e.g., using an aircraft marked with a red cross to carry armed soldiers, weapons, or ammunitions).

  - "It is a violation of LOAC to feign non-combatant status so that a tactical advantage may be gained. A surprise attack by a person feigning shipwreck, sickness or wounds undermines the protected status of those rendered incapable of combat.…Such acts of perfidy are punishable as war crimes" (Royal Australian Air Force, 2004, Chapter 11, p. 92-93).

  - "Misuse of a protective symbol is regarded as perfidy and forbidden by LOAC" (Royal Australian Air Force, 2004, Chapter 10, p. 88).

  - "Perfidious acts are prohibited under the law of armed conflict because they undermine the effectiveness of protective signs, signals, and symbols and thereby jeopardize the safety of civilians and non-combatants and/or the immunity of protected structures and activities" (United States Joint Defense Services, 2006c, Chapter 1, p. 8).

Additional definitions:

- *Behaviour:* "The actions or reactions of persons in response to external or internal stimuli" (North Atlantic Treaty Organization, 2007, Glossary, p. 1).

- *Detection:* "The discovery by any means of the presence of a person, object or phenomenon of potential military significance" (Department of Defence, Version 6.2.0, NATO definition).

- *Perfidy:* "The use of prohibited deceptions....designed to invite the confidence of the enemy to lead him to believe that he is entitled to, or is obliged to, accord a person, class of persons or objects protected status under LOAC. The intent of such acts is to betray the confidence that armed forces place in LOAC, and the respect accorded to protected individuals and objects" (Royal Australian Air Force, 2004, Chapter 11, p. 91).

DOMAIN PENETRATION

Definition of Domain Penetration:

'Domain Penetration' is defined as the ability of the Air Power system to penetrate specified domains in order to achieve designated goals. Specifically, the Air Power system must have the capacity to bypass or breach obstructions in order to gain access to specified targets.

Penetrate:
The term 'penetrate' has been defined as to "gain access to (an organization, place, or system), especially when this is difficult to do" (Oxford Dictionary Online, 2013). Within the current context, the concept of 'penetrate' refers to the capacity of Air Power assets to overcome obstructions which impede friendly force access to areas of the air, land, maritime, space, and cyberspace domains required for the accomplishment of specific goals.

Domain:
The concept of 'domain' is defined as "a medium with discrete characteristics in which, or through which, military activity takes place" (Department of Defence, 2013). Within a defence context, domains may be physical (e.g., air, space, maritime, land) or non-physical (e.g., cyberspace).

Achieve:
The term 'achieve' is defined as "to bring to a successful end; carry through; accomplish" (Macquarie Dictionary Online, 2013). In the context of the current analysis, the concept of 'achieve' will refer to the actions taken by a specified entity to attain a desired result.

Goals:
The Oxford Dictionary Online (2013) defines a 'goal' as "the object of a person's ambition or effort; an aim or desired result". For the current analysis, 'goals' refer to a desired result or set of results that a specified entity is tasked to attain.

Bypass:
'Bypass' is defined as "to manoeuvre around an obstacle, position, or enemy force" (Department of Defence, Version 6.2.0, Army definition). For the current analysis, the term 'bypass' will refer to the ability of friendly forces to manoeuvre around, under, or over obstructions whilst avoiding contact with those obstructions.

Breach:
'Breach' is defined as to "break through or secure a passage through an enemy defence, obstacle, minefield or fortification" (Department of Defence, Version 6.2.0, Army definition).

Obstruction(s):
The term 'obstruction' is defined as "a person or thing that obstructs" (Collins Dictionary Online, 2013), with 'obstruct' described as "to block or close up, or make difficult of passage with obstacles" and "to interrupt, make difficult, or oppose passage, progress, course, etc., of" (Macquarie Dictionary Online, 2013). Based on these definitions, for the current analysis, 'obstructions' will refer to any entities (e.g., weapons systems) or environmental characteristics (e.g., inclement weather) that significantly impede friendly force access to specified physical or non-physical domains.

Target(s):
The term 'target' has been defined as "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" (Department of Defence, Version 6.2.0, NATO definition). This broad definition captures an extensive range of physical objects and within the current context encompasses personnel, material, and capabilities.

- Personnel:
  The term 'personnel' is described as "those individuals required in either a military or civilian capacity to accomplish the assigned mission" (Department of Defence, Version 6.2.0, US Joint definition).

- Material:
  'Material' has been described as "things needed for doing or making something" (Princeton University, 2013), with 'thing' defined as a "material object without life or consciousness" (Macquarie Dictionary Online, 2013). Based on the above definitions, the concept of 'material' will refer to any object required for a particular function(s) that is devoid of life or consciousness. This may include, for example: major and minor equipment (e.g., land vehicles, radios, handheld weapons), expendable supplies and material (e.g., fuel, ammunition, surgical dressings, cleaning materials, medicines), and facilities (e.g., access roads, rail links, warehouses).

- Capability:
  The Oxford Dictionary Online (2013) defines 'capability' as "the power or ability to do something". Based on this definition a 'capability' will refer to those abilities or characteristics which enable a target to achieve its desired outcomes or effects. For example, a target's capabilities may refer to its capacity for flight, as required by an enemy fighter jet, or the capacity for real time information to be exchanged, as required by a command and control centre.

Rationale and supporting documentation:

- Domain Penetration is a purpose-related function of the Air Power system. The Air Power system must be capable of penetrating specified domains in order to achieve designated goals. Specifically, this function enables the Air Power system to target an adversary's critical capabilities as close to their source as possible in order to achieve maximum effect, whilst ensuring friendly forces retain the capacity to move personnel and material and transfer information between specified locations.

  - "The ability to reach and penetrate into enemy held territory can result in essential supplies being delivered….Air forces can penetrate where land and sea forces cannot, thus providing vital supply to otherwise unreachable places" (Royal Australian Air Force, 2002, p. 130).

  - "Modern aerospace power can be used to penetrate deep into enemy territory to strike a wide range of discrete strategic and other targets" (Royal Australian Air Force, 2002, p. 131).

- Due to the nature of modern warfare, the Air Power system must have the capacity to penetrate physical and non-physical domains in order to accomplish its designated goals.

  - "By virtue of its capacity to operate at varying altitudes, air power can bypass obstacles of terrain as well as the adversary's surface forces and, to a large degree, the air defence systems. This ability is enhanced by precision navigation and self-protection systems that permit operations over a very wide area and greater penetration of an adversary's territory to undertake deep strike missions that create effects independent of surface operations" (Air Power Development Centre, 2012b, p. 2).

  - "While physical access to a particular computer network may be limited, electronic access may prove the key to successful computer system penetrations" (United States Joint Defense Services, 2000, Chapter 4, p. 4).

- "Space-based surveillance systems, military and civil, have a capacity for virtual penetration that can greatly enhance a force's information capability. They can position themselves wherever required to monitor large areas, including remote and access-denied areas, to support communications, navigation, meteorology, oceanography and ISR" (Royal Australian Air Force, 2007a, p. 84).

As alluded to in the documentation above, Air Power has an inherent ability to penetrate land and sea barriers as a result of its capacity to operate at high altitudes. As a result of this capacity, along with those enabled by precision navigation and self-protection systems, Air Power assets are able to physically penetrate most obstructions in the air, land, and maritime domains. However, it is important to note that the Air Power system must also have the capacity to virtually penetrate selected domains. Virtual penetration refers to the use of sensors and software systems to gain non-physical access to simulated (e.g., computer networks) or real-world environments (e.g., hostile territory) for the purpose of information collection or manipulation.

- Penetration of specified domains may be achieved through two primary capabilities, specifically, bypassing and breaching. As defined previously, bypassing concerns manoeuvring around, under, or over obstructions. Bypassing is performed in an effort to save time and assets required for eliminating obstructions, and to reduce the risk associated with coming in direct contact with specific obstructions.

  - "Airlift affords commanders a high degree of combat maneuverability permitting adversary troop strongholds to be bypassed. This provides to friendly forces a potent offensive advantage, complicating the adversary's defensive preparations" (United States Joint Defense Services, 2006b, Chapter 4, p. 5).

  - "Enemy obstacles that disrupt, fix, turn, or block the maneuver force can affect the timing and flow of the operation. Most obstacles will be observed by the enemy and protected with fires; obstacles should be bypassed if possible" (United States Joint Defense Services, 2011a, Chapter 3, p. 4).

  - "Bypass is the preferred method when it offers a quicker, easier, and tactically sound means to avoid obstacles" (United States Army, 1985b, Chapter 2, p. 12).

  - "Bypassing an integrated antilanding defense is preferred over conducting an amphibious breach whenever possible; however, the commander must always consider whether a bypass would produce additional risks" (United States Joint Defense Services, 2011a, Chapter 3, p. 7).

  - "To save time and labor, obstacles are bypassed where possible. This should be done with caution, however. A bypass route that appears desirable at first may be a kill zone" (United States Army, 1985b, Chapter 5, p. 7).

  - "…an attacking force capable of airmobile or extended ground operations can usually find away *[sic]* over or around an obstacle. The defending force can then be bypassed, contained, or taken from the rear" (United States Army, 1985b, Chapter 9, p. 10).

- A further capability of Domain Penetration is breaching. Breaching refers to the Air Power system's ability to pass directly through an obstruction in order to achieve specified goals. Breaching is primarily employed in situations where bypassing may not be viable (e.g., where the best available bypass channels friendly forces into a kill zone) or where the passage of additional forces must be facilitated.

- "Its [covert breaching] primary purpose is to reduce obstacles in an undetected fashion to facilitate the passage of maneuver forces. A covert breach is conducted when surprise is necessary or desirable" (United States Joint Defense Services, 2011a, Chapter 3, p. 6).

- "In some cases, breaching may be a better tactical solution than bypassing" (United States Army, 1985b, Chapter 2, p. 12).

- "…breaching operations are some of the most complex of modern warfare but are not an end in themselves. They exist only as a part of the maneuver forces' operation that is focused on the objective. The goal of breaching operations is the continued, uninterrupted momentum of…forces to the objective" (United States Joint Defense Services, 2011a, Chapter 3, p. 4).

- "USAF [United States Air Force] strike platforms are also a key component of the assault breaching system in support of amphibious operations" (United States Joint Defense Services, 2011a, Chapter 4, p. 15).

Though not explicitly stated in the above excerpts, the Air Power system must have the capacity to bypass and breach non-physical obstructions. For example, in order for friendly forces to gain unauthorised access to adversary computer networks, security systems (e.g., software-based firewalls) must be circumvented or broken.

- In order to effectively penetrate specified domains and achieve designated goals, the Air Power system must have access to requisite intelligence relating to natural and man-made obstructions. Where obstructions have been emplaced by adversaries, the Air Power system must also have access to information regarding the location, intentions, and capabilities of those adversaries.

  - "Intelligence must provide joint forces with as much understanding as possible about obstacles—and about adversaries' capabilities to employ them" (United States Joint Defense Services, 2011a, Chapter 1, p. 2).

  - "Using intelligence, surveillance, and reconnaissance assets, engineers and planners identify the location of natural and man-made obstacles….They identify both actual and potential obstacles and propose solutions and alternate courses of action (COAs) to minimize or eliminate their potential impact" (United States Joint Defense Services, 2011a, Chapter 1, p. 3).

Additional definitions:

- *Access:* "The means or opportunity to approach or enter" (Oxford Dictionary Online, 2013).

- *Air domain:* The earth's atmosphere, which begins at the earth's surface and extends to the altitude where atmospheric effects (e.g., absorption of ultraviolet solar radiation, heat retention, and reduction of diurnal temperature extremes) become negligible (informed by Department of Defence, Version, 6.2.0, US Joint definition; and definition of 'atmosphere' from Wikipedia, 2013).

- *Altitude:* "The vertical distance of a level, a point or an object considered as a point, measured from mean sea level" (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Cyberspace:* A global domain consisting of the interdependent network of information technology infrastructures, including the Internet, telecommunications networks, computer systems, and embedded processors and controllers, and their resident data (informed by Australian Defence Glossary, Version 6.2.0, ADF Joint definition).

- *Electromagnetic spectrum:* "That range of frequencies in which oscillating electric and magnetic fields propagate waves at the speed of light. Note: This includes cosmic and gamma radiation, X-rays, ultraviolet, visible and infra-red radiation and radio waves" (Department of Defence, Version 6.2.0, Army definition).

- *Environment:* "The surroundings or conditions in which a person, animal, or plant lives or operates" (Oxford Dictionary Online, 2013).

- *Firewall:* "A computer system that isolates another computer from the internet in order to prevent unauthorized access" (Collins Dictionary Online, 2013).

- *Intention:* "An aim or design (as distinct from capability) to execute a specified course of action" (Department of Defence, Version 6.2.0, US Joint definition).

- *Land domain:* The solid surface of the earth that is not submerged under water (informed by Macquarie Dictionary Online, 2013).

- *Location:* "A place or situation occupied" (Macquarie Dictionary Online, 2013).

- *Maritime domain:*
  1). "The series of jurisdictional zones that surrounds the coast of a State. It includes territorial seas and the EEZ [exclusive economic zone]" (Royal Australian Navy, 2010, p. 199).
  2). "The oceans, seas, bays, estuaries, islands, coastal areas, and the airspace above these, including the littorals" (United States Department of Defense, 2013).

- *Move: "*To go or pass to another place or in a certain direction with a continuous motion" (Merriam-Webster Dictionary Online, 2013).

- *Navigation system:* An electronic system which aids in accurately ascertaining positional information, and planning and following a route (informed by Oxford Dictionary Online, 2013; Wikipedia, 2013).

- *Non-physical:* "Not tangible or concrete" (Oxford Dictionary Online, 2013).

- *Physical:* "Having material existence; perceptible especially to the senses and subject to the laws of nature" (Merriam-Webster Dictionary Online, 2013).

- *Risk:* "The possibilities of adverse outcomes, usually by way of deliberate actions, unforeseen environmental factors, miscalculation or other human error" (Department of Defence, Version 6.2.0, DMO definition).

- *Space domain:* The area 100 kilometres above mean sea level that is not recognised as sovereign territory (informed by Australian Defence Force, 2010, Chapter 1, p. 4).

- *Speed:* "Rapidity in moving, going, travelling, or any proceeding or performance" (Macquarie Dictionary Online, 2013).

- *Transfer:* "Copy from one medium or device to another" (Oxford Dictionary Online, 2013).

ASSET PROTECTION

Definition of Asset Protection

'Asset Protection' is defined as the ability of the Air Power system to protect human and material resources from external dangers. Specifically, this function enables the Air Power system to safeguard important assets from harm or destruction.

Protect:
The term 'protect' has been defined as "to defend or guard from attack, invasion, annoyance, insult" (Macquarie Dictionary Online, 2013), "to keep safe from harm or injury" (Oxford Dictionary Online, 2013), and as a "tactical task to provide safety for an individual, group or force and prevent any loss as a result of enemy or other action" (Department of Defence, Version 6.2.0, Army definition). In these definitions, the act of protecting describes the prevention of harm, injury, or loss, subsequently enhancing the likelihood of survivability. Within the current context, the Air Power system must be capable of protecting itself, as inclusive of its human and material resources, against external dangers, at all times and in all conditions.

Human resources:
The concept of 'human resources' is described as "the human component of an organisation, institution, business, country" (Macquarie Dictionary Online, 2013). For Asset Protection, the human component of the Air Power system encapsulates any RAAF, ADF, or allied personnel operating within the Air Power system.

