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Modelling and Assessing Air-Surface Integration

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Abstract : Air-Surface Integration (ASI) is an important theme in the Australian Defence Force (ADF). This paper describes a systems analysis approach to ASI in an Australian context presenting ASI models that describe the structure, function, and behaviour of the ASI system. ASI is an inherently cross-boundary capability that emerges at the macro-system level integrating the components into a coherent system for coordinating, controlling and deconflicting operations in the air and on the surface. The boundaries that are crossed include airspace control measures, roles managing each airspace control measure, roles across services, roles across nations, and information flows across components. The paper describes how the ASI baseline model has been used to evaluate the current ADF ASI force structure capability and identifies socio-technical issues in the ASI system for capability designers.

1. Introduction

Air Surface Integration (ASI) has been conducted by forces in a variety of operations dating back to World War I. However, it is poorly defined in Australian and UK doctrine. For example, the British Army Field Manual defines ASI as "the integration of air and land capabilities and activities in order to achieve the desired effects in accordance with the Commander's plan". Unfortunately, this leaves it to the discretion of the individual Commander as to the methods and procedures to be used, the degree of integration to be undertaken and the conceptual doctrinal framework within which to work (Pengelly 2009). Both the UK and US have experienced difficulties in ASI in current operations (Smyth 2007; Andres and Hukill 2007) resulting in many ad hoc ASI mechanisms (Neal 2006).

The authors are assessing the ADF ASI capability and have defined ASI as:

> *encompassing all the processes and mechanisms used to plan, coordinate, control and deconflict the use of airspace in a defined area of operations so as to achieve desired joint warfighting effects. Effective ASI allows targeting, intelligence collection, air defence and the execution of the Joint Scheme of Manouevre in the same battlespace without fratricide, or physical or electromagnetic interference. Adaptive ASI views the battlespace as having both physical and information dimensions and enables the use of real-time information flows to facilitate dynamic event-based activities concurrently with other activities in the battlespace.*

ASI is an important theme in the Australian Defence Force (ADF) for a number of reasons including: societal demands, new acquisitions, organisational issues, and conceptual issues. Current operations have revealed the priority placed on ASI reflecting the use of new technologies enabling precision dynamic targeting, a shift in warfighting emphasis to COIN operations, and increasing societal demands to minimise fratricide and collateral damage.

The ADF is in the process of acquiring new equipment that increases the demand on ASI. The new equipment includes a number of longer-range precision strike munitions and new amphibious capability. This new equipment changes the way an ADF amphibious task group operates, increases the number of air assets that may be operating in an amphibious area of operation and the complexity of the airspace control measures (ACMs), and thereby increases the complexity of managing ASI.

The ADF does not have a standing ASI organisation. The historical cycle has involved constructing an operation-specific ASI structure in a crisis, then allowing the ASI structure to decay in peacetime. At the same time, there is an increasing desire to move the focus of Joint C2 from the strategic-operational level down to the tactical level. ASI is a key domain for enabling this shift[1].

This paper models ASI in an Australian context. Section 2 discusses the need for a systems analysis approach to ASI. Section 3 models ASI in terms of structure and function, Section 4 models the ASI system behaviours. Section 5 describes the ASI system issues identified using the ASI system models to predict ASI performance at an ADF joint exercise.

2. A Systems Approach to ASI

The ADF does not have a standing ASI organisation. Instead context-specific ASI organisations are created for a particular operation. To be able to study such a changeable system, the authors take a systems perspective, examining the ASI system's underlying function, structures and behaviour (Senge 1990).

The function of ASI will be presented as a set of typical ASI missions together with a set of components which need to be integrated. The structure of the ASI system will be shown through a visualisation of ASI. Next the behaviour of the current ASI system is explored through the development of an ASI Activities model and a baseline model of the current ASI system.

Comparing the function and structure of the system to its behaviour reveals an underlying tension in the ASI system. Viewed in terms of its enduring function and structures, the ASI system is revealed to be intrinsically cross-boundary in nature. By contrast, behaviour of the system is characterised by isolated organisations and processes.

Based on analysis of the ASI system's function, structures and behaviour, predictions were then made for how it would behave in an ADF joint exercise, enabling testing and validation of the models. The systems approach and models also enabled the authors to recognise and understand ASI issues such as the formation of ASI 'islands of automation' - locally optimised processes which do not synchronise with each other.

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[1] In a previous ICCRTS paper titled "Models of Jointness", the desire to move from the strategic-operational level to the tactical level would be described as moving from the "Joint Headquarters" model of jointness to either the "Integrated Organisation" or "Integrated Systems" model of jointness.

