5th Generation Air C2 and ISR

Exploring new concepts for Air Command & Control and Intelligence, Surveillance & Reconnaissance related to F-35 employment in the RAAF and RNLAF

Bart A. Hoeben

5th Generation Air C2 and ISR

Exploring new concepts for Air Command & Control and Intelligence, Surveillance & Reconnaissance related to F-35 employment in the RAAF and RNLAF

Lieutenant-Colonel Bart A. Hoeben
Royal Netherlands Air Force

International Fellowship Paper

Disclaimer

The views expressed in this work are those of the author and do not necessarily reflect the official policy or position of the Department of Defence, the Royal Australian Air Force or the Government of Australia. The Commonwealth of Australia will not be legally responsible in contract, tort or otherwise, for any statements made in this document.

NATIONAL LIBRARY OF AUSTRALIA

A catalogue record for this book is available from the National Library of Australia

Published and distributed by:

Air Power Development Centre
F3-G, Department of Defence
PO Box 7932
CANBERRA BC 2610
AUSTRALIA

Telephone: + 61 2 6128 7041
Facsimile: + 61 2 6128 7053
Email: airpower@defence.gov.au
Website: www.airforce.gov.au/airpower

About the Author

Lieutenant-Colonel Bart Hoeben was born 3 March 1965. He joined the Netherlands Royal Air Force at age 21. After five years of military training and academic studies at the Royal Military Academy, Bart received his officer's commission in 1991. After training as a Fighter Controller and Air Battle Manager, Bart spent the first part of his career serving in Air Command and Control positions in The Netherlands and Germany, including a four-year tour on NATO AWACS. He was deployed several times for NATO peace-keeping and peace-enforcing operations. In 2007 Bart moved to Washington DC, to work in the F-35 Joint Program Office in the Interoperability Integrated Product Team. After returning to The Netherlands in 2009, Bart was assigned to a Joint Intelligence Surveillance and Reconnaissance requirements position in the Ministry of Defence. After a year of study at the Netherlands Defence College from 2012 to 2013, he returned to the Ministry of Defence to work as a Senior Staff Advisor in Unmanned Aircraft Systems, Space and Air Operations Control. In 2016, Bart filled the position of International Fellow at the Royal Australian Air Force Air Power Development Centre in Canberra, Australia.

Author's Preface and Acknowledgement

I've always wanted to make time to write down my thoughts on how I believe Air C2 and ISR could be improved to cope with the challenges and opportunities of the 'information age'. As a Fighter Controller by trade, I have been involved in Air C2 my whole military career. In my 25 years as an officer of the Royal Netherlands Air Force, I've seen 'my' Air Force change significantly. RNLAF evolved from being a relatively small part of an industry-age war machine on high readiness during the Cold War to an absolute small expeditionary Air Force. In recent decades, this Air Force has been hitting well above its weight in various operations. Surprisingly, I have not seen Air C2 change that much. To me, it seems that we fundamentally still apply industry-age-based Air C2 to our Air Forces. The Air C2 tenet of 'centralised command and control, decentralised execution' that remains a mantra of many scholars and practitioners of air power illustrates my point. Moving into the Information Age, I often ask myself the question if and how we, the air power professionals, could break free from this 'management straightjacket' and harvest the benefits of the Information Age as we so commonly do in our daily lives to make decisions. This is a time when no question needs to be left unanswered. This is the time of 'instant knowledge', as I call it. This is the time of *Google* (or *Bing*, if you're into that…).

To say that ISR is the military equivalent of *Google* overstates the case somewhat. But, isn't that what we actually want? Being able to have that instant knowledge to support our military operations when we make life-and-death decision? While I agree that you should not always believe what you find on *Google*, we nonetheless require more information quality assurance in our military version of *Google* ('Moogle'). However, the principles of being able to access the information you need, when and where you need it, is very powerful. Having worked ISR and UAV requirements for almost six years, I've had the chance to peak into the world of military information. The world of ISR has gone through a significant change as well. The military information profession has grown from a 'behind-closed-doors' intelligence activity to a modern information enterprise. This change was driven by operational experience in counter insurgency operations, new technologies, and force-wide acknowledgement of the value of the information provided through ISR. Yet, although I think the concept of a 'Combat Cloud' is here to stay, we are a long way of launching 'Moogle'.

I've also had the opportunity to work on the development of the F-35 Lighting II. For almost three years, I was part of the Interoperability Integrated Product Team in Washington, D.C., responsible for assuring that the F-35 would be able to exchange information within the battle space. Having up-close knowledge about the capabilities that the F-35 will bring to our Air Forces, made me understand that we now have a chance to progress significant into the information age. However, although the introduction of

the F-35 may be an important trigger to explore ways to grab that chance, it is not 'just' introducing the F-35 that will get us there. To reach its full potential, F-35 employment needs to be met with new ways of making decisions (Air C2) and managing information to support those decisions (ISR).