Material resources:
'Material' has been defined as "things needed for doing or making something" (Princeton University, 2013), with "thing" described as "a material object without life or consciousness" (Macquarie Dictionary Online, 2013). The concept of 'resource' has been defined as "a source of supply, support, or aid" (Macquarie Dictionary Online, 2013). For the current analysis, 'material resources' will refer to any object which is devoid of life or consciousness and contributes to Air Power capability (e.g., weapons, air bases, aircraft).

External:
The Oxford Dictionary Online (2013) defines 'external' as "coming or derived from a source outside the subject affected". For the purposes of the current analysis, the term 'external' has been used to denote those dangerous entities and environmental characteristics which originate outside of the Air Power system's control, such as an enemy fighter jet or inclement weather.

Danger(s):
'Danger' is described as the "state of being vulnerable to injury, loss, or evil" (Collins Dictionary Online, 2013). For the purposes of the current analysis, the concept of danger/dangers encompasses those threats which have the capacity to cause harm and destruction.

- Harm
  The Macquarie Dictionary Online (2013) defines 'harm' as "injury; damage; hurt". Within the current context, the concept of 'harm' captures consequences associated with physical hurt or intermittent damage.

- Destruction:
  'Destruction' has been described as "the act of destroying", with 'destroy' defined as "to reduce to pieces or to a useless form" (Macquarie Dictionary Online, 2013). Within the current context, 'destruction' is the capacity to destroy a specified target to the extent that is cannot function as intended or be restored to its original condition and denotes those permanent adverse outcomes attained by the human and material resources of Air Power.

Rationale and supporting documentation:

- Asset Protection is a purpose-related function of the Air Power system. The Air Power system must be capable of protecting all human and material resources from external dangers in order to achieve its functional purpose. As highly valued assets, Air Power human and material resources must be afforded an appropriate[10] degree of protection in order to ensure their ongoing preservation and operational effectiveness.

  - "The protection of information, platforms and people is essential to operational success" (Australian Defence Force, 2007a, Chapter 1, p. 11).

  - "Modern air power capability is essential to joint operations….Therefore, protection of these assets is vital" (Royal Australian Air Force, 2007a, p. 97).

  - "Modern air forces can scarcely afford to suffer anything greater than a low incidence of losses, in both personnel and materiel, and there are inherent lethal risks involved to aircrew in the pursuit of the physical destruction of an adversary" (Butler, 2008, p. 23-24).

- Based on information extracted from Air Force and Defence publications, the concepts of Asset Protection and force protection are interrelated. As defined by the Royal Australian Air Force (2007a, p. 114), 'force protection' captures all measures and means to minimise the vulnerability of personnel, facilities, equipment, and operations to any threat and in all situations, to preserve freedom of action and the operational effectiveness of the force. As suggested by this description, force protection encompasses all protective measures taken across the entire force in the avoidance of threats. This is distinct to the current conceptualisation of Asset Protection which is solely concerned with protecting the Air Power system from harm or destruction sustained through dangers originating outside of the Air Power system's control (e.g., enemy action, inclement weather).

  Asset Protection encompasses the protection of Air Power human and material resources from entities and environmental characteristics with the capability to and/or intent to cause harm or destruction. Within this context, 'entities' may refer to any personnel, material, or capabilities originating outside of the Air Power system. 'Environmental characteristics' will encompass the external conditions in which the Air Power system operates, which could include, for example, terrain features (e.g., hydrological and elevation features), atmospheric conditions (e.g., temperature, wind speed), and climate (e.g., long-term weather trends). Asset Protection does not involve protecting human and material resources of the Air Power system from disease or internal dangers[11] (e.g., material faults, human error).

- The Air Power system is often tasked to operate in dangerous environments. As such, the Air Power system must have the capacity to protect its human and material resources from a range of existing and evolving dangers originating from entities and environmental characteristics outside of the Air Power system's control.

  - "Protection against future ballistic missile threats is something that the Air Force will need to consider with other Services and our allies" (Royal Australian Air Force, 2007b, p. 36-37).

  - "The threat from state-based WMD [weapons of mass destruction] programs, and potential access to them by non-state groups, will remain serious security concerns for Australia" (Department of Defence, 2009, p. 101).

[10] It is important to note that over-protection of assets has the potential to needlessly divert valuable resources, while under-protection may result in an unnecessary loss of capability. Therefore, the Air Power system must have the ability to provide a level of protection appropriate to the specific context of the situation.

[11] Protection of Air Power human and material resources from internal dangers will be covered in an alternate subsystem of the Air Power model.

- "Considering the growing dependence on the world's cyberspace infrastructure, new variants and sources of vulnerabilities are tempting targets for strategic attack. Therefore, the ability to defend against attacks in cyberspace…is critical" (Royal Australian Air Force, in press, p. 128-130).

- "Even on a clear day, the impact of something as simple as the speed and direction of the wind can significantly impact operations. Severe weather such as large hail, high winds, and heavy rains can halt flying operations and even damage unprotected aircraft on the ground" (United States Air Force, 2012, Chapter 1, p. 8).

- "Space weather such as a proton event (high energy charged particles released from the sun) can disable satellite subsystems….By extension, space weather interference on space systems also impacts operations in the cyberspace domain since a great deal of cyberspace mission data transits the space domain" (United States Air Force, 2012, Chapter 1, p. 12).

As demonstrated in the statements above, danger exists within physical and non-physical domains of the operational environment. Whilst kinetic weaponry (e.g., bombs, missiles) is considered to be the primary threat in the physical domains (i.e., air, space, land, maritime), environmental characteristics (e.g., high winds, low visibility) can also endanger friendly assets. In addition, danger may also be present in the non-physical cyberspace domain (e.g., disablement of communications and sensor systems, network corruption).

- In order to effectively protect Air Power human and material resources from external dangers, the Air Power system must have the capacity to detect and identify those entities and environmental characteristics which have the potential to cause harm and/or destruction. Advanced warning cues, together with the ability to differentiate between intentional and unintentional effects, enable implementation of the most effective protection measures.

  - "…multi-layered protection extends awareness and influence….This maximizes the ability to disrupt attacks and provide the earliest warning possible, while ensuring the best protection for the Service's most valuable assets, its people…" (United States Air Force, 2011d, Chapter 1, p. 3).

  - "Air Force weather operations collect and analyse data on the state of the atmosphere through the use of polar orbiting and geostationary satellites, and through the employment of a complex network of attended and unattended ground-based, airborne, and maritime sensors" (United States Air Force, 2012, Chapter 1, p. 5).

  - "Knowledge of these factors [sub-surface, surface, and air conditions] allows forces to avoid adverse environmental conditions while taking advantage of other conditions to enhance operations" (United States Joint Defense Services, 2013, Chapter 2, p. 5).

- In situations where Air Power systems or platforms have no capacity to protect themselves, they must rely upon other assets for protection.

  - "All Air Force assets must be able to be protected by design, either because they have some organic ability to protect themselves or they come under the protection of another system" (Royal Australian Air Force, 2007b, p. 36).

  - "Aircraft with no integral self-protection systems may require protection from other systems or actors, not necessarily RAAF, when operating in hostile environments" (Royal Australian Air Force, 2007a, p. 97).

- "Friendly aircraft en route to or from a target area may be assigned escort aircraft to protect them from enemy air-to-air and surface-to-air threats" (United States Air Force, 2011a, Chapter 3, p. 20).

Additional definitions:

- *Force:* "An aggregation of military personnel, weapon systems, equipment, and necessary support, or a combination thereof" (Department of Defence, Version 6.2.0, US Joint definition).

- *Weather:* "All meteorological and space environmental factors as exploited by Services, support agencies, and other sources. These factors include the whole range of atmospheric (weather) phenomena, from the earth's surface up to the space environment (space weather)" (United States Air Force, 2012, Chapter 1, p. 1).

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Appendix B: Glossary of Transport Subsystem Purpose-related Functions

This appendix presents an unclassified version of the glossary developed for the purpose-related functions of the transport subsystem of Air Power. Each function is defined in detail and is supported by a rationale and relevant documentation. It is important to highlight that supporting documentation has been sourced both from publications specific to the Australian context and from American, British, and Canadian contexts. Where supporting evidence from Australian publications has been excluded for classification purposes, equivalent evidence from public release allied Defence texts has been included.

ASSET DEPLOYMENT

Definition of Asset Deployment:

'Asset Deployment' is defined as the ability of the Air Power system to deliver necessary human and material resources to designated locations.

Deliver:
The term 'deliver' is described as "to carry (goods, etc.) to a destination, esp [especially] to carry and distribute (goods, mail, etc.) to several places" (Collins Dictionary Online, 2013). For the purposes of the current analysis, the concept of 'deliver' will encompass the capacity to carry necessary resources and position them in designated locations.

- Carry:
  The Oxford Dictionary Online (2013) describes the term 'carry' as to "support and move (someone or something) from one place to another".

- Position:
  The term 'position' is defined as "to put in the proper or appropriate place" (Collins Dictionary Online, 2013). For the current analysis, the Air Power system must have the capacity to accurately position required assets in accordance with command directives.

Necessary:
The Collins Dictionary Online (2013) describes the term 'necessary' as "needed to achieve a certain desired effect or result". By adopting this definition, the Air Power system must be capable of delivering those human and material resources required for the achievement of specified mission objectives.

Human resources:
The concept of 'human resources' is described as "the human component of an organisation, institution, business, country" (Macquarie Dictionary Online, 2013). For Asset Deployment, the human component of the Air Power system encapsulates any Royal Australian Air Force (RAAF), Australian Defence Force (ADF), or allied personnel operating within the Air Power system.

Material resources:
'Material' has been defined as "things needed for doing or making something" (Princeton University, 2013), with 'thing' described as "a material object without life or consciousness" (Macquarie Dictionary Online, 2013). The concept of 'resource' has been defined as "a source of supply, support, or aid" (Macquarie Dictionary Online, 2013). For the current analysis, 'material resources' will refer to any object which is devoid of life or consciousness and contributes to Air Power capability (e.g., weapons, air bases, aircraft).

Locations:
The term 'location' is defined as a "place or situation occupied" (Macquarie Dictionary Online, 2013). For the current analysis, the concept of 'location' will refer to specific geographical positions, such as towns or cities, to be occupied by specified assets.

Rationale and supporting documentation:

- To satisfy the functional purpose of Air Power, the Air Power system must have the ability to deliver the necessary resources to designated locations as required. Specifically, the Air Power system must be capable of carrying and accurately positioning resources as directed. This dual function enables the Air Power system to conduct and sustain operations in the physical environment.

- "Operational success can only be achieved if the various components of the force can move to the right place at the right time and in the right force composition whilst, at the same time, receiving sustainment to maintain combat power" (Australian Defence Force, 2006c, Chapter 6, p. 1).

- "The ability of Air Force airlift and ADF rotary wing capabilities to reach remote places and deliver relief and other support will be vital in NWO [non-warlike operations]" (Royal Australian Air Force, 2007b, p. 44).

- "Airdrop allows commanders to project and sustain combat power into areas where a suitable ALZ [air landing zone], or a ground transportation network may not be available. This delivery method allows rapid insertion of combat forces to numerous target areas" (United States Air Force, 2011a, p. 39).

As these statements attest, Asset Deployment allows significant lethal and non-lethal effects to be generated and applied across air and surface domains. As such, the air Power system relies on Asset Deployment to achieve operational effectiveness.

- The Air Power system is reliant on the capacity to carry necessary resources over extended distances in order to achieve its functional purpose (i.e., to secure Australia and its interests from threats). As described in the definition of Asset Deployment, the ability to carry resources involves both the support[12] and movement[13] of human or material resources. In order to support resources, the Air Power system must have access to transport assets with the capacity to bear or tolerate specific payloads.

  - "Aircraft are able to carry a wide range of payloads, including weapons, sensors, communications systems, passengers and cargo, rapidly and over long distances….specialised aircraft also carry increasingly large and powerful payloads of surveillance, reconnaissance and communications systems" (Royal Australian Air Force, 2007a, p. 95).

  - "With advances in aircraft design and engineering, modern aircraft payloads and their effect on the structure of the aircraft can be calculated with great accuracy" (Royal Australian Air Force, 2002, p. 131).

  Within the current context, the ability to support human and material resources is reliant on both the structural strength of the transport vehicle, together with available passenger and stowage space. In situations where the weight or size of resources to be delivered exceeds the transport vehicle's payload capacity, an increased sortie rate may be employed.

- In addition to bearing specific payloads, Air Power assets must be capable of physically moving resources between specified locations, both on the ground and in the air, and mechanically manipulating those movements when directed.

  - "The role of an ADF Pilot is to operate an aircraft (fixed or rotary wing) to achieve mission objectives through use of appropriate tactics, operational procedures and effective employment of aircraft controls, systems and resources" (Capability Development Group, 2010, p. 1).

  Specified Air Power assets (e.g., tanker aircraft) must be capable of regulating their movements at all times, both in the air and on land. This function is predominately enabled by the propulsion systems of air vehicles (e.g., aircraft engine, propeller/propulsive nozzle) and land vehicles

[12] The term 'support' is defined as to "bear all or part of the weight of; hold up" (Oxford Dictionary Online, 2013).
[13] The concept of 'movement' refers "to go or take from one place to another" (Collins Dictionary Online, 2013).

(e.g., engine, wheels, axles), as well as steering and other movement control systems (e.g., flight control, ground control).

- A second aspect of Asset Deployment is concerned with the ability to accurately position resources in accordance with command directives. Within the context of Air Power, this principally concerns the use of delivery systems (e.g., improved container delivery system, joint precision airdrop system), communication systems, and navigational aids (e.g., global positioning system, inertial navigation system).
  - "The Global Positioning System (GPS) is the primary source of positioning, navigation, and timing information" (United States Joint Defense Services, 2012b Chapter 1, p. 4).
  - "The JPADS [joint precision airdrop system] is a high-altitude airdrop system that increases on-ground accuracy of aerial delivery cargo operations, allows for the use of smaller drop zones (DZ)…and compensates for aircraft release point errors" (United States Army, 2009).
- An inherent aspect of Asset Deployment is the need for precise, timely, cost-effective, and safe delivery of Air Power assets.
  - "In some contexts, the correct payload delivered quickly and precisely can be of more value in stabilising a crisis than a larger payload delivered after the crisis has matured" (Royal Australian Air Force, 2007a, p. 96).
  - "Air mobility operations allow cargo and passengers to be delivered precisely where and when they are needed, thereby increasing the concentration of military effects" (United States Air Force, 2011a, p. 4-5).
  - "Emerging capabilities such as GPS-guided airdrop will allow the Air Force to combine the precise delivery of airland with the reduced threat exposure of airdrop" (United States Air Force, 2011a, p. 37).
  - "Airland delivery, as opposed to airdrop, is the preferred method of aerial delivery when conditions permit, because it is the most efficient, safest, and least expensive way to deliver personnel and cargo. It minimizes the risk of injury to personnel and damage to equipment…" (United States Air Force, 2011a, p. 37).
- It is important to highlight that the delivery of human and material resources into hostile environments will often be necessary. As such, the Air Power system will require appropriately trained operators and specially fitted transport assets.
  - "Airborne operations can also be conducted to deliver special forces in enemy-controlled or politically sensitive territories. The degree of risk, physical and political, inherent in these operations and the challenging environment in which they may be conducted require detailed, integrated planning and organisation, and may require specially trained aircrews" (Royal Australian Air Force, 2007a, p. 132).
  - "Some aircraft (including unmanned aerial vehicles) may befitted with specific equipment and countermeasures that either limit or enhance their capacity for particular missions; for example, sensors, threat warning receivers, winching equipment and external load lift capability" (Australian Defence Force, 2004a, Chapter 2, p. 4).