3. The Function and Structure of the ASI System

The function of the ASI system can be viewed from two perspectives: the different air and surface[2] components which need to be integrated, and as a set of typical ASI missions.

3.1 Components of ASI

To coordinate, control and deconflict the wide range of missions that use the airspace, a functional representation of the ASI should highlight its integrative nature. Figure 2 shows the "functional" components that comprise ASI which include:

- The air and land pictures
- Airspace control measures
- Ground-based air defence
- Strategic and tactical ISR and their products
- Joint scheme of manoeuvre (both land and maritime)
- Targeting and target acquisition
- Spectrum coordination
- Space situation awareness (GPS, communications, weather information)
- Battle damage and post-mission assessment

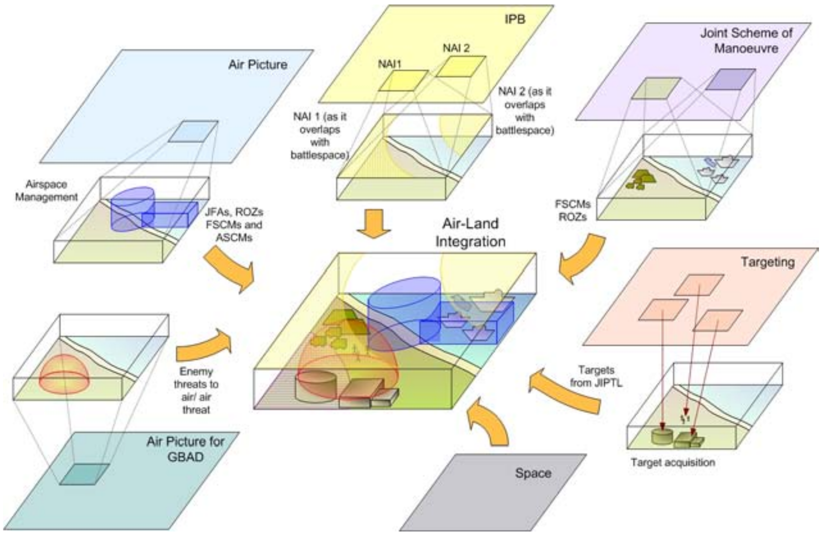

Figure 1. The components of the ASI system

3.2 ASI Missions

From a functional perspective, ASI may be seen as including the planning, coordinating, controlling and deconflicting the airspace for the following types of missions: tactical transport, air-mobile, close air support (CAS), strategic ISR, tactical ISR, artillery, naval gunfire support, offensive counter-air (OCA), defensive counter-air (DCA), combat air patrols, strategic and maritime strike, time-sensitive targeting, dynamic targeting, ground-based air defence, troops-in-contact (TIC) and casualty evacuations (CASEVAC). Figure 2 is a cross-section of the airspace that shows examples of these missions and the associated assets in a cross section of the airspace.

In the delivery of kinetic effects, a key issue is ensuring that the airspace is deconflicted and that there is no risk of fratricide in the air or on the surface. The key activities for ensuring deconfliction and avoiding fratricide are the decision processes

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[2] Surface includes both the land environment and the maritime environment.

that lead to a “clear air”, “clear land”, and “clear water” call as the situation requires. A “clear air” call signifies that there is a clear path through the airspace for the weapon to traverse. A “clear water” call signifies that there is a clear path over the water where the weapon will not risk hitting another blue or white asset. A “clear land” call signifies that the target area has been acquired to the appropriate accuracy, that there is no risk of fratricide, and that any potential collateral damage satisfies the extant rules of engagement.