When I learned that there may be an opportunity for an RNLAF officer to fill an international fellowship at the RAAF Air Power Development Centre in Australia, I didn't have to think for more than a few seconds for a suitable topic: Air C2, ISR and F-35. A few months later, the journey started that would lead to this fellowship paper. At first, my focus was very technical and tactical, that is, right within my comfort zone and in line with the initial study proposal: Air C2 – ISR integration, related to F-35 employment. However, going through discussions with RAAF Air C2 and ISR colleagues and stimulated by my mentor, Dr Sanu Kainikara, I realised that the technical and tactical level were only part of the puzzle. So that's when my journey really started: at the moment when I had to discontinue pursuing finite answers to well defined questions. I ventured into an area that to me, and to many colleagues I consulted with, is new: rethinking concepts for Air C2 and ISR at the operational and strategic level related to the evolution towards a 5th Generation Air Force.

As with almost all studies, time was short. I could have gone on exploring new concepts until I would have lost my way back. Not only because of the vast open (Air C2, ISR and F-35) research area that lay before me. I also wandered into what was for me the unknown world of RAAF, a world which proved to be exciting and full of professionalism, growth potential, good ideas and cooperation opportunities. Luckily, my mentor was there to give me two essential words that would guide me back to this fellowship paper: 'Start writing!'. And so I did, resulting in a paper that perhaps only scratches the surface of an exciting journey our Air Forces are undertaking towards becoming more agile through new concepts of Air C2 and ISR in relation to F-35 employment. I can only hope my work contributes to the successful transformation to a 5th Generation Air Force.

I would like to express my gratitude to all my RAAF, RNLAF and NATO colleagues who offered their time and expertise to this fellowship paper. I mention specifically WGCDR Rob Elliot and SQNLDR Rod Barton from HQ RAAF ISR; WGCDR Tracy Douglas from Team *Jericho*; WGCDR Julian Greening from HQ RAAF AIR6500; WGCDR Stephen Gray from DGS AUS; LtCol. Wilbert Ligtenberg, Maj. Stuart Lorraine, Maj. Jan ter Braake, and Capt. Antonie Franken from HQ RNLAF C4ISR; Maj. Corné Luijkx from the RNLAF HQ F-35 Transition Team; Maj. Marije Willigenburg from the RNLAF A&SWC; Maj. Freek van Heck from NLD MoD Plans Directorate; LtCol. Fred Akkerman from NATO CAOC2; LtCol. Jos van de Moosdijk from NATO Join Forces Command Brunssum, and LtCol. Ron Brunsting from the Netherlands Defence Academy. A special thanks to GPCAPT Richard Pizzuto, whose creative thinking helped me venture beyond known territory. My utmost

gratitude goes to my mentor, Dr Sanu Kainikara, for his guidance, patience and wisdom. I'm going to miss the colourful discussions we shared on many security topics throughout the year.

Last but not least, I would like to thank my partner Monique Valoes for putting up with the many weeks I claimed our living room table for typing my paper, and her sound analytical advice on many items of my study. It was a wonderful year, both professionally and personally with you, Monique!

Contents

Abbreviations and Acronyms

A2/AD	Anti-Access/Area-Denial
ACCS	Air Command and Control System
ACO	Airspace Control Order
ADF	Australian Defence Force
AEW&C	Airborne Early Warning and Control
Air C2	Air Command and Control
AJP	Allied Joint Procedure
AOC	Air Operations Centre
AOD	Air Operations Directive
ASACS	Air Surveillance And Control System
ATO	Air Tasking Order
AWACS	Airborne Warning And Control System
BDA	Battle Damage Assessment
BLOS	Beyond Line of Sight
C4ISR DA	Command, Control, Communication. Computers, Intelligence, Surveillance and Reconnaissance Design Authority
CAOC	Combined Air Operations Centre
CFAC	Combined Force Air Component
CIOG	Communication and Information Officer Group
CIS	Communication and Information System
CISSO	Command and Intelligence Systems Support Office
CM	Collection Management
COA	Course Of Action
COM	Collection Operations Management
COP	Common Operational Picture
CR	Collection Requirement
CSAR	Combat Search And Rescue
CSD	Coalition Shared Database
CTP	Common Tactical Picture
DGS-AUS	Defence Ground Segment Australia
DMO	Distributed Mission Operations
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership and education, Personnel, Facilities and Policy
DSAR	Distribution – Storage - Archival – Retrieval
ESM	Electronic Support Measures