Additional definitions:

- *Airdrop:* "Delivery of personnel or cargo from aircraft in flight" (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Airland:* “Combat forces moved by air and deplaned, or unloaded, after the aircraft has landed or while a helicopter is hovering” (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Asset:* A valuable or useful source of supply, support, or aid (informed by Macquarie Dictionary Online, 2012; Royal Australian Air Force, 2007b, p. 36).

- *Directive:* Any authoritative communication which initiates or governs action, conduct, or procedure (informed by Department of Defence, Version 6.2.0, NATO definition).

- *Effect:* “The adverse physical, physiological, psychological or functional impact on the enemy as a result, or consequence of, own military or non-military actions” (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Hostile environment:* “An environment where Australian Defence Force operations are likely to be opposed by local forces and/or the local population” (Department of Defence, Version 6.2.0, Army definition).

- *Lethal:* “The method of attack which is intended to cause physical damage to personnel, material or capabilities” (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Load:* “The total weight of passengers or cargo transported” (Department of Defence, Version 6.2.0, NATO definition).

- *Non-lethal:* Not resulting in or capable of causing permanent physical damage to personnel, material, or capabilities (informed by Collins Dictionary Online, 2013; Department of Defence, Version 6.2.0, ADF Joint definition).

- *Payload:* “The load, in addition to its unladen weight, that a vehicle is designed to transport under specified conditions of operation” (Department of Defence, Version 6.2.0, NATO definition).

- *Propulsion:* A means of creating force leading to movement. A propulsion system has a source of mechanical power (e.g., engine, muscles) and some means of using this power to generate force (e.g., wheel and axles, propellers, wings, legs) (Wikipedia, 2013).

- *Safe:* “Secure from liability to harm, injury, danger, or risk” (Macquarie Dictionary Online, 2013).

- *Sortie:* “In air operations, an operational flight by one aircraft” (Department of Defence, Version 6.2.0, NATO definition).

- *Steer:* “To guide the course of (anything in motion) by a rudder, helm, wheel, etc.” (Macquarie Dictionary Online, 2013).

ASSET RECOVERY

Definition of Asset Recovery:

'Asset Recovery' is defined as the ability of the Air Power system to recover human and material resources from specified locations.

Recover:
The concept of 'recover' has been described as "to bring back (equipment, etc.) from a battlefield after an action" (Macquarie Dictionary Online, 2013) and "to find again or obtain the return of" (Collins Dictionary Online, 2013). For the current analysis, the concept of 'recover' will refer to the planned extrication of human and material resources, inclusive of disabled or abandoned material, from specified locations, with or without the use of force.

Human resources:
The concept of 'human resources' is described as "the human component of an organisation, institution, business, country" (Macquarie Dictionary Online, 2013). For Asset Recovery, the human component of the Air Power system encapsulates any RAAF, ADF, or allied personnel operating within the Air Power system, or an existing or potential source[14].

Material resources:
'Material' has been defined as "things needed for doing or making something" (Princeton University, 2013), with 'thing' described as "a material object without life or consciousness" (Macquarie Dictionary Online, 2013). The concept of 'resource' has been defined as "a source of supply, support, or aid" (Macquarie Dictionary Online, 2013). For the current analysis, 'material resources' will refer to any object which is devoid of life/consciousness and contributes to Air Power capability (e.g., weapons, air bases, aircraft).

Locations:
The term 'location' is defined as a "place or situation occupied" (Macquarie Dictionary Online, 2013). For the current analysis, the concept of 'location' will refer to specific geographical positions, such as towns or cities that are occupied by specified assets.

Rationale and supporting documentation:

- Asset Recovery is a purpose-related function of the Air Power system. The Air Power system must be capable of recovering human and material resources from specified locations for its functional purpose to be achieved. Specifically, this function enables the Air Power system to preserve its operational capability by retrieving valuable resources from designated locations.
  - "The recovery of personnel is an important mechanism for the preservation of capability…" (Australian Defence Force, 2006a, Chapter 1, p. 2).
  - "Personnel are the most important and valuable resource for the Air Force" (United States Air Force, 2012, p. 14).
  - "Skilled individuals represent a considerable training investment that cannot be replaced quickly" (United Kingdom Ministry of Defence, 2003, Chapter 1, p. 1).
  - "…of concern is the loss of key items of equipment. Certain equipment is rare and/or sensitive and its loss may potentially greatly reduce operational effectiveness. Should the tactical situation allow, there will be occasions when, as well as personnel needing

[14] A 'source' refers to a person from whom information can be obtained for intelligence purposes (informed by Department of Defence, Version 6.2.0, NATO definition). Within the current analysis, for example, a source may be a foreign national in the employ of an intelligence activity or a combatant that has been captured by friendly forces.

recovery, there will be a requirement to recover high value or sensitive equipment" (United Kingdom Ministry of Defence, 2003, Chapter 1, p. 1).

- "There will be occasions, particularly during a withdrawal, when a lack of resources will preclude the repair and recovery of equipment, or the backloading of excess stocks in time to prevent such materiel falling into enemy hands" (Australian Defence Force, 2004b, Chapter 4, p. 17).

- Raw data derived from Australian and allied Defence publications suggest that the purpose-related function of Asset Recovery encapsulates those terms which broadly denote planned extrication of human and material resources from areas in which military activities are conducted. Specifically, when terms like 'extract', 'withdraw', and 'exfiltrate', are referred to in an Air Power context, the recovery capacity of the Air Power system is ultimately reflected.

  - "Military aircraft are designed specifically for operating on basic airfields to…extract cargo and personnel in high threat or administrative environments" (Australian Defence Force, 2006c, Chapter 4, p. 13).

  - "SOF [special operations forces] employ close combat tactics and techniques when the mission requires precise or discriminate use of force or the recovery or capture of personnel or materiel" (United States Joint Defense Services, 2011, Chapter 2, p. 6).

  - "SOF employ sophisticated communications systems and special means of…exfiltration to…return from hostile, denied, or politically sensitive areas" (United States Joint Defense Services, 2011, Chapter 1, p. 2).

  - "Normally limited in scope and duration, DA [direct action] usually incorporates an immediate withdrawal from the planned objective area" (United States Joint Defense Services, 2011, Chapter 2, p. 6).

  The above statements provide context for how Asset Recovery is captured within Defence publications. Although these terms are distinct from a definitional perspective, they can all be captured under the umbrella term of 'recovery' (see definitions above). That is, they all refer to the ability to extricate resources from operational areas in which military activities are conducted.

- For the current analysis, the Air Power system must have the capacity to recover human and material resources in anticipation of, or in response to, a range of situations or events.

  - "…public perception of what is the national interest can quickly change. Such influences can result in the withdrawal of a country's troops…" (Australian Defence Force, 2009b, Chapter 4, p. 6).

  - "After completion of or a change in operational requirements, forces recover and reconstitute to restore combat capability before redeployment" (Australian Defence Force, 2006c, Chapter 7, p. 4).

  As alluded to in the statements above, the recovery of resources may be required for the accomplishment of various goals/missions. This includes, but is not limited to, goals concerned with extricating resources for the purposes of: upholding public opinion; concentrating forces in other areas; avoiding further losses of human or material resources; or restoring health, well-being, or function.

- Due to the nature of modern military operations, human and material resources will often require recovery from areas under hostile control. Such operations involve a degree of risk, not only to the resources being extricated, but to those assets involved in the recovery function. In

order to uphold required safety and efficiency standards, the Air Power system must ensure that the recovery of specific resources does not expose recovery assets to unwarranted danger.

- "Recovery and repair crews may require dedicated protection when working in exposed locations" (Australian Defence Force, 2006b, Chapter 5, p. 12).
- "Extraction of the force may have to take place in contact with the enemy. Extraction planning must be detailed with sufficient reserves of firepower and lift assets to ensure success" (Australian Defence Force, 2004a, Chapter 2, p. 4).
- "Commanders should ensure that, while the recovery of key equipment is highly desirable, its recovery does not compromise the wider operational/tactical mission or place personnel at undue levels of risk" (United Kingdom Ministry of Defence, 2003, Chapter 4, p. 4).
- "Commanders must evaluate the risk of extracting materiel as compared to the impact of abandonment and replacement" (United States Joint Defense Services, 2006, Chapter 1, p. 17).

Additional definitions:

- *Abandoned:* "Having been deserted or left" (Oxford Dictionary Online, 2013).
- *Danger:* "The state of being vulnerable to injury, loss, or evil" (Collins Dictionary Online, 2013).
- *Disabled:* "Incapacitated in some way, especially by permanent injury" (Macquarie Dictionary Online, 2013).
- *Exfiltration:* "The removal of personnel or units from areas under hostile control" (Department of Defence, Version 6.2.0, NATO definition).
- *Extraction:* "The withdrawal of forces from an area of operations" (Australian Defence Force, 2004a, Chapter 2, p. 2).
- *High value:* Likely to be required for the completion of a specified mission (informed by definition of 'high value target' from Department of Defence, Version 6.2.0, Army definition).
- *Military activity:* An action or collection of actions required for the completion of a military commander's objectives (informed by definition of 'activity' from Department of Defence, Version 6.2.0, US Joint definition).
- *Operation:* "A designated military activity using lethal and/or non-lethal ways and means to achieve directed outcomes in accordance with national legal obligations and constraints" (Department of Defence, Version 6.2.0, ADF Joint definition).
- *Risk:* "The possibilities of adverse outcomes, usually by way of deliberate actions, unforeseen environmental factors, miscalculation or other human error" (Department of Defence, Version 6.2.0, DMO definition).
- *Sensitive:* "Requiring special protection from disclosure that could cause embarrassment, compromise, or threat to the security of the sponsoring power. May be applied to an agency, installation, person, position, document, material, or activity" (Department of Defence, Version 6.2.0, US Joint definition).
- *Withdraw:* "To disengage and move away from a hostile element" (Department of Defence, Version 6.2.0, Army definition).

VIP TRANSPORT

Definition of VIP Transport:

'VIP Transport' is defined as the ability of the Air Power system to carry VIPs to domestic or international destinations in a secure and comfortable environment.

Carry:
The term 'carry' is defined as to "support and move (someone or something) from one place to another" (Oxford Dictionary Online, 2013). Within the current context, the concept of 'carry' refers to the ability to support and move VIPs (very important persons) to specified destinations in a secure and comfortable environment. Special purpose aircraft—such as the 737 Boeing Business Jet (BBJ) and CL-604 Challenger aircraft—are currently utilised to achieve this function.

VIPs:
The term 'VIP' or 'very important person' is generally used to describe "a high official with special privileges" (Merriam-Webster Dictionary Online, 2013). For the current analysis, 'VIPs' are inclusive of, but not limited to: members of the Royal family; members of the Commonwealth Parliament; Governors of Australian States; the Chief of the Defence Force, Vice Chief of the Defence Force, Service Chiefs; and people of comparable status to other entitled persons, who are formally representing their nation whilst visiting Australia (Department of Defence, 2007, p. 1-2).

Secure:
'Secure' has been described as "free from danger, damage, etc." (Collins Dictionary Online, 2013) and "affording safety" (Merriam-Webster Dictionary Online, 2013). For the purposes of the current analysis, the Air Power system must have the capacity to ensure that VIPs are not exposed to any undue danger whilst travelling between destinations. This may be achieved by implementing appropriate protection measures against those dangerous entities or phenomena originating outside of the Air Power system's control (e.g., enemy fighter jets, adverse weather conditions) and those dangerous entities or phenomena originating within the Air Power system (e.g., aircrew errors, system/component faults).

Comfortable:
The Oxford Dictionary Online (2013) defines the term 'comfortable' as "providing physical ease and relaxation". The Air Power system must be able to provide transport vehicles that afford comfort commensurate with the status of a VIP.

Environment:
The term 'environment' is described as "the surroundings or conditions in which a person, animal, or plant lives or operates" (Oxford Dictionary Online, 2013). In the context of the current analysis, the concept of 'environment' refers to those surroundings or conditions to which VIPs are exposed when travelling to domestic or international destinations. This is inclusive of the air and land domains in which transport assets operate and, more specifically, includes the internal surroundings or conditions of the transport asset (e.g., Challenger CL-604 aircraft).

Rationale and supporting documentation:

- To satisfy the functional purpose of Air Power, the Air Power system must have the capacity to carry VIPs to specified domestic or international destinations. This function enables resident and foreign dignitaries to meet commitments associated with their official, parliamentary, or political responsibilities.

    - "No. 34 Squadron provides a professional air transport capability to the Australian Government, Governor General, visiting heads of state and dignitaries. It is proud of its role in allowing Australia to take its place on the world stage, as well as connecting the people

of Australia with their politicians, leaders, and visiting dignitaries" (Royal Australian Air Force, 2012c).

- "In the past 12 months alone, No. 34 Squadron has supported such high-profile initiatives as the 2011 Federal Election, 2011 Royal Tour by Her Majesty Queen Elizabeth II (whose first flight with No. 34 Squadron was in 1963), and 2011 Royal Tour by His Royal Highness Prince William Duke of Cambridge, and Frederick, Crown Prince of Denmark, with Mary, Crown Princess of Denmark. No. 34 Squadron was also a critical element to the 2011 visit to Australia by President of the United States Barack Obama whilst on the ground at Defence Establishment Fairbairn" (Royal Australian Air Force, 2012c).

- "Special airlift missions (SAM) move senior federal government leaders around the world to meet their requirements" (United States Air Force, 2011a, p. 30).

➢ To better understand the concept of VIP Transport, the fundamental aspects relating to this purpose-related function were explored through raw data analysis. From this process, it was first determined that in order to carry VIPs in a level of comfort accordant with their status, the Air Power system must have specially allocated aircraft, fitted with the facilities required for VIPs to perform their duties and to attain necessary rest.

- "The RAAF's current VIP aircraft are two leased Boeing Business Jets and three Bombardier Challengers which are operated by No. 34 Squadron RAAF and are based at Canberra International Airport. The Boeing Business Jets are custom configured Boeing 737-700s fitted with facilities such as conference tables, offices suites, secure satellite and communication capabilities" (Wikipedia, 2014).

- "Special airlift missions normally use specially configured aircraft with extensive air-to-ground communications…" (United States Air Force, 2011a, p. 37).

Special purpose aircraft (i.e., 737 BBJ and CL-604 Challenger) are specially designed, built, and used for the purpose of transporting VIPs. These aircraft are fitted to satisfy the unique operational requirements necessary to convey VIPs in a comfortable environment.

➢ In order to reach specified domestic and international destinations, the specially fitted aircraft referred to above must also have a sound capacity for range and endurance once airborne. Specifically, the Air Power system must be capable of flying long distances from various bases, at home and abroad, with or without the use of air-to-air refuelling (AAR) support.

- "The BBJ combines the fuselage of the Boeing 737-700 aircraft with a strengthened aft section, and the centre-section, wing and landing gear of the 737-800 aircraft. Winglets are standard, affording 5 to 7 per cent reduction in cruise drag, resulting in 4 to 5 per cent increase in range" (Royal Australian Air Force, 2012a).

- "The CL-604 Challenger is a derivative of the Challenger 600, which has been progressively updated to improve range, performance and reliability" (Royal Australian Air Force, 2012b).