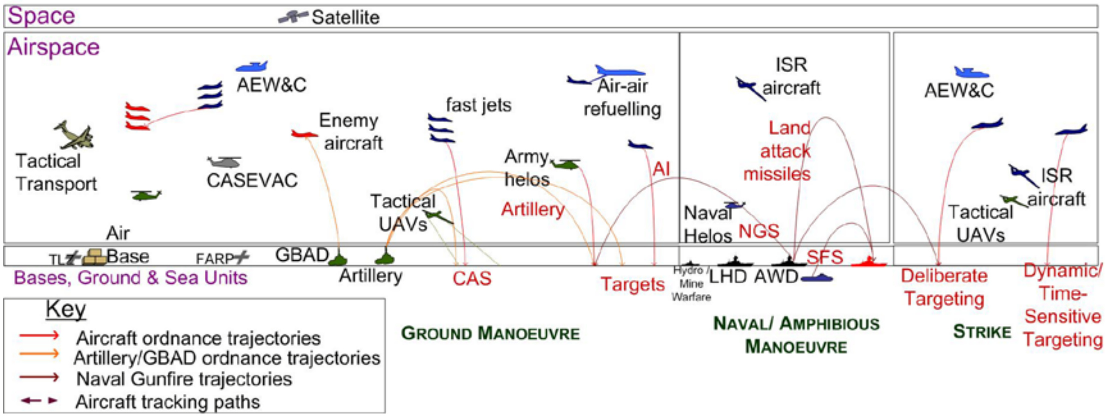

Figure 2. Examples of ASI Missions and Assets

3.3 The Structure of the ASI System

In terms of structure, the ASI system may be visualised as a set of “touch-points” between the air and surface environments and the transit paths between these touch-points. Touch-points include air bases, tactical landing zones, forward air refuelling points, ship landing decks, surface-based weapons operating in the airspace, and the targets to be dealt with. ASI coordinates and deconflicts physical assets that transit the airspace between the touch-points, noting that situation awareness should increase as an asset gets closer to a touch-point[3]. Those that need to be managed include fixed and rotary-wing aircraft, UAVs, weapons (missiles, bombs, rockets, and artillery rounds). Use of the electro-magnetic spectrum and its impact on other actors needs to be coordinated.

The third structural feature of the ASI system is the set of airspace and surface management measures that enable the whole system to function. Most notably these are Airspace Control Measures (ACMs) which mark out three dimensional sections of airspace monitored and controlled by an ASI role. Examples are sectors, restricting operating zones (ROZ), no fly zones, and AEW&C tracks. Other measures such as fire support control measures and fire support control lines mark out similar sections on the ground and sea surface.

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[3] For example, on a CAS mission, the fast jet pilot will have information about the weapons load-out and kill-box to start operating in when they launch from the airfield. Once in the kill-box, the pilot will get detailed information about the JTAC to communicate with and detailed target information in the form of a 9-line brief. Engagement of the target may result in even finer granularity of information ranging from GPS target coordinates to weapon seeker-head matching to target geometries. When the mission is completed and the pilot returns to the airbase, the pilot will get detailed information about runways and landing patterns when in close proximity to the airbase.