EPIE	European Partnership ISR Enterprise
F2T2EA	Find – Fix – Track – Target – Engage – Assess
FAST	Flexible, Advanced C2 services for NATO Joint Time Sensitive Targeting
FMV	Full Motion Video
GBAD	Ground Based Air Defence
GSC	Ground Control Station
HALE UAV	High Altitude Long Endurance Unmanned Aerial Vehicle
IADS	Integrated Air Defence System
ICT	Information & Communication Technology
IR	Intelligence Requirements
IRM&CM	Intelligence Requirements Management and Collection Management
IS	Islamic State
ISR	Intelligence, Surveillance and Reconnaissance
JAOP	Joint Air Operations Plan
JFACC	Joint Forces Air Component Commander
JFC	Joint Forces Commander
JISR	Joint Intelligence Surveillance and Reconnaissance
JOC	Joint Operations Centre
JTF	Joint Task Force
LOO	Line Of Operation
LVC	Life Virtual Constructive
MAAP	Master Air Attack Plan
MAJIIC	Multi-intelligence All-source Joint ISR Interoperability Coalition
MALE UAV	Medium Altitude Long Endurance Unmanned Aerial Vehicle
MASE	Multi-Aegis Site Emulator
MOD	Ministry of Defence
MOE	Measure Of Effectiveness
MOP	Measure Of Performance
NAC	North Atlantic Council
NADGE	NATO Air Defence Ground Environment
NASOC	National Air and space Operation Center
NOIS	Netherlands Operational ISR Service
OAF	Operation *Allied Force*
ODS	Operation *Desert Storm*
OEF	Operation *Enduring Freedom*
OIF	Operation *Iraqi Freedom*

OOD	Operation *Odyssey Dawn*
OODA	Observe – Orient – Decide – Act
OPCOMD	Operational Command
OPCON	Operational Control
OUP	Operation *Unified Protector*
PED	Processing – Exploitation – Dissemination
R2P	Responsibility to Protect RAAF
RAAF	Royal Australian Air Force
RAP	Recognized Air Picture
RDAF	Royal Danish Air Force
RNLAF	Royal Netherlands Air Force
RNOAF	Royal Norwegian Air Force
ROE	Rules Of Engagement
RTS	Raise, Train and Sustain
SA	Situational Awareness
SAPF	Special Access Program Facility
SCAR	Strike Coordination Armed Reconnaissance
SCIF	Secret Compartmented Information Facility
SOF	Special Operating Forces
TACS	Tactical Air Control System
TACOMD	Tactical Command
TACON	Tactical Control
TBM	Theatre Ballistic Missile
TBMCS	Tactical Battle Management Core System
TBMF	Tactical Battle Management Function
TCPED	Task – Collect – Process – Exploit – Disseminate
TST	Time Sensitive Target
TTP	Tactics, Techniques and Procedures
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
USA	United States of America
USAF	United States Air Force
VCDF	Vice Chief of Defence Force

Executive Summary

In future conflict, we may end up having to fight a peer adversary. In such a fight, we will not have a decisive technology advantage. Furthermore, it is likely that we will be physically outnumbered. In that fight, the way we orchestrate our force will be vital in gaining us the advantage and ultimately to win the conflict. Air Command and Control (Air C2) is all about orchestrating our Air Forces. Through exercising Air C2, we strive for decision superiority. A major stepping stone towards achieving decision superiority is achieving information superiority. Intelligence, Surveillance and Reconnaissance (ISR) aims at just that.

The future operation environment in which we fight a peer adversary has the potential to become very complex and highly dynamic. In that environment, we need to be able to adjust our actions constantly to cope with any situation that may develop and react in real-time to emerging threats and opportunities. We need to be agile; ready to resort to high degree of dynamic (re-)tasking to out-pace and out-manoeuvre the adversary. This puts extraordinary strain on the real-time link between Air C2 and ISR to achieve and maintain decision superiority.