➢ An additional aspect of the current purpose-related function concerns conveying VIPs to designated locations in a secure travel environment. Specifically, the Air Power system must have the capacity to transport VIPs in a safe manner, whenever and wherever tasked to do so, by reducing the associated risk emanating from external sources to an acceptable level. This is achieved by special preparation of aircraft and the provision of additional security requirements, both on the ground and in the air.

- "Officers authorising flights by RAAF aircraft are to ensure that passengers are not carried on flights of a hazardous nature, unless such carriage is required for a specific RAAF purpose. Factors such as the purpose of the flight, the weather, the experience and

competence of the crew and, if appropriate, the type of crew training sequences to be practised during the flight, are to be considered before the carriage of passengers is authorised" (Department of Defence, 1997, p. 1).

- "Friendly aircraft en route to or from a target area may be assigned escort aircraft to protect them from enemy air-to-air and surface-to-air threats" (United States Air Force, 2011b, p. 20).

- "Active protection for an HVAA [high value airborne asset] normally is performed by fighter escorts, a fighter CAP [combat air control] between the HVAA and all potential air-to-air threats, or surface-based AD [air defence] systems between the HVAA and the enemy" (United States Joint Defense Services, 2012a, Chapter 3, p. 21).

As posited in the above statements, if tasked to operate in less than benign air environments, VIP transport aircraft must rely upon other Air Power platforms and systems to provide adequate protection against intent-driven threats (e.g., combat aircraft). This is due to the fact that VIP transport aircraft do not usually carry lethal weaponry or electronic warfare self-protection (EWSP) systems. Ensuring the security of VIPs from a range of external and internal dangers will be required and will often require forward planning (e.g., monitoring weather conditions, ensuring staff competence through appropriate certification, regular maintenance activities).

- Interconnected with the concept of VIP Transport is the notion of cost-effectiveness. Specifically, in order to achieve the functional purpose of the Air Power system, the conveyance of VIPs to designated locations must be conducted in the most cost-conscious manner by considering the most efficient means of achieving the required conveyance.

  - "When considering the use of Special Purpose Aircraft, the first consideration is the availability and suitability of commercially available travel. In circumstances where commercial alternatives are readily available, the Special Purpose Aircraft are not used in order to reduce the costs to taxpayers" (Royal Australian Air Force, 2012d).

  - "In most cases, the aircraft will remain overnight with the VIP to reduce costs, but there may be circumstances where this is not possible or desirable. This may be due to aircraft maintenance requirements, lack of aircraft parking availability, lack of appropriate security, or a requirement to undertake other tasks or essential aircrew training" (Royal Australian Air Force, 2012d).

  These statements suggest that the Air Power system will only perform the function of VIP Transport when other travel alternatives for VIP conveyance (e.g., commercial flights) are not suitable, due to location, timing, or security considerations. VIP Transport capability is expensive, and as such, in order to fulfil its functional purpose, the Air Power system must respect its economic obligations by considering the most efficient means for achieving the task required. Within the current context, this is achieved by considering the use of commercial air travel where appropriate, reducing unnecessary flight time where possible (e.g., leaving aircraft at the VIPs destination until the return flight is required), and using the most efficient aircraft for a particular task (e.g., the BBJ for long distance travel or large groups, the Challenger CL-604 for shorter tasks requiring landing in small airfields).

Additional definitions:

- *Air-to-air refuelling (AAR):* "The process of transferring fuel from one aircraft (the tanker) to another (the receiver) during flight" (Wikipedia, 2013).

- *Dignitary:* "Someone who holds a high rank or office, especially in a government" (Macquarie Dictionary Online, 2013).

- *Electronic warfare self-protection (EWSP):* "Protects platforms using sensors and countermeasures to detect, identify, destroy or evade specific threats. EWSP systems may be either manually or automatically initiated and are reliant on current technical databases containing accurate threat system information" (Australian Defence Force, 2013, Chapter 2, p. 12).

- *Endurance:* "The time an aircraft can continue flying, or a ground vehicle or ship can continue operating, under specified conditions" (Department of Defence, Version 6.2.0, Navy definition).

- *External:* "Coming or derived from a source outside the subject affected" (Oxford Dictionary Online, 2013).

- *Intent:* "Something that is intended; aim; purpose; design" (Collins Dictionary Online, 2013).

- *Lethal weapon:* An object that can be used to cause permanent damage to personnel, material, and capabilities (informed by definitions of 'lethal' and 'weapon' from Collins Dictionary Online, 2013; Department of Defence, Version 6.2.0, NATO definition).

- *Range:* "The distance between any given point and an object or target" (Department of Defence, Version 6.2.0, NATO definition).

- *Special purpose aircraft:* "An aircraft permanently or temporarily designated for the express purpose of carrying VIPs" (Department of Defence, 2001b, p. 1).

AIR-TO-AIR REFUELLING

Definition of Air-to-Air Refuelling:

'Air-to-Air Refuelling' is defined as the ability of the Air Power system to supply additional fuel to airborne aircraft. This function enables the Air Power system to extend its influence over large distances so that its endurance is limited only by aircrew fatigue and engineering factors.

Supply:
The term 'supply' has been described as to "make (something needed or wanted) available to someone" (Oxford Dictionary Online, 2013).

Fuel:
The term 'fuel' is defined as "any substance burned as a source of heat or power, such as coal or petrol" (Collins Dictionary Online, 2013).

Airborne aircraft:
'Airborne' is defined as "the state of an aircraft the instant it becomes entirely sustained by air until it ceases to be so sustained" (Department of Defence, Version 6.2.0, NATO definition), with 'aircraft' defined as "any machine supported for flight in the air by buoyancy (such as balloons and other lighter-than-air craft) or by dynamic action of air on its surfaces (such as aeroplanes, helicopters, gliders, and other heavier-than-air craft)" (Macquarie Dictionary Online, 2013). Based on the above definitions and the current context, 'airborne aircraft' will refer to powered fixed-wing and rotary-wing aircraft hovering or moving within the air domain.

Rationale and supporting documentation:

- To satisfy the functional purpose of Air Power, the Air Power system must have the capacity to supply additional fuel to airborne aircraft. This function facilitates the performance of long-range missions and significantly expands the options available to a commander by increasing the payload and endurance capability of aircraft.

  - "The objective of AAR operations is to enhance combat effectiveness by extending the range, payload or endurance of receiver aircraft" (North Atlantic Treaty Organization, 2010, Part 1, Chapter 1, p. 2).

  - "It [aerial refueling] significantly expands deployment, employment, and redeployment options available by increasing the range, payload, and flexibility of air forces. AR [aerial refueling] is an essential capability in conducting air operations worldwide and is especially important when overseas basing is limited or not available" (United States Joint Defense Services, 2013, Chapter 1, p. 4).

  As these statements attest, the supply of additional fuel to airborne aircraft can play a pivotal role in achieving overall operational success. The function of Air-to-Air Refuelling permits missions at extended distances and of increased duration to be performed on a global basis. Furthermore, by offsetting fuel against payload for take-off, the load capacity of Air Power aircraft can be increased, which in turn improves operational efficiency by enabling the conduct of multiple consecutive missions.

- It is important to highlight that increased range and endurance capabilities cannot be perpetually maintained by the function of Air-to-Air Refuelling. The physiological requirements of personnel (e.g., sleep) together with the engineering factors of refuelling aircraft (e.g., oil consumption) will limit the amount of time that aircraft can safely remain in the air.

- "…by eliminating en route stops, AAR ensures maximum availability of air assets through reducing the potential for maintenance and servicing problems associated with shutting down and restarting engines, and cycling of landing gear; however, this is offset by an increased crew duty day" (Canadian Department of National Defence, 2011, Chapter 2, p. 31).

- "To reduce vulnerability to performance impairing fatigue it is recommended that duty periods should not exceed 15 hours within a 24 hour period" (Australian Defence Force, 2009a, Chapter 7, Annex G, p. 6).

- "The aim of limiting crew duty periods is to ensure that flying safety is not compromised by aircrew operating aircraft when excessively fatigued" (Department of Defence, 2001a, p. 1).

- "Air power has a significant degree of relative impermanence. Air platforms cannot stay airborne indefinitely, nor can they hold ground in the conventional sense…. Although technological developments are improving the ability to mitigate impermanence through AAR and long endurance UAS [unmanned aerial system], aircraft must still return to a base to be serviced and re-armed" (Royal Australian Air Force, in press, p. 148).

- "While air-to-air refuelling can greatly extend the range and endurance of aircraft, no means has yet been found to rearm, re-crew or service an aircraft in flight" (Royal Australian Air Force, 2002, p. 127).

➢ Air-to-Air Refuelling, as a function, captures those capabilities which relate to the conveyance of consumable sources of power (i.e., fuel) between airborne platforms. As such, physical contact between supplying aircraft (i.e., KC-30A multi-role tanker transport) and receiving aircraft (e.g., F/A-18F Super Hornet) must be established and maintained. In order to achieve this function, the Air Power system's airborne platforms (i.e., aircraft) must be capable of moving at a stable, specified speed and altitude, along a designated flight path.

- "During refuelling, the formation lead must fly precise airspeeds, altitudes and heading in order to maintain a stable platform for aircraft in the formation" (North Atlantic Treaty Organization, 2010, Part 2, Chapter 2, Annex A, p. 8).

- "To complete a safe join, the receiver should achieve a stable formation position (ie zero rate of closure) on the tanker…" (North Atlantic Treaty Organization, 2010, Part 2, Chapter 4, p. 1).

- "Ideally, all contacts and disconnects should occur in straight and level flight…" (North Atlantic Treaty Organization, 2010, Part 2, Chapter 4, p. 2).

- "Most intratheater AR is conducted in airspace specifically designated for AR. For peacetime operations, AR airspace is published in flight information publications with boundaries, altitudes, and communications frequencies agreed to by the ATC [air traffic control] authorities….Routing to and from the AR airspace will also change in response to changes in air operations and adversary threats to friendly forces" (United States Joint Defense Services, 2013, Chapter 5, p. 9).

In line with the statements above, the Air Power system must be capable of regulating the movements of its airborne platforms in line with prescribed procedures. Moving in a stable, regulated manner increases the efficiency of fuel transfer and will lower the risk of collision. In addition to regulating aircraft movement, the Air Power system must have access to aircraft that have been equipped with conduits and connections capable of transferring fuel during flight.

- To achieve the purpose-related function of Air-to-Air Refuelling, electrical contact must be established and maintained between airborne aircraft tasked with supplying and receiving fuel. This function enables aircraft to congregate in designated airspace and to synchronise the execution of refuelling procedures. The Air Power system's communications systems and navigational aids are predominantly used to achieve these functions.

  - "The primary task of an AAR tanker is to be in the right place at the right time with sufficient fuel to meet the task….Making an effective rendezvous requires specialist communications and navigation equipment in both tanker and receiver" (Teager, 1995, p. 14).

  - "AR operations are highly dependent on both air-to-air and air-to-ground communications. Throughout AR operations, tankers must be able to communicate with their receivers, AWACS [airborne warning and control system] controllers, local ATC, and other tankers in formation and maintain at least a listening watch on designated high frequency channels" (United States Joint Defense Services, 2013, Chapter 5, p. 9).

  - "Communications capability between tanker and receiver will be maintained during the entire refuelling operation" (North Atlantic Treaty Organization, 2010, Part 3, Chapter 5, p. 1).

- The purpose-related function of Air-to-Air Refuelling requires compatibility in terms of equipment, airborne procedures, and aircraft performance. This compatibility may be a requirement for Australian participation in coalition operations.

  - "It is essential that aircraft requiring AAR are fitted with probes/receptacles and fuel systems compatible with the characteristics of the tanker aircraft employed, eg drogue/boom system, fuel surge pressures, fuel type etc." (North Atlantic Treaty Organization, 2010, Part 1, Chapter 1, p. 2).

  - "It is essential for tanker and receiver aircraft performance to be compatible in terms of AAR speeds and altitudes" (North Atlantic Treaty Organization, 2010, Part 1, Chapter 1, p. 2).

  - "It is essential for tankers and receivers to employ pre-planned and compatible procedures for rendezvous, making contact, fuel transfer and departure" (North Atlantic Treaty Organization, 2010, Part 1, Chapter 1, p. 2).

  These statements emphasise the importance of having consistent equipment, procedures, and performance capabilities between supplying/tanker and receiving aircraft in order to achieve operational efficiency. Though not explicitly stated, the Air Power system's airborne platforms must be compatible with those of other domestic and international Services in order to allow joint, allied, and coalition operations to be performed as required.

- An additional aspect of Air-to-Air Refuelling is concerned with force protection. Through the capacity to increase the range of aircraft via refuelling during flight, the Air Power system gains the ability to contribute to force protection requirements by distancing airborne platforms from potential threats.

  - "Positioning forces outside the adversary's reach permits a greater portion of combat assets to concentrate on offensive rather than defensive action. As a result of the reduced need to forward-deploy forces, AR reduces force protection requirements as well" (United States Joint Defense Services, 2013, Chapter 5, p. 1).

  - "Theater-based AR assets bolster the security of combat and combat support air assets by allowing them to be based beyond the range of adversary threats" (United States Joint Defense Services, 2013, Chapter 5, p. 5).

- "AR can mitigate operational risk for strike or support aircraft by decreasing reliance on…forward basing locations" (United States Joint Defense Services, 2013, Chapter 5, p. 5).

- Conversely, the function of Air-to-Air Refuelling also has the capacity to introduce considerable risk to human and material resources, thus jeopardising the completion of missions and achievement of goals.

  - "Because operations enabled by AAR may involve aircraft operating at ranges from which they cannot return to base unaided, use of AAR has the potential to introduce a point of vulnerability to the mission" (Royal Australian Air Force, 2007a, p. 132-133).

  - "…the use of AAR provides a vulnerable point of failure (the tanker) because if the enemy shoots down the tanker, the entire strike package could be lost" (Royal Australian Air Force, 2002, p. 135).

  As demonstrated in the above statements, supplying additional fuel to airborne aircraft has the ability to introduce significant risk to a mission. This vulnerability results from the Air Power system's reliance on the function of Air-to-Air Refuelling to achieve its goals, thus marking refuelling assets as high value targets. As such, dedicated force protection elements will often be required to cover refuelling activities.

Additional definitions:

- *Aircrew:* "A person whose airborne role in an aircraft is an integral part of that aircraft's operation and is necessary for the unit operating the aircraft to fulfil its designated role. For example, a pilot, a navigator, a fighter controller, a flight test engineer, an airborne electronics officer or an airborne electronic analyst, a flight engineer, a flight test system specialist, a loadmaster, and a crew attendant" (Department of Defence, 2004, p. 1).

- *Air domain:* The earth's atmosphere, which begins at the earth's surface and extends to the altitude where atmospheric effects (e.g., absorption of ultraviolet solar radiation, heat retention, and reduction of diurnal temperature extremes) become negligible (informed by Department of Defence, Version 6.2.0, US Joint definition; and definition of 'atmosphere' from Wikipedia, 2013).

- *Airspace:* "The zone next to the earth consisting of atmosphere capable of sustaining flight" (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Fatigue:* "Fatigue is the state of feeling tired, weary, or sleepy that results from prolonged periods awake, loss of normal sleep, mental or physical work, extended periods of anxiety and exposure to harsh environments. Generally, fatigue causes deterioration in mood, decreased powers of judgment and reasoning, and slow and inaccurate performance" (Australian Defence Force, 2009a, Chapter 7, Annex G, p. 1).