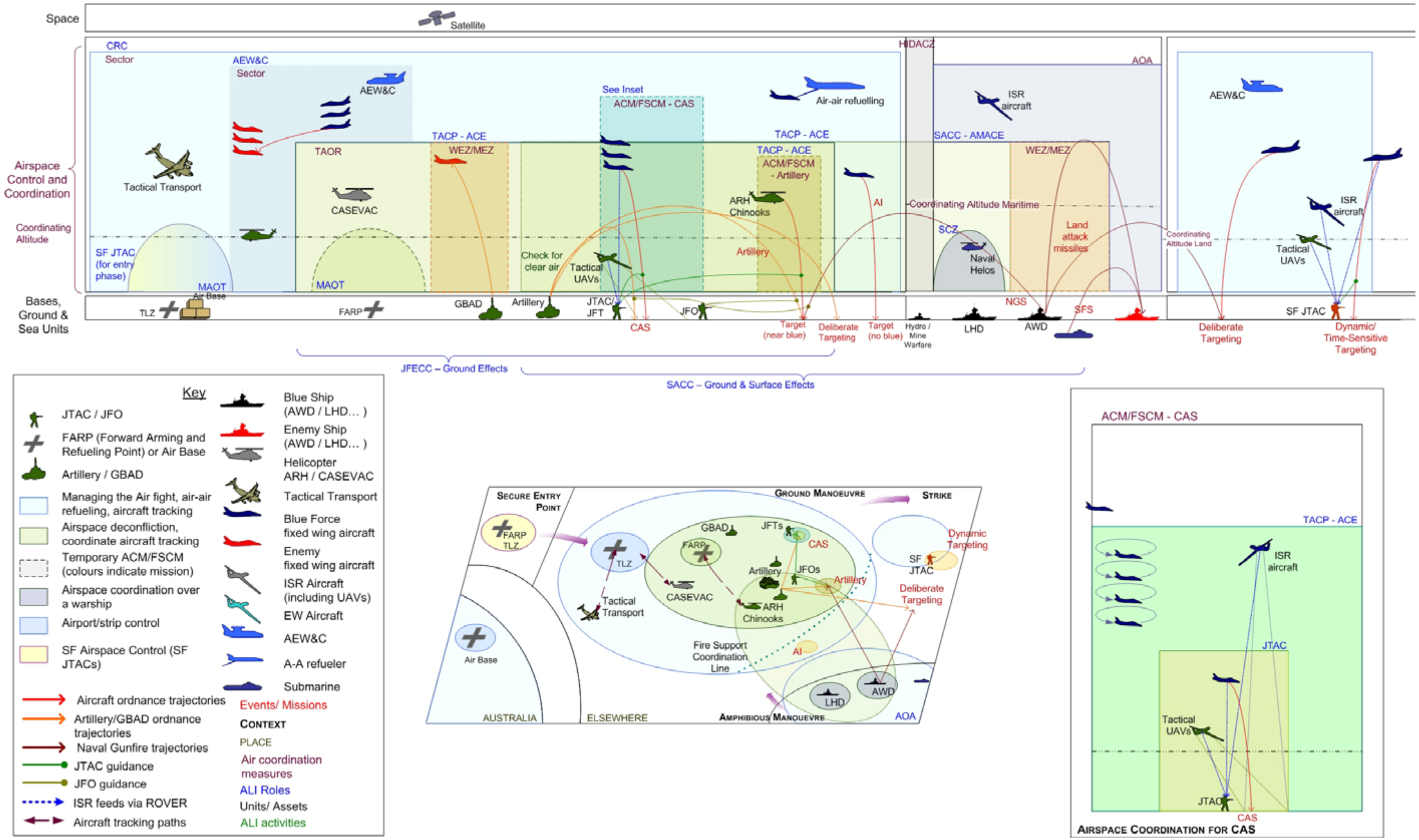

Figure 3. Visualisation of the Structure of the ASI System

Building on Figure 2, Figure 3 visualises this ASI structure with the following components:

- the diagram at the top is a cross-section of the airspace that shows how the ACMs, roles, missions, and assets relate to each other;
- the diagram at the centre is a view looking down through the airspace shown in the top diagram to show the geographical layout as a plan or map view; and
- the bottom right diagram shows the complexity of the airspace required to manage a close air support (CAS) stack in current operations.

3.4 The Cross-Boundary Nature of ASI

From its functional and structural definition, ASI can be seen as a cross-boundary capability that emerges at the macro-system level integrating the components shown in Figure 1 into a coherent system for coordinating, controlling and deconflicting concurrent operations in the air and on the surface across all the elements shown in Figure 3. Some of the cross-boundary aspects include:

- assets transiting across multiple ACMs
- assets transiting across multiple ACMs owned by different roles
- assets transiting across multiple ACMs owned by roles from different Services (Navy, Army, Air Force, Special Forces) and civilian agencies (civilian air traffic control)
- assets transiting across multiple ACMs owned by roles from different Services and civilian agencies across nations in a coalition context
- real-time information flows from assets (for example a stack of CAS aircraft) needing to be integrated across traditional intelligence areas in real-time to tactical assets potentially traversing across multiple ACMs to enable response in a dynamic battlespace.

The scale of the cross-boundary nature of ASI can be shown by the following numbers:

- an ADF operation may have over a hundred extant ACMs
- an ADF operation may conduct hundreds of missions through, or around, these ACMs per day
- ADF participation in a coalition operation may range from hundreds to thousands of coalition missions through these ACMs per day

The new equipment in acquisition for the ADF further highlights the cross-boundary nature of ASI. Long-range precision munitions will transit multiple ACMs owned by a variety of roles, probably from different Services. The new amphibious capability in an Australian context will increase the number of assets transiting through ACMs. Some of these ACMs will be owned by the Amphibious Task Group, some will be owned by the Army’s Joint Fires Effects Coordination Centre (JFECC), and some will be owned by various Air Force organisations.

4. ASI Behaviour

A systems perspective compares the structure and function of the system with the system’s behaviour. Section 3 has described the function and structure of the ASI system with the aid of Figures 1, 2, and 3. This section describes the ASI system behaviour models. The ADF ASI system behaviour was determined by modelling the ASI activities, then developing an ASI Baseline model comprising the: ASI C2 structure, ASI trade structure, ASI workforce inventory and ASI systems inventory.

4.1 The ASI Activity Model

The ASI Activity Model shown in Figure 4 documents how ASI is conducted by three interdependent processes defined below: deliberate battlespace effects (DBE), response to events (R2E), and immediate battlespace management (IBM). The model was developed from ADF doctrine[4] for the DBE and IBE layers, and developed from analysis of the conduct of current operations for the response to events layer.

The Deliberate Battlespace Effects layer (top third of Figure 4) shows the planning process for assets that will use the airspace. This process begins with the identification of a need or request for an air mission, and follows through to the tasking orders for the following day's flights. In an Australian context, there are separate planning processes for fixed-wing and Army rotary-wing assets. In an Amphibious Task Group context, a separate Air Tasking Order (ATO) is produced internally for the Amphibious Task Group from the ATO produced for all other assets.