- *Flight path:* "The line connecting the successive positions occupied, or to be occupied, by an aircraft, missile, or space vehicle as it moves through air or space" (Department of Defence, Version 6.2.0, NATO definition).

- *Force protection:* "All measures and means to reduce the vulnerability of personnel, facilities, equipment and operations to any threat and in all situations, to preserve the freedom of actions and the operational effectiveness of the force" (Royal Australian Air Force, 2007a, p. 134).

- *High value target:* "Assets which are likely to be required for the completion of the enemy commander's mission" (Department of Defence, Version 6.2.0, Army definition).

- *Hovering:* “A self-sustaining manoeuvre whereby a fixed, or nearly fixed, position is maintained relative to a spot on the surface of the earth or underwater” (Department of Defence, Version 6.2.0, NATO definition).

- *Move: “*To go or pass to another place or in a certain direction with a continuous motion” (Merriam-Webster Dictionary Online, 2013).

- *Powered aircraft:* Those aircraft that use “onboard propulsion with mechanical power generated by an engine of some kind” (Wikipedia, 2013).

PEOPLE RESCUE

Definition of People Rescue:

People Rescue is defined as the ability of the Air Power system to retrieve people and personal property from a threatened place, disaster area, or inhospitable environment and deliver them to a place of refuge. Specifically, the Air Power system must have the capacity to contribute to the rescue of people whose lives or health are at risk due to the effects of real or threatened occurrences or inadequate treatment resources.

Retrieve:
The concept of 'retrieve has been described as to "extricate from trouble or danger; rescue or save" (Collins Dictionary Online, 2014).

People:
The Oxford Dictionary Online (2013) defines 'people' as "human beings in general or considered collectively". As such, the concept of 'people' encompasses individuals—whether man, woman, or child—or to groups of people unified by different attributes. Within the current analysis the concept of 'people' will be constrained to Australian nationals and approved foreign nationals (AFN).

Personal property:
The term 'personal' has been described as "of or relating to the private aspects of a person's life" (Collins Dictionary Online, 2013), with 'property' defined as "anything that may be owned" (Department of Defence, Version 6.2.0, US Joint definition). For the purposes of the current analysis, the concept of 'personal property' will refer to tangible and portable possessions belonging to people (e.g., clothing) that do not pose a threat to security (e.g., weapons, explosives). It is important to note that limits are imposed on the amount of personal property that will be evacuated during rescue activities. In addition, pets and livestock will not be rescued by ADF assets (Australian Defence Force, 2011, Chapter 5, p. 4).

Threatened place:
The term 'threatened' is defined as "in danger or under threat", with 'danger' described as "the state of being vulnerable to injury, loss, or evil" (Collins Dictionary Online, 2013), and 'threat' defined as "a person or thing likely to cause damage or danger" (Oxford Dictionary Online, 2013). The concept of 'place' is defined as "a geographical point, such as a town, city, etc." (Collins Dictionary Online, 2013). Based on the above definitions, the concept of a 'threatened place' will refer to a specified geographical position endangered by: an event or intention with the ability to adversely affect the safety and wellbeing of people, the natural environment, material, or infrastructure. A place may be threatened by an act of nature (e.g., flooding, drought, cyclone, earthquake, volcanic eruption, disease epidemic) or an act of man (e.g., riots, civil unrest, war, terrorism).

Disaster area:
The concept of 'disaster area' is described as "an area so nominated in which there is a breakdown of communications, supplies and services, as a result of some catastrophe" (Macquarie Dictionary Online, 2013) and "an area officially declared to be the scene of an emergency created by a disaster and therefore qualified to receive certain types of governmental aid (as emergency loans and relief supplies)" (Merriam-Webster Dictionary Online, 2013). For the current analysis, a 'disaster area' will refer to a region whose population has been affected by an event causing damage, death, destruction, and a breakdown of essential public services (e.g., communications, transport, water, gas, electricity, medical care).

Inhospitable environment:
The term 'inhospitable' has been defined as "providing no shelter or sustenance" (Merriam-Webster Dictionary Online, 2014), with 'sustenance' described as a "means of sustaining health or life" (Collins Dictionary Online, 2014). The concept of 'environment' has been defined as "the

surroundings or conditions in which a person, animal or plant lives or operates" (Oxford Dictionary Online, 2013). For the purposes of the current analysis, the concept of 'inhospitable environment' will refer to surroundings or conditions which are void of the resources required to maintain a person's health (e.g., adequate housing, medical facilities and supplies, clean water).

Deliver:
The term 'deliver' is described as "to carry (goods, etc.) to a destination, esp [especially] to carry and distribute (goods, mail, etc.) to several places" (Collins Dictionary Online, 2013). For the purposes of the current analysis, the concept of 'deliver' encompasses the capacity to support and move people from one location to another based on the requirements of the people being transported (e.g., medical facilities, food supplies).

Place of refuge:
The term 'place' has been defined as "a geographical point, such as a town, city, etc." (Collins Dictionary Online, 2014), with 'refuge' described as "a safe place" and "something or someone turned to for assistance or security" (Princeton University, 2014). Based on these definitions, within the current context, the concept of 'place of refuge' will refer to specified geographic locations that offer protection, shelter, or aid to people whose lives or health are in jeopardy.

Treatment resources:
The term 'treatment' has been defined as "the application of medicines, surgery, psychotherapy, etc, to a patient or to a disease or symptom (Collins Dictionary Online, 2014), with 'resource' described as "a source of supply, support, or aid" (Macquarie Dictionary Online, 2013). For the current analysis, the concept of 'treatment resources' will encompass medical supplies and equipment (e.g., medicines, surgical equipment, dressings, medical imaging machinery), medical personnel (e.g., surgeons, nurses, radiographers, psychiatrists), and medical facilities (e.g., hospitals, surgical theatres, rehabilitation centres, psychiatric wards).

Rationale and Supporting Documentation:

- To satisfy the functional purpose of Air Power, the Air Power system must have the ability to retrieve people and personal property from a threatened place, disaster area, or inhospitable environment and deliver them to a place of refuge. Specifically, the Air Power system must have the capacity to contribute to the rescue of people whose lives or health are jeopardised due to the effects of real or threatened occurrences or inadequate treatment resources. This function is necessary to save human life and to restore or maintain a person's well-being and health when the resources of authorities discharged to protect Australian nationals and AFNs are insufficient. By contributing to rescue of Australian nationals and AFNs, Defence's commitment to being a "force for good" is solidified (Department of Defence, 2002, p.1). This capacity plays a role in retaining internal and external support for the RAAF by demonstrating respect for human life.

    - "Where the scale of the emergency or disaster exceeds or exhausts the response capacity and capabilities (government, community and/or commercial) of the State or Territory or where resources cannot be mobilised in sufficient time, they may seek Commonwealth assistance, including from Defence" (Department of Defence, 2012, Chapter 1, p. 1).

    - "The Commonwealth will use the ADF for DFACA [defence force aid to the civil community] only when all civilian authority response options have been exhausted or when the situation can most appropriately be resolved by the use of military force or by military units" (Department of Defence, 2010, p. 1).

    - "Aeromedical evacuation is used to transport ill or injured personnel by air under medical supervision to appropriate medical treatment facilities….The Air Force's AME [aeromedical evacuation] capability can also be used to augment national medical emergency assets,

especially where responsiveness, reach and capacity are critical" (Royal Australian Air Force, 2007a, p. 133).

It is important to highlight that the ADF and RAAF do not explicitly develop capabilities for issues relating to the rescue of people that are primarily the responsibility of other government agencies or international bodies. For example, the Department of Foreign Affairs and Trade (DFAT) is the principle body responsible for evacuating Australian nationals and AFNs from foreign countries when their lives are endangered by war, civil unrest, or natural disaster. In such situations, the ADF and RAAF support, rather than supplant these authorities (Australian Defence Force, 2011, Chapter 1, p. 1-2), when necessary.

- The Australian Government, and by extension the ADF and RAAF, are morally and legally obligated to ensure the safety and well-being of all Australian nationals and AFNs when contributing to People Rescue, whether at home or abroad.

  - "A government's first duty is to provide for the security and wellbeing of its citizens" (Royal Australian Navy, 2010, p. 39).

  - "Australian citizens overseas may be afforded protection from persecution or danger to life or safety" (Royal Australian Air Force, 2004, p. 26).

  - "International law provides that every state shall render assistance to any person who is found at sea and is in danger of being lost, and to any persons in distress, if informed of their need for assistance" (Royal Australian Air Force, 2004, p. 27).

  - "Search and rescue of the civilian population in an emergency is carried out as a humanitarian and legal obligation…" (United States Joint Defense Services, 2007b, Appendix A, p. 1).

  Though not explicitly stated in the above statements, friendly diplomatic mission arrangements and common interests are likely to lead to Australia accepting responsibility for the rescue of foreign nationals in certain situations. In such circumstances, the Australian Government, ADF, and RAAF will become ethically responsible for the safety and well-being of all AFNs. The ways in which these obligations to protect Australian nationals and AFNs can be met will be constrained by domestic and international law, together with regional political considerations.

  - "Political considerations will influence the nature and extent of ADF participation. The ADF may simply assist with the relatively orderly evacuation of Australians and AFN, or it may be required to mount a military operation, possibly without the sanction of the local government" (Australian Defence Force, 2011, Chapter 1, p. 2).

  - "Deployed forces, including elements providing CASEVAC [casualty evacuation], are always subject to international humanitarian law (IHL) and the law of armed conflict (LOAC) and may be subject to the laws of the host nation (HN). Health planners must consider the health implications of the IHL, LOAC, the status of forces agreement, the applicability of international human rights legislation, and HN laws" (Australian Defence Force, 2008, Chapter 3, p. 3).

- By virtue of the nature of the People Rescue function, certain rescue activities may take place in environments that are inherently dangerous. Such danger can emerge from a myriad of sources, be it hostile/enemy interactions, extreme weather (e.g., strong wind), or natural disasters (e.g., volcanic eruption). To militate against these potential dangers, assets contributing to People Rescue (e.g., fixed-wing aircraft, rotary-wing aircraft) must be protected by design, come under the protection of another system, or initiate procedures to avoid potential danger (e.g., varying operating altitude of an aircraft to avoid strong winds or volcanic ash).

- "…rescue helicopters and long-range rescue aircraft may be unarmed and therefore vulnerable to enemy attack. This is particularly important when downed aircrew have to be rescued from within enemy territory or near to enemy coasts in opposed CSAR [combat search and rescue] operations. In these circumstances it may be necessary to involve combat forces such as attack helicopters, fighter-bombers and SEAD [suppression of enemy air defences] to provide covering firepower for rescue aircraft" (Royal Australian Air Force, 2002, p. 211).

- "Aviation operations are also subjected to external influences, most particularly weather. Operations in extreme weather conditions can be debilitating and potentially even fatal to personnel" (Royal Australian Air Force, 2007b, p. 91).

It should be noted that People Rescue is not always conducted in dangerous environments nor does every situation requiring rescue constitute an emergency. For example, People Rescue encompasses air activities involving the transport of ill or injured people to or between appropriate medical facilities.

- The Air Power system will often be required to assist in the function of People Rescue at very short notice due to the unpredictability of threats to people's health and safety (e.g., natural disasters, terrorist attacks).

  - "Naval and air forces may therefore be required to engage in search and rescue operations at very long range and in extremely demanding conditions with little notice" (Royal Australian Navy, 2010, p. 113).

  - "Evacuation operations are characterized by uncertainty and may be directed without warning because of sudden changes in a country's government, reoriented diplomatic or military relationships…or a devastating natural or man-made disaster" (United States Joint Defense Services, 2007a, Chapter 1, p. 3).

- It is important to highlight that whilst it is a requirement to detect, monitor, locate, and identify threats and/or a distressed party before rescue can be initiated; these functions do not represent primary capabilities through which People Rescue is achieved. Instead detection, monitoring, localisation, and identification exist as distinct purpose-related functions that are topologically linked to People Rescue.

Additional definitions:

- *Approved foreign national (AFN):* "A person, who, by virtue of their nationality, is deemed eligible for evacuation by Australian forces" (Department of Defence, Version 6.2.0, ADF Joint definition).

- *Australian nationals:* People who are native to, naturalised, or resident in Australia, including military personnel who are classified as non-combatants (e.g., chaplains, medical personnel, casualties) (informed by definition of 'citizen' from Collins Dictionary Online, 2014).

- *Domestic law*: "Domestic or municipal law encompasses those internal laws that govern the behaviour of persons within a state and in some cases may affect nationals abroad. An Act of Parliament such as the *Defence Force Discipline Act* 1982 (DFDA) is an example of a domestic law that binds Australian Service personnel within Australia and abroad. International law can also become part of a state's domestic law; the Australian Parliament's ratification of the 1977 Protocols Additional to the Geneva Conventions of 1949 (Additional Protocols) being just one example. In the absence of specific legislation, international law can still be regarded as part of domestic law; although certain legal conditions are required" (Royal Australian Air Force, 2004, p. 2).

- *International law*: "Operations law is primarily a product of international law which is itself concerned with international law and order and security. While it defies precise definition, international law is equally applicable to individuals despite the fact that it governs relations between states. In international law the term 'states' refers to nations which are accepted as legitimate members of the international community" (Royal Australian Air Force, 2004, p. 1).

- *Natural disaster:* "An emergency situation posing significant danger to life and property that results from a natural cause" (Department of Defence, Version 6.2.0, US Joint definition).

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Appendix C: Glossary of Intelligence, Surveillance, and Reconnaissance Subsystem Purpose-related Functions

This appendix presents an unclassified version of the glossary developed for the purpose-related functions of the intelligence, surveillance, and reconnaissance subsystem of Air Power. Each function is defined in detail and is supported by a rationale and relevant documentation. It is important to highlight that supporting documentation has been sourced both from publications specific to the Australian context and from American, British, and Canadian contexts. Where supporting evidence from Australian publications has been excluded for classification purposes, equivalent evidence from public release allied Defence texts has been included.

THREAT DETECTION

Definition of Threat Detection:

'Threat Detection' is defined as the ability of the Air Power system to establish the presence of targets with the potential to inflict harm on friendly assets and/or the civilian population and its infrastructure.

Establish:
The Macquarie Dictionary Online (2012) defines the term 'establish' as "to show to be valid or well grounded; prove". The inclusion of the term 'establish' in the definition of Threat Detection is intended to highlight the importance of providing accurate and precise information when detecting potential threats. In order to meet these criteria the physical objects employed (e.g., airborne early warning and control aircraft, sensors) must be fully operational, along with support processes, enabling effective collection and dissemination of information.

Presence:
The concept of 'presence' is defined as "the state or fact of being present" (Macquarie Dictionary Online, 2012). In the context of the current analysis, 'presence' refers to the ability of the Air Power system to detect the general existence of a target of potential military significance. This capability is predominantly achieved through collection and dissemination processes enabled by airborne, space, surface, and sub-surface sensors (e.g., visual observation, electro-optical devices, airborne microwave radars), and operations conducted in the cyberspace domain; however communication capabilities, intelligence personnel, and other airborne assets also provide support in detecting potential threats.

Targets:
Within Defence, the term 'target' refers to "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" or "a country, area, installation, agency or person against which intelligence activities are directed" (Department of Defence, Version 6.1.1, NATO definition). Within the current context, the concept of 'target' includes, but is not limited to, independent persons and groups; military and non-military organisations, specifically friendly forces and adversaries; countries and specific geographic areas; environmental conditions; platforms (e.g., ships, submarines, aircraft); operating bases (e.g., air, maritime, land); and munitions (e.g., missiles, torpedoes).

Harm:
The concept of 'harm' is generally defined as "damaging something" or "the occurrence of a change for the worse" (Princeton University, 2012). Within a Defence context, 'harm' is described as "any negative consequence, such as compromise of, or damage to, or loss incurred by, the Commonwealth" (Department of Defence, Version 6.1.1, Intelligence and Security definition). In the context of the current analysis, examples of 'harm' may relate to loss of human life, compromise of friendly intelligence systems, or damage to aircraft and/or air bases. As such, the concept of 'harm' encompasses both damage and exploitation.

- Damage:
  The term 'damage' is described as "injury or harm that impairs value or usefulness" (Macquarie Dictionary Online, 2012). Within the context of the current analysis, the concept of 'damage' refers to the extent to which an entity is injured or harmed beyond its specific use for a permanent or temporary period of time. As such, damage can encapsulate permanent, destructive damage to an entire target or temporary damage to a target. Damage to assets may result from actions or events that physically alter an object or system, or alternatively, from actions or events that influence the emotions, motives, and reasoning of individuals, groups, organisations, and governments.

- Exploitation:
  Generally, the term 'exploit' has been defined as "to take advantage of (a person, situation, etc.), esp [especially] unethically or unjustly for one's own ends" (Collins Dictionary Online, 2012). The Department of Defence further defines the concept of 'exploit' as "to gain access to enemy command, control, communications, computers, intelligence, surveillance, target acquisition and reconnaissance systems, to collect information or to plant false or misleading information" (Version 6.1.1, Army definition) and "to take advantage of any information or weakness for military purposes" (Version 6.1.1, ADF Joint definition). Based on these definitions, civilians and military forces, together with their assets, may be targets of exploitation. For the current analysis, the term 'exploit' captures the ability to gain access to a target's assets and utilise these assets, or the information collected from them, to attain a desired end.

Friendly assets:
The term 'friendly' generally refers to assets which belong to, or are allied or partnered[15] with, one's own defence forces (informed by Macquarie Dictionary Online, 2012; United States Department of Defense, 2012), with 'assets' described as valuable or useful sources of supply, support, or aid (informed by Macquarie Dictionary Online, 2012; Royal Australian Air Force, 2007a, p. 114, 2007b, p. 36). Based on these definitions, the concept of 'friendly assets' encompasses all personnel, materiel, information, and facilities which belong to, or are allied with, the Australian Department of Defence.

- Personnel:
  The term 'personnel' is described as "those individuals required in either a military or civilian capacity to accomplish the assigned mission" (Department of Defence, Version 6.1.1, US Joint definition).

- Materiel:
  Within the current analysis, the term 'materiel' refers to all moveable major equipment (e.g., aircraft, vehicles, complex surveillance systems) and minor equipment (e.g., radios, hand-held weapons), together with expendable supplies and materials (e.g., fuel, ammunition, chaff, paint, cleaning and preserving materials, surgical dressings, medicines, spare parts) necessary to equip, operate, maintain, and support the entire range of military activities (informed by the Department of Defence, Version 6.1.1, ADF Joint definition; Royal Australian Air Force, 2007a, p. 39; United States Department of Defense, 2012). It is important to highlight that the concept of 'materiel' is confined to military equipment and supplies and does not include civilian objects.

- Information:
  The Royal Australian Air Force (2007b, p. 66) defines 'information' as "unprocessed data of every description which may be used in the production of intelligence". Within the context of the current analysis, the concept of 'information' can relate to a target's presence, location, classification, identity, capabilities/limitations, and intentions (informed by the Royal Australian Air Force, 2007a, 2007b).

- Facilities:
  'Facilities' refer to tangible and immovable property, owned by the Australian Department of Defence or its allies, including land, buildings, structures, and utilities systems, together with any equipment attached to and made part of buildings or structures (e.g., heating systems). Based on this definition, access roads, rail links, fencing, and training areas may be considered as 'facilities' (informed by definition of 'real property' from Department of Defence, Version 6.1.1, US Joint definition; Macquarie Dictionary Online, 2012).

[15] Within a defence context, the concept of 'partner' encompasses countries that are not traditional allies but who have some form of defence agreement (informed by definition of 'coalition' from Department of Defence, Version 6.2.0, ADF Joint definition).

Civilian population:
The International Committee of the Red Cross (1977) defines a 'civilian' as "any person who is not a member of the armed forces" (Article 50), with 'civilian population' comprising "all persons who are civilians" (Article 50).

Civilian infrastructure:
The concept of 'civilian infrastructure' can be defined as any fixed or permanent installations, fabrications, or facilities that are not used to achieve military objectives (informed by definition of 'infrastructure' from Department of Defence, Version 6.1.1, ADF Joint definition; Macquarie Dictionary Online, 2012; and 'civilian objects' from International Committee of the Red Cross, 1949, 1977). Within this context, the term 'military objectives' are those "objects which by their nature, location, purpose or use make an effective contribution to military action and whose total or partial destruction, capture or neutralization, in the circumstances ruling at the time, offers a definite military advantage" (International Committee of the Red Cross, 1977, Article 52). Examples of civilian infrastructure include hospitals, schools, and churches (on the condition that they are not used by forces for military purposes).

Rationale and supporting documentation:

- Threat Detection is a purpose-related function of the Air Power system because it must have the ability to establish the presence of targets with the potential to harm friendly assets and/or the civilian population and its infrastructure in order to achieve its functional purpose. Detecting the presence of targets with the ability to inflict harm enables the Air Power system to attain a warning of viable threats to Australia's national security. If acquired promptly, this knowledge enables the Air Power system to initiate preventative action, thereby avoiding strategic surprise and potentially gaining a competitive advantage.

  - "Australia has an enduring strategic interest in ensuring that any attempt by nearby states to develop the capacity for sustained military operations against us would be detected with as much warning time as possible" (Department of Defence, 2009, p. 28).

  - "We need to remain alert to developments in military capability in the region so that we get as much warning as possible of the emergence of strategic risks, as well as developments that might pose a significant challenge to ADF [Australian Defence Force] activities in particular areas" (Department of Defence, 2009, p. 39).

  - "Defence intelligence has a vital role in providing us with strategic warning. It gives decision makers time to think, plan and act before events occur. At the strategic level, indicators and warnings help provide the lead-time necessary to make longer term capability investments and to adjust plans. This helps to prevent strategic surprise" (Department of Defence, 2009, p. 102).

  As documented above, Australia has an "enduring strategic interest" in early detection of threats as a means of creating apposite defence capabilities and adjusting plans to meet current requirements. In the Defence White Paper, the concept of 'strategic interests' is described as those national interests that concern the structure and features of the international order that ensure security from armed attack—and in relation to which Australia might contemplate the use of force (Department of Defence, 2009, p. 41).

- Based on raw data analysis, it was determined that threats to Australia's national security exist in a variety of forms. Thus, the Air Power system must have the capacity to detect a range of threats emanating from a number of sources.

- "Threats to the security of Australia or its interests can appear at any point on a spectrum of conflict that extends from stable peace and dealing with natural disasters through to major armed conflict or war" (Royal Australian Air Force, 2007a, p. 39).

- "The security of our community, our nation's economy and the integrity of our environment can all be threatened by illegal activities (such as people smuggling, illegal fishing and the drug trade), by pandemic disease outbreaks and by quarantine breaches. Natural disasters such as cyclones, earthquakes, floods and bushfires can also threaten the security and safety of the Australian people" (Department of Defence, 2009, p. 24).

- "Over the next 15 years it is likely that even more attention will be paid to so-called non-military threats such as pandemics, illegal immigration, refugee flows, environmental degradation, narcotics and transnational crime" (Royal Australian Air Force, 2002, p. 67).

- "Cyber warfare has emerged as a serious threat to critical infrastructure, piracy has re-emerged as a threat to maritime security and space is being used by more nations for strategic purposes" (Department of Defence, 2009, p. 9).

- "The threat from state-based WMD [weapons of mass destruction] programs, and potential access to them by non-state groups, will remain serious security concerns for Australia" (Department of Defence, 2009, p. 101).

As the above statements demonstrate, the concept of 'threat' encompasses a wide range of events and actors across all spectra of conflict, from warfighting to humanitarian relief operations. For the purposes of the current analysis, threats may derive from state actors (e.g., hostile armed forces), non-state actors (e.g., terrorists, militias, insurgents), and environmental events (e.g., natural disasters, pandemic disease outbreaks). It is important to highlight that whilst the Air Power system must be capable of detecting threats emanating from environmental conditions, the main focus of Air Power's Threat Detection capability is the detection of adversaries, encompassing both state and non-state actors.

➢ In order to satisfy the requirements of Threat Detection as a purpose-related function, the Air Power system must be capable of effectively managing and utilising its assets, in addition to acting on operational environments, to make detection possible. To this end, the Air Power system must firstly have the requisite assets available for usage. Secondly, the Air Power system must have these assets positioned in areas with a high probability of sensing threats. Additionally, adversaries must be operating within the detection and discrimination threshold[16] capabilities of the Air Power system. Finally, in the event that adversaries are operating below the detection and discrimination thresholds of the Air Power system, the system must have the ability to raise the operation profile of adversaries in order to establish their presence.

- "I have so few ISR [intelligence, surveillance, and reconnaissance] assets that I can't afford to look where the target can't be. I've got understand *[sic]* the battlefield and put those 'soda straws' of those ISR assets that I have in a place where there is a high probability there is going to be a target. I can't just go out and gander over the countryside hoping somebody drives through my soda straw so I can go kill it" (Hurd, 2004, p. 32).

- "Airborne ISR in the future force must be able to capitalise on any opportunity to sense potential adversaries operating above the detection threshold, and discriminate them from the background of complex terrain" (Hallen, 2009, p. 48).

[16] 'Detection and discrimination threshold' refers to the level at which an adversary's activity enables their detection by friendly forces and the ability of the force to discriminate a potential adversary from the complex terrain. The level of each threshold will be governed by the nature of the operating environment, as well as reflecting the total intelligence, surveillance, and reconnaissance (ISR) capabilities of the force in question (Hallen, 2009, p. 43).

- "Discriminating the adversary enables the development and execution of a course of action that will allow the force to achieve their objective while minimising the amount and degree of any unintended impact on the environment surrounding the adversary. For this approach to be successful the force must be able to execute its course of action during the period that the adversary is operating within their detection and discrimination capabilities" (Hallen, 2009, p. 45-46).

- "If an adversary is operating below the force's ability to detect them, the force can act to stimulate a response from the adversary that will raise their operational profile to a level that will allow their detection. With the adversary operating within the force's detection capabilities, ISR efforts can be focused on discriminating the adversary from the complex terrain" (Hallen, 2009, p. 45).

- "In complex terrain such as an urban environment the requirement for high-end airborne ISR capabilities pushes the very edge of the technological envelope—after all, detecting and discriminating terrorists or insurgents who deliberately conceal themselves among the civilian population is a much more demanding task than identifying a tank in an open battlefield" (Clark & Kainikara, 2007, p. 47).

- In order to achieve its detection capabilities, the Air Power system must utilise its human operators, electronic sensors, computer software, and communication components to effectively obtain information by way of its collection and dissemination processes.

  - "The APG-79 active electronically scanned array (AESA) radar provides significantly more capability for threat detection and precise identification and location accuracy" (Williams, 2007, p. 11).

  - "Products resulting from this collection and exploitation process [network warfare support] include an electronic order of battle (EOB) and parametric data reflecting the electronic characteristics of various EW [electronic warfare] threat systems, which aid detection…" (United States Air Force, 2011a, Chapter 4, p. 24).

  - "…distributed electronic sensors and/or human operators would serve as the 'trip wire' initially to indicate an Air Force network is under attack" (United States Joint Defense Services, 2012, Chapter, 3, p. 21).

Additional definitions:

- *Adversary*: "A party acknowledged as potentially hostile to a friendly party and against which the use of force may be envisaged" (Department of Defence, Version 6.1.1, Navy definition).

- *Alliance:* "The relationship that results from a formal agreement between two or more nations for broad, long-term objectives that further the common interests of the members" (United States Department of Defense, 2012, p. 12).

- *Expendable supplies and materials:* All stores and supplies that are consumed in normal use or that lose their identity during periods of use, such as fuel, explosive ordnance, and spare parts (informed by Department of Defence, Version 6.1.1, NATO definition).

- *Military activities:* All functions, missions, or actions which contribute to achieving friendly force objectives across the spectrum of conflict (e.g., from natural disasters through to armed conflict or war) (informed by the Department of Defence, Version 6.1.1, ADF Joint definition; Royal Australian Air Force, 2007a, p. 39-41).

- *Military force:* A group of people organised for military duties and activities (informed by Collins Dictionary Online, 2012).

- *Non-state actors:* "Those groups and persons who are involved in activities within a state but are not officials of that state .... Non-State Actors can range from private corporations and non-governmental organisations (NGOs) through to militant, armed groups" (Royal Australian Air Force, 2002, p. 71).

- *Potential:* “Capable of being or becoming” (Macquarie Dictionary Online, 2012).

- *State actors:* “Those groups and persons who participate officially in the activities of the state. That is, they draw their legitimacy from that state” (Royal Australian Air Force, 2002, p. 71).

TARGET MONITORING

Definition of Target Monitoring:

'Target Monitoring' is defined as the ability of the Air Power system to survey the activities of specified targets. In particular, the Air Power system must have the capacity to survey the activities of adversaries, friendly forces, and environmental conditions.

Survey:
The term 'survey' is defined as "to view in detail, especially to inspect or examine formally or officially in order to ascertain condition, value, etc." (Macquarie Dictionary Online, 2012) and to "keep under surveillance" (Princeton University, 2012). By adopting these definitions, the ability to 'survey' will refer to the capacity of the Air Power system to follow, record, and examine the activities and resources of specified targets or environments. Ultimately, this will enable the Air Power system to ascertain information which may be used to support the functions, missions, and activities conducted by friendly forces in the achievement of its functional purpose (i.e., to secure Australia and its interests from threats). It must be noted that the Air Power system must have the capacity to monitor all operating environments (i.e., air, space, land, maritime, and cyberspace) (Royal Australian Air Force, 2007b, p. 31).

The ability to 'survey' a specified environment or entity is predominantly achieved through collection and dissemination processes enabled by airborne, space, surface, and sub-surface sensors (e.g., visual observation, electro-optical devices, airborne microwave radars), and operations conducted in the cyberspace domain. However, the ability to "ascertain condition, value etc." (Macquarie Dictionary Online, 2012) is primarily a function of information processing, and thus emphasises the human component of the Air Power system.

Activities:
The concept of 'activity' is described as "the state of action; doing" (Macquarie Dictionary Online, 2013). This broad definition enables the concept of 'activity' to capture a range of actions from peace and human rights monitoring to observing adversary dispositions and courses of action. In addition, the definition of 'action' as "a process existing in or produced by nature" (Princeton University, 2012) enables the concept of 'activity' to capture naturally occurring environmental phenomena (e.g., weather patterns, distribution of pandemic disease outbreaks).