The Immediate Battlespace Effects layer (bottom third of Figure 4) shows how the airspace, and the assets using the airspace are coordinated, controlled and deconflicted in real-time. The IBE layer shows: the control of the airspace; the resource management of the airspace, assets, spectrum and weather; the air battlespace management for the blue versus red air fight; the terminal guidance for targeting; and the audit trail.

Finally, the Response to Events layer (middle third of Figure 4) shows how the ASI capability adapts to dynamic events in the battlespace. These events may include launching assets and coordinating CASEVAC missions or developing courses of action and retasking assets already in the air to prosecute dynamic targets or time-sensitive targets. The key issue in the R2E layer is the feedback loops into the IBE layer for reassigning assets, moving assets, changing ACMs; and the feedback loops for the DBE layer for the effects on future ATOs. This feedback loop is necessary because allocating aircraft to respond to a dynamic event may reduce aircraft availability for the next day because of asset availability or aircrew rest requirements.

4.2 ASI Baseline Model

The ASI baseline model involved:

- identifying the ASI C2 Structure and the ASI roles that populate this structure
- developing an ASI trade structure that groups the ASI roles into "trades" of similar skill sets, reusing the existing Service trade structures where possible
- constructing a workforce inventory that shows for each ASI role which ASI activities they perform from Figure 4
- constructing a systems inventory that describes the systems used by each ASI role to perform each ASI activity

Over 250 positions were identified in the ASI C2 Structure.

Developing the ASI trade structure enabled an assessment across the services of common skill sets and gaps in skill sets. For example, the need for the Air Traffic Controller skill set was common across a number of services resulting in a proposal to

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[4] ADF Joint Fires Support doctrine and ADF Airspace Control doctrine

combine this training program rather than having two separate, independent programs. An example of a skill set gap was the need to correlate the blue-force tracker picture with the radar picture and identifying which role would perform this activity and the skills required.