Targets:
Within Defence, the term 'target' refers to "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" or "a country, area, installation, agency or person against which intelligence activities are directed" (Department of Defence, Version 6.1.1, NATO definition). Within the current context, the concept of 'target' includes, but is not limited to, independent persons and groups; military and non-military organisations, specifically friendly forces and adversaries; countries and specific geographic areas; environmental conditions; platforms (e.g., ships, submarines, aircraft); operating bases (e.g., air, maritime, land); and munitions (e.g., missiles, torpedoes).

Rationale and supporting documentation:

- Target Monitoring is a purpose-related function of the Air Power system because it must have the ability to survey the activities of specified targets in order to achieve its functional purpose. Monitoring of specific targets enables the Air Power system to attain specific information about a target's intentions and capabilities or limitations. It also allows friendly forces to be tracked and environmental phenomena to be monitored.

  - "Airborne ISR has proved to be particularly valuable in providing time critical and persistent capability to find, fix, track and monitor the adversary" (Clark & Kainikara, 2009, p. 29).

- The definition of the current purpose-related function incorporates aspects from the North Atlantic Treaty Organization's (NATO) definitions of 'monitoring':

  - "The act of listening, carrying out surveillance on, and/or recording of enemy emissions for intelligence purposes" (Department of Defence, Version 6.1.1, NATO definition).

  - "The act of listening, carrying out surveillance on, and/or recording the emissions of one's own or Allied forces for the purpose of maintaining and improving procedural standards and security, or for reference, as applicable" (Department of Defence, Version 6.1.1, NATO definition).

  Whilst the above definitions highlight the surveillance aspects of Target Monitoring, they only take account of enemy and allied force emissions. Within the Air Power system the focus of monitoring actions is predominately concentrated on the activities of adversaries, friendly forces, and environmental phenomena.

- Based on raw data analysis, it was first determined that monitoring is a fundamental element of peace operations.

  - "The ADF has participated in many UN [United Nations] sponsored peacekeeping, peace enforcement, or peace monitoring operations, including major commitments in Cambodia, Somalia, and East Timor" (Royal Australian Air Force, 2004, p. 31).

  - "The RAAF [Royal Australian Air Force] could be involved in UN operations through the provision of specialist personnel and by providing support, monitoring and/or enforcement elements. Operations could include the enforcement of air exclusion zones, enforcement of air or naval blockades, precision strikes against selected targets, strategic and tactical airlift, air support for ground forces, air monitoring of peace agreements, aerial surveys…" (Royal Australian Air Force, 2004, p. 32).

  - "We have monitored ceasefires, provided security for the delivery of humanitarian aid, election processes and the demobilisation of belligerents, and otherwise helped to bring peace to troubled areas" (Department of Defence, 2009, p. 56).

  - "Conflict prevention can include fact-finding missions, consultations, warnings, inspections, and monitoring" (United States Joint Defense Services, 2007b, Chapter 1, p. 8).

  - "Most United Nations multi-dimensional peacekeeping operations are therefore mandated to promote and protect human rights by monitoring and helping to investigate human rights violations and/or developing the capacity of national actors and institutions to do so on their own" (United Nations, 2008, Chapter 2, p. 27).

  As documented in the raw data above, Target Monitoring is utilised widely within peace operations for purposes comprising the monitoring of ceasefires, peace agreements, and conflict prevention. This serves to create stability[17] within Australia's regional neighbourhood and international environment. Through these actions the Air Power system is likely to reduce threats directed at Australia and its interests, therefore fulfilling the functional purpose of the system. In addition, monitoring of non-warlike operations may also fulfil the value and priority measure of humanity[18], as the conduct of these operations is also likely to be motivated by charity and compassion.

[17] 'Stability' has been identified as a value and priority measure of Air Power at the system level of abstraction. It is defined as the ability of the Air Power system to contribute towards maintaining and restoring peace where and when required. In particular, the Air Power system must have the capacity to participate in various non-warlike operations to contribute towards maintaining or re-establishing a secure environment.

[18] 'Humanity' has been identified as a value and priority measure of Air Power at the system level of abstraction. It is defined as the ability of the Air Power system to minimise the suffering, injury, and destruction inflicted on civilians and civilian

- It was further established that the monitoring of specified targets is required to support a wide range of military activities. Therefore, the Air Power system must have the capacity to conduct multiple monitoring operations across various operational environments.

  - "Earth orbiting satellites, or space vehicles, are designed to perform a variety of functions. These include Earth observation, weather monitoring…" (Australian Defence Force, 2010, Chapter 1, p. 2).

  - "Environmental health and hygiene reconnaissance and monitoring are indispensable for troop health and welfare" (Canadian Department of National Defence, 2002, Chapter 3, p. 8).

  - "The wider range of military tasks can include assisting in disarmament and demobilization, monitoring of elections, de-mining assistance, restoration of infrastructure and conducting concurrent enforcement operations" (Canadian Department of National Defence, 2002, Chapter 1, p. 1).

  - "The deployment of Unmanned Aerial Vehicles (UAVs), although not always a land force asset, may have particular utility in all PSO [peace support operations], not just to monitor hostile acts but to track forces and monitor refugee movement" (North Atlantic Treaty Organization, 2001, Chapter 5, p. 2).

  - "The nature and content of local media will have to be monitored and an information campaign developed to ensure the mission's objectives are transparent to the locals" (Canadian Department of National Defence, 2002, Chapter 6, p. 10).

  As the above statements demonstrate, the Air Power system must be capable of monitoring targets as they perform a range of activities. It is important to highlight that Target Monitoring is not confined to activities related to surveying peace operations and friendly and adversary movements. Target Monitoring is also concerned with activities regarding environmental monitoring in which information relating to weather and geography is collected for navigational and planning purposes. Given the scope of activities to be monitored, the Air Power system must be capable of operating within a variety of environments, ranging from hostile through to permissive and uncertain.

- In order to effectively monitor the aforementioned activities, the Air Power system must have assets capable of securing specific information and distributing it to the appropriate recipients.

  - "Reconnaissance is defined as missions undertaken to obtain information about the activities and resources of a designated enemy, or to secure data concerning the meteorological, hydrographic or geographic characteristics of a particular area" (Royal Australian Air Force, 2007a, p. 128).

  - "The Air Force provides surveillance and reconnaissance systems with the flexibility to detect, identify and track a wide range of specific targets in contexts that individually require specific techniques and persistence of coverage" (Royal Australian Air Force, 2007a, p. 128).

  - "Space-based surveillance systems, military and civil, have a capacity for virtual penetration that can greatly enhance a force's information capability. They can position themselves wherever required to monitor large areas, including remote and access-denied areas, to support communications, navigation, meteorology, oceanography and ISR" (Royal Australian Air Force, 2007a, p. 84).

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objects. More specifically, the Air Power system must have the ability to perform the actions required with humanity for a range of operations in times of both peace and conflict.

- Both air and space-based surveillance and reconnaissance systems provide a considerable contribution to Air Power's Target Monitoring capability; however, the human factor in monitoring must also be considered.

    - "In PSO, strategic and operational level observation and monitoring may be conducted by maritime and air assets, including satellites, but ultimately will rely heavily on the human factor, i.e., the observations of troops on the ground and in proximity to the parties and indigenous population" (North Atlantic Treaty Organization, 2001, Chapter 6, p. 8).

    - "Observers may be employed individually or in small multinational joint teams to observe, monitor, verify, and report and, where possible, to use confidence building measures to defuse situations of potential conflict. Specific tasks may be to provide early warning to trigger political initiatives, to observe a withdrawal or to monitor the movement of refugees and other displaced persons" (North Atlantic Treaty Organization, 2001, Chapter 6, p. 8).

Additional definitions:

- *Belligerent:* "In time of crisis or war, an individual, entity, military force or state engaged in conflict" (Department of Defence, Version 6.1.1, Navy definition).

- *Capability:* "The power or ability to do something" (Oxford Dictionary Online, 2012).

- *Friendly forces:* The term 'friendly' generally refers to assets which belong to, or are allied or partnered with, one's own defence forces (informed by Macquarie Dictionary Online, 2012; United States Department of Defense, 2012), with 'force' described as a "group of persons organised for particular duties or tasks" (Collins Dictionary Online, 2012). In the current analysis, the concept of 'friendly forces' encapsulates any RAAF, ADF, or allied assets.

- *Hostile environment:* "An environment where Australian Defence Force operations are likely to be opposed by local forces and/or the local population" (Department of Defence, Version 6.1.1, Army definition).

- *Intelligence, surveillance, and reconnaissance (ISR):* "A collection activity that synchronises and integrates the acquisition, processing and provision of information and single source intelligence by sources and agencies tasked to satisfy a collection requirement" (Department of Defence, Version 6.1.1, ADF Joint definition).

- *Intention:* "An aim or design (as distinct from capability) to execute a specified course of action" (Department of Defence, Version 6.1.1, US Joint definition).

- *Limitation:* "Something that limits a quality or achievement" (Collins Dictionary Online, 2012).

- *Non-warlike operations:* "Those military activities designed to assist in resolving crises where the application of force is limited to self-defence….Non-warlike operations include peacekeeping, humanitarian and disaster-relief operations and assistance to civil authorities" (Royal Australian Air Force, 2007a, p. 42-43).

- *Peace operations:* "An operation that impartially makes use of diplomatic, civil and military means, normally in pursuit of United Nations Charter purposes and principles, to restore or maintain peace" (Department of Defence, Version 6.1.1, Navy definition).

- *Permissive environment:* "Local authorities, forces and the population are unlikely to oppose or are willing to support Australian Defence Force operations. The area of operations near the special recovery operation is likely to be hostile due to influence by an adversary or the environment" (Department of Defence, Version 6.1.1, Army definition).

- *Surveillance:* “The systematic observation of aerospace, surface or sub-surface areas, places, persons, or things, by visual, aural, electronic, photographic, or other means” (Department of Defence, Version 6.1.1, ADF Joint definition).

- *Uncertain environment:* “The reactions of local authorities, forces and/or the population can not be predicted despite host nation government willingness to support Australian Defence Force operations” (Department of Defence, Version 6.1.1, Army definition).

TARGET LOCALISATION

Definition of Target Localisation:

'Target Localisation' is defined as the ability of the Air Power system to determine the exact location of specified targets.

Location:
The ability to 'locate' is defined as "to set, fix, or establish in a place, situation, or locality" (Macquarie Dictionary Online, 2012), with 'location' described as a "place or situation occupied" (Macquarie Dictionary Online, 2012). The Air Power system needs to be able to determine the exact location of a target, firstly, in order to facilitate the collection of additional target specific information (e.g., identity, classification) and, secondly, to support other operational requirements related to achieving its functional purpose (i.e., to secure Australia and its interests from threats).

Targets:
Within Defence, the term 'target' refers to "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" or "a country, area, installation, agency or person against which intelligence activities are directed" (Department of Defence, Version 6.1.1, NATO definition). Based on these definitions, the concept of 'target' includes, but is not limited to, independent persons and groups; military and non-military organisations, specifically friendly forces and adversaries; countries and specific geographic areas; environmental conditions; platforms (e.g., ships, submarines, aircraft); operating bases (e.g., air, maritime, land); and munitions (e.g., missiles, torpedoes).

Rationale and supporting documentation:

- Target Localisation is a purpose-related function of the Air Power system because it must have the ability to determine the exact location of specified targets in order to achieve its functional purpose. In particular, the Air Power system must have the capacity to locate a diverse range of targets, from friendly personnel to adversary combat forces and civilian population groups.
  - "Where the location of missing units or personnel is uncertain, surface, sub-surface and air platforms may provide sustained surveillance using visual, electromagnetic and/or spectral means" (Australian Defence Force, 2011, Chapter 3, p. 2).
  - "While fixed-wing aircraft are generally unable to effect the direct recovery of isolated personnel, they are able to provide…airborne reconnaissance to locate and identify adversary activity in the recovery area…" (Australian Defence Force, 2011, Chapter 3, p. 4).
  - "The Joint ISR system of systems must be capable of detecting, locating and identifying adversary combat forces" (Canadian Department of National Defence, 2003, Chapter 5, p. 4).
  - "During Peace Support Operations (PSO*)* the distribution of population groups may also be important" (Canadian Department of National Defence, 2003, Chapter 5, p. 2).
- Based on raw data analysis, it was first established that the Air Power system is obligated under operational and international law (e.g., law of armed conflict) to avoid "loss of civilian life, injury to civilians and damage to civilian objects" (Royal Australian Air Force, 2004, p. 64) when undertaking operational requirements. In order to achieve this requirement, the Air Power system must be able to locate both military objectives and civilian populations.
  - "Protocol I duties of commanders…avoid the location of military objectives within or near densely-populated areas" (Royal Australian Air Force, 2004, p. 66).

- "Where the military situation permits, commanders are to make every reasonable effort to warn the civilian population located in close proximity to a military objective targeted for attack" (Royal Australian Air Force, 2004, p. 67).

- "It is prohibited to make any military objective located within a concentration of civilians the object of attack by other than air-delivered incendiary weapons, except where the military objective is clearly separated from the civilians and all feasible precautions are taken to minimise incidental loss of civilian life and damage to civilian objects" (Royal Australian Air Force, 2004, p. 75).

As demonstrated by the above documentation, the Air Power system must have the capacity to avoid inflicting damage to particular locations so as to preserve civilian life and uphold operations law. In order to achieve this requirement, the Air Power system must have the capacity to locate both military objectives and civilian populations and objects. It is important to highlight that the ability to 'locate' these targets is independent of the Air Power system's identification capability. That is, the Air Power system must first locate the precise position of specified populations or objects, then use this positional information to facilitate activities to identify the class (e.g., hostile, non-hostile, civilian) and identity (e.g., friendly forces or adversaries, a fighter aircraft, civilian commercial aircraft) of specified targets. Localisation may therefore be considered as a first step in establishing the class and identity of specified targets (see Target Identification glossary).

- It was further established that localisation is requisite to the identification of an adversary's disposition, strength, and condition of readiness. Once obtained, this knowledge "can render an adversary relatively, but never wholly, transparent to friendly commanders" (Royal Australian Air Force, 2007a, p. 73).

  - "Positional intelligence is required in order to identify adversary posture to assist in assessing intentions and threat, provide warning and enable efficient targeting to be carried out" (Canadian Department of National Defence, 2003, Chapter 5, p. 2).

- It is important to highlight that the Air Power system's ability to locate targets may be impeded by concealment methods purposefully employed in an effort to disrupt localisation capabilities.

  - "Target location and other information must be refined enough to permit engagement, which requires ISR capabilities that can identify stationary and mobile targets, day or night, in all weather, through all forms of terrain, camouflage, and concealment—all in a timely manner" (United States Air Force, 2011b, Chapter 3, p. 51).

  - "Known adversaries are adept at camouflage, concealment, and deception, complicating the targeting process" (United States Joint Defense Services, 2012, Chapter 4, p. 7).

  As suggested by the above statements, the purposeful concealment of assets can affect the ability of the Air Power system to accurately locate adversary forces. It should be noted that concealment methods may also affect the ability of friendly forces to locate their own assets. Given that concealment is utilised by the ADF and other international forces, the Air Power system must have the capacity to strike a balance between concealing Australian assets and allowing for localisation of friendly targets.

- In order to achieve the capabilities that the Air Power system affords to Target Localisation, various physical objects (e.g., radar, global positioning system, unmanned aerial vehicle) must be employed to effectively locate specified targets by way of its collection, processing, and dissemination activities.

- “Advances in computer processing, precise global positioning, and telecommunications provide commanders with the capability to determine accurate locations of friendly and enemy forces, as well as to collect, process, and disseminate relevant data to thousands of locations” (United States Joint Defense Services, 2007a, Chapter 1, p. 25-26).

- “Some radar sensors provide moving target indicator capability to detect and locate moving targets such as armour and other vehicles” (United States Joint Defense Services, 2007a, Appendix B, p. 2).

TARGET IDENTIFICATION

Definition of Target Identification:

'Target Identification' is defined as the ability of the Air Power system to establish the class and identity of specified targets.

Identification:
The North Atlantic Treaty Organization (NATO) defines 'identification' as "1. the indication by any act or means of one's own friendly character or individuality" and "2. the process of attaining an accurate characterization of a detected entity by any act or means so that high confidence real-time decisions, including weapons engagement, can be made" (Department of Defence, Version 6.1.1). Based on these definitions, the Air Power system must have the ability to determine the character of a target in order to make accurate and timely decisions. Within the current context, the 'character' of an entity may refer to "the aggregate of qualities that distinguishes one person or thing from others" (e.g., F-22 aircraft from Su-27 aircraft) (Macquarie Dictionary Online, 2012). Alternatively, it may refer to the "status or capacity" of a specific entity (e.g., friendly versus hostile) (Macquarie Dictionary Online, 2012). Therefore, for the purposes of the current analysis, the concept of Target Identification will encompass the ability to establish the character of a specified target, which can ultimately be determined through the evaluation of a target's class and identity.

- Class:
  The concept of 'class' has been described as "a collection of things sharing a common attribute", with the term 'classify' defined as "to arrange or order by classes or categories" (Princeton University, 2012). Within the current framework, establishing the 'class' of targets requires only a general grouping of targets based on their common attributes. For example, classifying an airborne object as an aircraft involves the ability to determine whether the object's shape and size corresponds to any known aircraft type (Lee, 2005, Chapter 1, p. 3).

- Identity:
  The term 'identity' has been described as the "individual characteristics by which a person or thing is recognized" (Collins Dictionary Online, 2012). The concept of 'identity' differs to 'class' in that establishing the 'identity' of a target requires more specific recognition, not through common attributes, but through the identification of individual characteristics. Sufficient object detail and information will need to be available in order for an object's identity to be accurately established.

Targets:
Within Defence, the term 'target' refers to "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" or "a country, area, installation, agency or person against which intelligence activities are directed" (Department of Defence, Version 6.1.1, NATO definition). Within the current context, the concept of 'target' includes, but is not limited to, independent persons and groups; military and non-military organisations, specifically friendly forces and adversaries; countries and specific geographic areas; environmental conditions; platforms (e.g., ships, submarines, aircraft); operating bases (e.g., air, maritime, land); and munitions (e.g., missiles, torpedoes).

Rationale and supporting documentation:

- To satisfy the functional purpose, the Air Power system must have the ability to establish the class and identity of specified targets based on their individual characteristics and common attributes. As such, the current purpose-related function captures the Air Power system's capacity to accurately distinguish between hostile, non-hostile, and civilian people or objects.

- "The Joint ISR system of systems must be capable of detecting, locating and identifying adversary combat forces" (Canadian Department of National Defence, 2003, Chapter 5, p. 4).

- Based on raw data analysis, it was first established that the Air Power system is obligated under operational and international law (e.g., LOAC) and guided by its value system to positively identify and distinguish targets when undertaking operational requirements.

  - "LOAC is based largely on the distinction between combatants and non-combatants. This principle of distinction is also referred to as the principle of identification" (Royal Australian Air Force, 2004, p. 51).

  - "A commander's responsibility, when carrying out attacks, is to distinguish between legitimate military targets and the civilian population. This obligation is dependent on the quality of the information available at the time of the decision. If a commander makes reasonable efforts to gather intelligence, reviews the intelligence available, and concludes in good faith that he is attacking a military objective, only to find he has ordered an attack on a town unknowingly filled with refugees, he does not violate the principle of distinction" (Royal Australian Air Force, 2004, p. 52).

  - "We will discriminate between those who are our enemies and the innocents who have merely had the misfortune to be caught up in the conflict" (Royal Australian Air Force, 2002, p. 261).

  As the statements above demonstrate, the concept of Target Identification is based on the Air Power system's ability to accurately distinguish between hostile, non-hostile, and civilian individuals, groups, or objects. Within the current framework, the ability to 'distinguish' is dependent on the system's capacity to determine both the class and identity of specific entities. Being able to determine only one fundamental aspect of Target Identification (i.e., class or identity) is not adequate to achieve the functional purpose of the Air Power system. That is, being able to recognise an aircraft as an F/A-18F (identity) is inconsequential if it can not be determined if that aircraft is hostile or friendly (class). Alternatively, being able to determine the class of an entity is not useful without the added information regarding the identity of the entity, as planning regarding appropriate offensive or defensive actions may be hindered (e.g., the best defensive manoeuvres may be different depending on the types of platforms involved).

- Secondly, it was determined that the concept of Target Identification is time sensitive.

  - "Timely identification of actors and their motives, establishing cause and complicity and restoring capability are the cornerstones of effective and properly focused response" (Canadian Department of National Defence, 1998, Chapter 3, p. 10).

  As documented in the statements above, in order to achieve the functional purpose, Target Identification must be conducted in a timely manner. Even if the most accurate and reliable information or intelligence is not made available in sufficient time for decisions to be made it will be of no use.

- Additionally, Target Identification is dependent on the fusion of information from discrete platforms and individuals.

  - "The real issue has not been necessarily in finding an adversary or threat, but in identifying them as such, which requires the fusion of information from multiple sources and disciplines and then its transition into actionable intelligence" (Clark & Kainikara, 2010, p. 32).

  - "From an Intelligence point of view, the effectiveness of a Commander's force protection plan will be dependent upon the fusion of multi-source Intelligence to identify and to assess

the threat in a timely and accurate manner" (Canadian Department of National Defence, 2003, Chapter 1 p. 5).

As documented in the raw data above, the generation of accurate and timely identification is dependent upon the fusion of information from multiple sources. Within the current analysis, the concept of 'fusion' refers to the blending of intelligence or information from multiple sources, in order to extract more accurate, reliable, and comprehensive information about specific entites (informed by definitions of 'fusion' and 'data fusion', Department of Defence, Version 6.1.1, ADF definition).

- In order to identify the class and identity of specified targets, physical objects (e.g., sensors) are used to differentiate combatants from non-combatants.

  - "Persistent surveillance is able to identify targets as they emerge in the battlespace. Advanced sensors on board a networked aircraft can then acquire a target more easily and differentiate it from non-military objects and civilians" (Butler, 2008, p. 157).

  - "The APG-79 active electronically scanned array (AESA) radar provides significantly more capability for threat detection and precise identification and location accuracy" (Williams, 2007, p. 11).

Additional definitions:

- *Combatant:* "An organised armed force, group or unit, except medical service and religious personnel, who is under the command of a party to a conflict and is subject to an internal disciplinary system" (Department of Defence, Version 6.1.1, ADF Joint definition).

- *Fusion:* "The blending of information and/or intelligence from multiple sources or agencies into a coherent picture. The origin of the initial individual items should then no longer be apparent" (Department of Defence, Version 6.1.1, NATO definition).

- *Hostile:* "The designation given to a track, object or entity whose characteristics, behaviour or origin indicate that it is a threat to friendly forces" (Department of Defence, Version 6.1.1, NATO definition).

- *International law:* "Operations law is primarily a product of international law which is itself concerned with international law and order and security. While it defies precise definition, international law is equally applicable to individuals despite the fact that it governs relations between states. In international law the term 'states' refers to nations which are accepted as legitimate members of the international community" (Royal Australian Air Force, 2004, p. 1).

- *Law of armed conflict (LOAC):* "The international law regulating the conduct of States and combatants engaged in armed hostilities" (Department of Defence, Version 6.1.1, ADF Joint definition).

- *Operations law:* "Operations law is that domestic and international law associated with planning and execution of military operations in peacetime or during armed conflict. It includes but is not limited to LOAC, air law, law of the sea, anti-and counter-terrorist activities, overseas procurement, discipline, pre-deployment preparation, deployment, status of forces agreement, operations against hostile forces, aid to the civil authority, border protection and civil affairs operations" (Royal Australian Air Force, 2004, p. 2).

- *Rules of engagement (ROE):* "Directions endorsed by Government and issued by commanders, which delineate the circumstances, and limitations within which military force may be applied to achieve military objectives" (Department of Defence, Version 6.1.1, ADF Joint definition).

THREAT PREDICTION

Definition of Threat Prediction:

'Threat Prediction' is defined as the ability of the Air Power system to predict the intentions of specified targets.

Predict:
The concept 'predict' has been described as to "foretell on the basis of observation, experience, or scientific reason" (Merriam-Webster Dictionary Online, 2012). Within the context of Air Power, the ability to 'predict' relates to the capacity of the Air Power system to anticipate future situations and circumstances in order to support effective decision-making. Accurate prediction is dependent on assets used for the collection, processing, and dissemination of information.

Intention:
The concept of 'intention' is described as "an aim or design (as distinct from capability) to execute a specified course of action" (Department of Defence, Version 6.1.1, US Joint definition). The Air Power system is capable of collecting, processing, and disseminating information specific to a target's intentions, as achieved by the fusion[19] of information. Such information may pertain to adversary presence, location, movements, class, identity, activities, and resources. In addition, documented knowledge relating to a target's culture, values, doctrine, and capabilities may provide further indications as to intent. For example, Threat Prediction enables the Air Power system to understand an adversary's most likely course of action and scheme of manoeuvre, and how an adversary is likely to interpret friendly action and react.

Targets:
Within Defence, the term 'target' refers to "the object of a particular action, for example a geographic area, a complex, an installation, a force, equipment, an individual, a group or a system" or "a country, area, installation, agency or person against which intelligence activities are directed" (Department of Defence, Version 6.1.1, NATO definition). Within the current context, the concept of 'target' includes, but is not limited to, independent persons and groups; military and non-military organisations, specifically friendly forces and adversaries; countries and specific geographic areas; environmental conditions; platforms (e.g., ships, submarines, aircraft); operating bases (e.g., air, maritime, land); and munitions (e.g., missiles, torpedoes).

Rationale and supporting documentation:

- Threat Prediction is a purpose-related function of the Air Power system because it must have the ability to predict the intentions of adversaries in order to fulfil its functional purpose. The accurate prediction of intentions enables the Air Power system to anticipate adversary action, thereby enabling the system to establish information and decision-making advantage. Within the current context, the prediction of intentions facilitates strategic advantage over an adversary through its capacity to inform the Air Power system of probable adversary actions, which may then be prevented or mitigated through effective planning and decision-making.

  - "When justified by the available evidence, intelligence should forecast future adversary actions and intentions" (United States Joint Defense Services, 2007a, Chapter 2, p. 9).

  - "With predictive, accurate, and relevant intelligence, commanders may gain the critical advantage of getting inside the adversary's decision-making cycle, improving insight into how the adversary will act or react. The commander can therefore formulate plans based on

[19] Within an intelligence context, 'fusion' refers to "the blending of intelligence and/or information from multiple sources or agencies into a coherent picture. The origin of the initial individual items should then no longer be apparent" (Department of Defence, Version 6.1.1, NATO definition).

this knowledge and thus decrease the risks inherent in military operations and increase the likelihood of success" (United States Joint Defense Services, 2007a, p. 21).

- "The most important role of intelligence in military operations is to assist commanders and their staffs in understanding and visualizing relevant aspects of the operational environment. This includes…discerning adversary probable intentions and likely COAs [course of action]" (United States Joint Defense Services, 2007a, p. 21).

- Based on raw data analysis, it was determined that intelligence is considered to be of greatest value when its output is future-oriented, supporting the need for predictive intelligence within the Air Power system.

  - "Information is of greatest value when it contributes to or shapes the commander's decision-making process by providing reasoned insight into future conditions or situations" (United States Joint Defense Services, 2007a, Chapter 1, p. 1).

  - "Intelligence allows anticipation or prediction of future situations and circumstances, and it informs decisions by illuminating the differences in available courses of action (COAs)" (United States Joint Defense Services, 2007a, Chapter 1, p. 1).

  - "Although intelligence must identify and assess the full range of adversary capabilities, it is most useful when it focuses on the future and adversary intentions" (United States Joint Defense Services, 2007a, Chapter 2, p. 9).

- In addition, the ability to make effective and measured decisions is afforded by predictive intelligence.

  - "By helping the commander form the most accurate possible vision of future events in the operational environment, intelligence serves to expand the timeline within the decision-making process" (United States Joint Defense Services, 2007a, Chapter 1, p. 25).

  As demonstrated in the above statements, prediction of adversary intentions affords the Air Power system with an increased time frame in which to make decisions. Logically this increase should facilitate the ability to implement more informed and accurate decisions at a rate faster than the adversary.

- In order to achieve the previously mentioned capabilities, object-related processes, including persistent surveillance and analytical techniques, are used to obtain and process information by way of the Air Power system's collection, processing, and dissemination resources.

  - "Countering improvised explosive devices (IED), for example, requires a suite of force protection measures ranging from blast protection, electronic countermeasures, enhancements to communications and personnel protection equipment through to predicting as best we can the adversary's intentions, using modelling and analysis" (Department of Defence, 2009, p. 133).

  - "Persistent surveillance facilitates the prediction of an adversary's behaviour and the formulation and execution of preemptive activities to deter or forestall anticipated adversary courses of action" (United States Joint Defense Services, 2007a, Glossary, p. 15).

- It is important to highlight that within an intelligence context, predictive approaches are subject to error due to difficulty obtaining complete knowledge and understanding of an adversary.

  - "…the level of understanding that we possess about the adversary will rarely be complete" (Royal Australian Air Force, 2002, p. 148).

- "The long-term projection of adversary intention is particularly difficult because, at the time that intelligence personnel are being asked to determine it, adversaries may not yet have formed their intention, may be in the process of changing their intention, or may not yet have undertaken any detectable action that would provide indicators of their future plans" (United States Joint Defense Services, 2007a, Chapter 1, p. 26-27).

Additional definitions:

- *Course of action (COA):* "A possible plan open to an individual or commander that would accomplish, or is related to accomplishment of, the mission. Note: It is initially stated in broad terms with the details determined during staff war gaming" (Department of Defence, Version 6.1.1, ADF Joint definition).

- *Scheme of manoeuvre:* "Description of how arrayed forces will accomplish the commander's intent. It is the central expression of the commander's concept for operations and governs the design of supporting plans or annexes" (Department of Defence, Version 6.1.1, US Joint definition).

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19. ABSTRACT

Work domain analysis, the first dimension of cognitive work analysis, provides a structured description of a system that is independent of particular actors and situations, giving it utility across a range of applications. Documented in this report is a work domain analysis of Australia's Air Power system, focusing on the purpose-related functions of three key subsystems within the model—combat; transport; and intelligence, surveillance, and reconnaissance. This focus provides a preliminary understanding of some of the major functions of the system that must be supported to achieve the fundamental purposes of Air Power. The work domain model presented in this report has already demonstrated its usefulness through two significant applications. Firstly, the model contributed to the development of a narrative of the Royal Australian Air Force's doctrine and strategy, documented in the sixth edition of The Air Power Manual (AAP 1000-D). Additionally, the Air Power work domain model was utilised to assist with the formulation of the Royal Australian Air Force's forthcoming edition of The Future Air and Space Operating Concept. Further applications of this model could encompass organisational design, capability definition, and the generation of organisational narratives beyond doctrine and strategy.