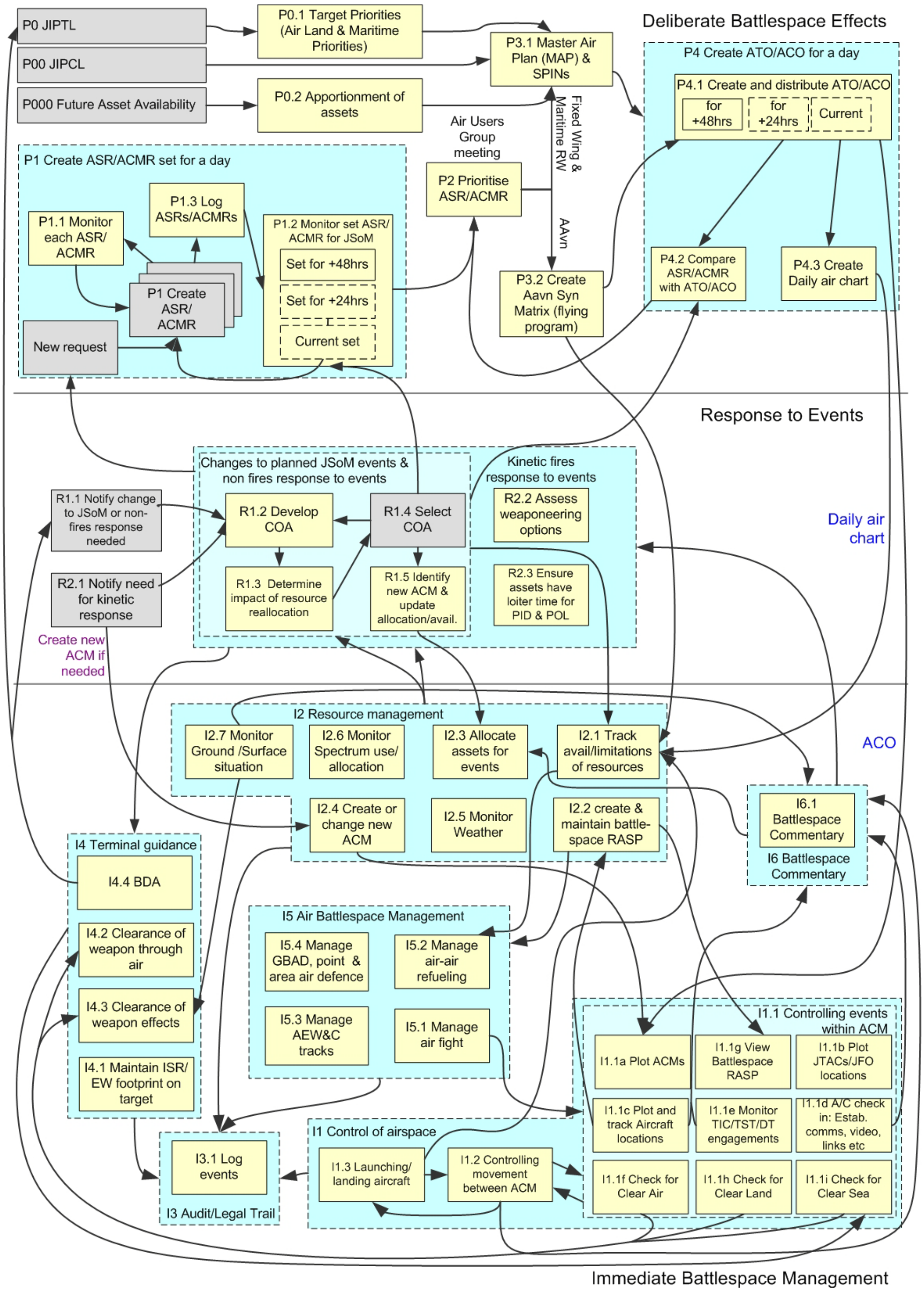

Figure 4. ASI Activity Model

4.3 Assembling an Operation-Specific ASI Organisation

The ADF does not have a standing ASI organisation and assembles an operation-specific ASI organisation to meet the requirements of a particular operation or exercise. Key determinants in assembling an operation-specific ASI organisation include:

- the type of operation being conducted on the spectrum of conflict
- the types of ASI missions to be conducted (see Section 3.2)
- the number of each ASI mission to be conducted per day and the number of concurrent missions expected in the airspace at any time
- whether operating from permanent airbases, tactical landing zones, or from an amphibious task group
- the size of the airspace and the complexity of the airspace (ranging from no fly zones and commercial air corridors through to the design of safe corridors and weapon engagement zones)

Based on these parameters, a selection is then made for:

a) how much of the ASI C2 Structure is implemented (from Section 4.2). For example, a small-scale peacekeeping operation with very few missions and flights per day does not require the activation of the Air Operations Centre (AOC) and Control and Reporting Centre (CRC).

b) how much of the ASI Activity Model is implemented (see Section 4.2). For example, the response to events layer is required for dynamic targeting, time-sensitive targeting, and Close Air Support missions. In non-warfighting situations, this layer may not need to be established and staffed.

c) how many of the roles are required. For example, many of the ASI roles (see Section 4.2) are liaison officer roles. Liaison positions are only required if the capability is needed to conduct the defined missions. For example, fast jet expertise is not required for a disaster relief operation.

d) whether the volume of missions is low enough to enable some roles to expand their duties, negating the need to stand-up a broader organisation. For example, if the number of flights per day are low, can the Airspace Control Element (ACE) control a much wider area of airspace, negating the need to stand-up a CRC.

The principles then for assembling an operation-specific ASI organisation may then be reduced to: “what is the smallest ASI organisation required to conduct this particular operation”. It is rare for the ADF to assemble the full 250+ ASI roles in a complete ASI organisation structure. The dilemma is that while the ADF is designed for high-end warfighting, if the entire ASI organisation is rarely activated, then some activities, missions, roles, systems, and systems integration will not be tested and used.

As a result, isolated processes and organisations may arise both inside and external to the ADF. For example, in the activity model (DBE), both Army rotary-wing assets and assets assigned to an Amphibious Task Group follow a separate planning (DBE) process. The ASI baseline model – in particular the systems inventory – revealed that even when units followed the same process, different C2 systems were often used, especially across different sites. Further evidence of isolated organisations within ASI were seen in the ASI trade structure, where the same skill sets were identified across different services as described in section 4.2 above.

Where ASI needs to integrate across civil and military organisations, or across organisations in a coalition context as described in Section 3.4, these disconnects are even more pronounced.

5. Emerging Issues from Assessing ASI System Behaviour

Sections 3 and 4 have described the ASI system models for assessing the structure, function and behaviour of the ASI system. This section examines the following issues that have emerged from this assessment: islands of automation; proliferation of liaison officers; monitoring of the airspace; clear air, clear land, clear water; and ASI battle rhythm.

5.1 Islands of Automation

Evaluating the ASI systems inventory, and confirmed during the exercise assessment, revealed the development of "islands of automation" throughout the ASI capability. An island of automation is where a particular C2 node had developed a good technological system for implementing an aspect of ASI, but this technological system was not integrated into the technological systems at other C2 nodes. For example, for the R2E layer, some C2 nodes may use JADOCs, while others use the incompatible C2PC, or BCSS.

Section 3.4 described the macro-system integration, cross-boundary nature of ASI, while Section 4.3 described how the operation-specific ASI organisation is assembled and the presence of isolated processes and organisations within the ASI system. Given this, it is not unexpected that islands of automation exist for particular C2 nodes or sets of C2 nodes. The challenge for capability designers is how to design technological systems for ASI that enable the ASI activities at each node and allows these systems to be loosely-coupled to other technological systems at other C2 nodes particularly as these C2 nodes cross-boundaries (service boundaries, national boundaries).

5.2 Proliferation of Liaison Officers

The ASI trade structure highlighted the high number of liaison officer positions in the ASI C2 Structure. These liaison officers form a manual means for addressing the problems caused by the islands of automation discussed above. While liaison officers can manually fill the gaps in a socio-technical system, there are cognitive limitations to the number of parallel events that they can track at one time, particular when responding to events. Further, in order to effectively understand and fill gaps in the socio-technical system, liaison officers need specific skills and training on a career trajectory to be effective, particularly at the MAJ(E) and above.

The key challenge for the design of an ASI system concerns identifying the key ASI activities liaison officers need to perform as a result of system integration shortfalls in a particular socio-technical system design.

5.3 Monitoring the Airspace

Section 3.4 described ASI as an integrative capability at the macro-systems level across the components shown in Figure 1. As the activities in the IBE layer of the Activity Model (Figure 4) suggest, key aspects of ASI include knowing the location, tasking and limitations of the physical assets in the airspace and on the surface in real or near-real time and being able to communicate that knowledge to other roles in a timely fashion (the Battlespace Commentary activity in the ASI Activity Model).

A fundamental question is how to construct a "Recognised Air Surface Picture" (RASP) that integrates across all the components shown in Figure 1 in a cross-boundary context. The RASP is a key enabler for coordinating, controlling and deconflicting the airspace and for allowing adaptivity in the R2E layer. In the current ASI system, monitoring the airspace can be achieved through three different of socio-technical mechanisms, each with implications for the creation of a RASP.

Procedural control involves assigning each airborne asset[5] a volume of airspace or pre-planned flight path to operate in for a period of time. Airborne assets are responsible for operating within the assigned volume of airspace, or checking-in with the appropriate air traffic controllers when they want to move between volumes of airspace. There are a number of issues which arise from procedural control. Airborne assets must stay within the assigned volume of airspace or negotiate with the airspace controller for a new space. Also, the airspace controller must contact the airborne asset by voice to determine the exact location of the airborne asset at any time (which requires persistent and pervasive communication coverage). Only friendly aircraft which are aware of the procedural control measures can be reliably monitored in this system, whereas the controller would also like to know about enemy air assets and launched weapons. A final issue is that the manual nature of procedural control risks cognitive overloads for the air traffic controller in managing complex airspaces.

Positive control means that the aircraft are being tracked in real-time via radar and that the location of the airborne asset is always known. The issues with positive control include: that radars only operate in line-of-sight and have range, terrain and environmental limitations; that radars need to be calibrated (especially for mobile radars); when multiple radars are operating, the tracks need to be correlated across radars.

Blue-force tracking provides a transponder signal from both surface and air blue force assets allowing the generation of a RASP. Blue-force tracking provides the benefits of procedural control, with the location of the assets, without the costs of positive control. This system can only be used to monitor assets with blue-force tracking (which obviously does not include enemy air). Another key issue with blue-force tracking is the latency in the system and the rate of updates. Latency and update rates for surface assets may not be suitable for airborne assets given their different velocities. If there are significant latency issues, then correlating blue-force tracking pictures with radar pictures becomes more difficult.

The technical design of a modern ASI system now includes airspace monitoring configurations as combinations of procedural control, positive control and blue-force tracking for the IBE layer of the ASI activity model. The key element in the socio-technical design is ensuring that the workforce inventory fit is aligned with the particular configuration of airspace management configuration options, and that the liaison officer design issues described in Section 5.2 match the airspace configuration option.

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[5] Airborne assets may include fixed-wing aircraft, rotary-wing aircraft, UAVs, missiles and munitions.

5.4 Clear Air, Clear Land, Clear Water

The “clear air”, “clear land”, “clear water” activities are stressed by two factors: the cross-boundary nature of ASI, and the use of non-radar mechanisms for monitoring the airspace. The cross-boundary nature of ASI means that a weapon may need to transit through ACMs managed by different roles, from different services, and potentially controlled number of nations.

Constructing a “clear path” for the weapon may be relatively straightforward if all roles are using the same system with positive control with the same integrated information feeds and can collaborate in real-time to ensure a “clear path” through the multiple ACMs in the airspace in a deconflicted manner and provide the “clear air” call. The Tactical Air Integration System (TAIS) is an example of such a system.

The “Clear Air” call becomes more complex when:

- procedural control is being used as each ACM to be transited requires the role responsible for each ACM to manually contact each airborne asset and clear a path through the airspace;
- different systems are used for positive control with non-integrated feeds, meaning that the role responsible for each ACM can more easily clear a path, but the construction of the path is still a manual, voice process between the roles across the relevant ACMs, increasing the risk of error if the “path” is not entered in the same way on each system (either due to manual error, or different mapping accuracy on each system);
- different latencies across systems resulting in “clear air” calls being provided when the airspace is not deconflicted. This is particularly of concern if a hybrid blue-force tracker and radar system is used for airspace monitoring.

5.5 ASI Battle Rhythm

The “clear air” call issues are an example of the complexity arising from the cross-boundary nature of ASI and the need for a clear ASI Battle Rhythm across these boundaries.

An ASI Battle Rhythm is needed for the DBE layer to ensure that there is time for appropriate planning input, that all the inputs are synchronised and deconflicted, that appropriate plans (ATOs, ACOs etc) are produced and have time to be disseminated and updated if required. This process becomes more difficult as the operation crosses Service and National boundaries, and is a good example of the need to push the Joint C2 construct into the tactical battlespace as outlined in Section 1.

An ASI Battle Rhythm is needed for the IBE layer. Airspace controllers have well established mechanisms for “handing-off” airborne assets as they move between ACMs. More critical is the battle rhythm that ensures “clear air” across ACMs as described in Section 5.4.

The ASI Battle Rhythm for the R2E layer can be both the simplest and most difficult of constructs. At its simplest, the ASI Battle Rhythm for the R2E layer involves the allocation of assets on stand-by to respond to the emerging event – for example aircraft assigned for combat search and rescue are launched if such an event occurs. The ASI Battle Rhythm becomes more complex when all the assets are assigned to other tasking, and assets need to be re-tasked, or additional assets need to be acquired from the operational level. In these circumstances, an assessment needs to occur not only of how to respond to the event, but also of the impact on both today's ATO, and the flow on implications for future ATOs. The reassignment of assets or requests for additional assets can be further complicated when the response crosses service boundaries and national boundaries. The key issue is how to have situation awareness of the priorities, the allocation of assets, and the opportunities to reallocate assets while respecting national tasking boundaries.

6. Conclusions

This paper describes a systems analysis approach to ASI in an Australian context, presenting ASI models that describe the structure, function, and behaviour of the ASI system. ASI is an inherently cross-boundary capability that emerges at the macro-system level integrating the components into a coherent system for coordinating, controlling and deconflicting operations in the air and on the surface.

The ASI models have been used to predict the performance of the ADF ASI system during an exercise. The key issues that emerge are primarily at the cross-boundary system integration level from a socio-technical perspective.

Future work for this study is to apply the ASI models described in this paper to evaluate socio-technical options for the ASI capability as a result of introducing planned systems to be acquired under the Australian Defence Capability Plan as well as other systems. The options will be examined in terms of:

- whether the allocation of roles performing activities from the ASI systems inventory remains valid (a simple substitution)
- whether there is a reallocation of activities between roles
- whether some roles are no longer required or additional roles need to be created

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References

Andres, R.B. and Hukill, J.B. *Anaconda: a flawed joint planning process*, Joint Force Quarterly, December 2007.

Neal, C.V. *JAGC2: A Concept for Future Battlefield Air-Ground Integration*, Field Artillery, November-December, 2006, pp13-17.

O'Neill, J., G. Kingston, F. O'Brien *Models of Jointness: Infrastructure Issues for Inter-Organisational Working*, 7th ICCRTS, 2002.

Pengelly, R. *UK confronts increased air-land integration*, Jane's International Defense Review, January 2009 p5.

Senge, P. *The Fifth Discipline: The Art and Practice of the Learning Organisation*, Currency, 1990.

Smyth, H. *From Coningham to Project Coningham-Keyes: Did British Forces Relearn Historical Air-Land Cooperation Lessons During Operation Telic?*, Defence Studies, Vol. 7 No. 2, 2007, pp 258-286.