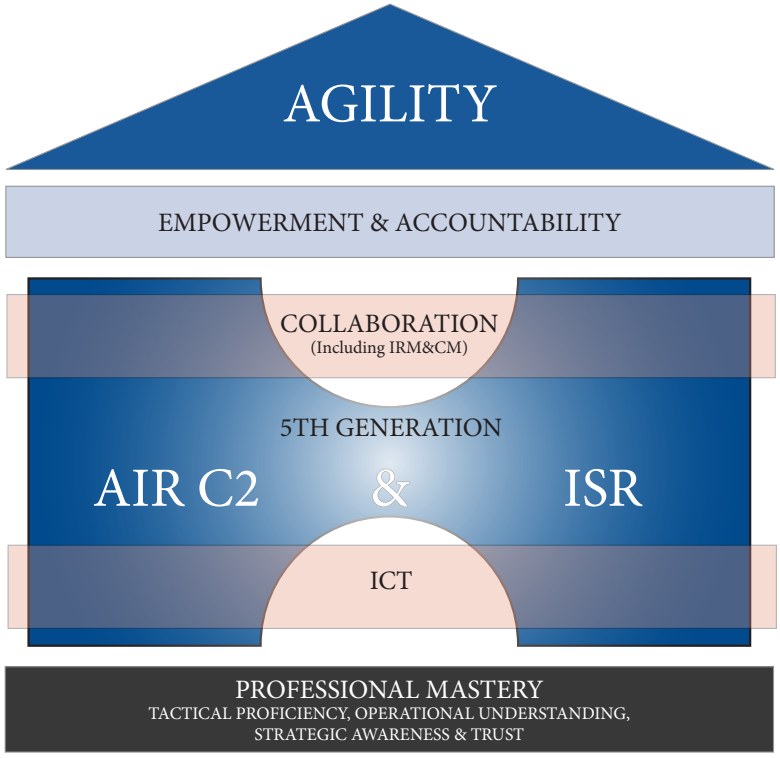
Both the RAAF and the RNLAF will significantly transform during the next decade, as captured in Plan *Jericho* and CLSK 3.0.[1] One of the driving factors for the transformation is the introduction of the F-35 Lightning II. To employ it effectively and efficiently, RAAF and RNLAF will have to look critically at how we operate, and probably apply new concepts. Both Forces have a vested interest in understanding how current and planned Air C2 and ISR systems and concepts support exploiting the RAAF and RNLAF combat potential to the max. They furthermore share the interest in evolving Air C2 and ISR to suit F-35 employment in a future, 5th Generation Air Force to achieve the required agility to operations at the tactical, operational and strategic level. This paper explores these new concepts for Air C2 and ISR related to F-35 employment.

The paper provides tangible recommendations about improving Air C2 and ISR systems, their integration, collaboration and Information & Communication Technology (ICT) at the tactical level, including the possible application of a combat cloud, and towards F-35 employment and follow-on development. It furthermore explores the possibility for distribution of control towards the tactical edge, concluding that RAAF and RNLAF should further pursue this concept. The paper also looks at command and ISR at the operational level and strategic employment of F-35 and draws two conclusions: first, that new concepts for Air C2 and ISR related to F-35 employment deserve increased attention from RAAF and

1 At the date of publication of this fellowship paper the RNLAF has released the publication '5th Generation Air Force'.

RNLAF, and second, that successfully employing F-35 requires strong(er) influence of RAAF and RNLAF at the operational and strategic level. Overall, the paper recommends possible ways in which RAAF and RNLAF could cooperate to face the Air C2 and ISR challenges and opportunities that come with the transition to a 5th Generation Air Force. This could involve stimulation and facilitating international discussion on new concepts for Air C2 and ISR.

The paper provides a framework for 5th Generation Air C2 and ISR, which illustrates the importance of coherence among Air C2, ISR, collaboration and ICT when formulating requirements for system improvements, tied to enhancing Air C2 – ISR integration at the tactical level. It can also be used as a framework to further discuss the new concepts for Air C2 and ISR related to F-35 employment. Furthermore, the framework supports a broader view of these concepts, including the required professional mastery, collaboration and ICT. Hence, it could also be used as a point of departure for further Air C2 and ISR analysis and concept development to support the transformation towards a 5th Generation Air Force.



Framework for 5th Generation Air C2 and ISR

1. Introduction

Background

In future conflict, we may end up having to fight a peer adversary. In such a fight, we will not have a decisive technology advantage. Furthermore, it is likely that we will be physically outnumbered, as Western military numbers are dwindling and potential adversary numbers are rising. In such a fight, the way we orchestrate our force will be vital in gaining us the advantage and ultimately win the conflict. This goes as much for air forces as for other forces. Air Command and Control (AirC2) is all about orchestrating our air force. Air C2 is fundamental to the effective and efficient employment of Air Power and is distinct from the concept of commanding Air Power.[1] Through exercising Air C2, we strive for decision superiority in order to maximize the lethality of our capabilities and, ultimately, get us the advantage over a peer adversary.[2]

A major stepping stone towards achieving decision superiority is achieving information superiority. Intelligence, Surveillance and Reconnaissance (ISR) aims at just that. The fundamental objective of ISR is getting the right information and intelligence, to the right people, in the right format, at the right time,[3] thus enabling battlespace awareness, information superiority and decision superiority.[4] To achieve this objective, ISR in itself needs to be subjected to Air C2 to 'understand' what that 'right information and intelligence' entails, to collect it and get it 'to the right people, in the right format, at the right time'. Therefore, Air C2 and ISR are inextricably linked in our efforts to achieving decision superiority.

The future operation environment in which we fight that peer adversary has the potential to become very complex and highly dynamic. In this environment, we need to be able to constantly adjust our actions to cope with the situation as it develops and react in real-

---

1 Royal Australian Air Force, Australian Air Publication 1000-D—*The Air Power Manual*, sixth edition, Air Power Development Centre, 2013, par. 6.16.

2 R. Vine, *Theatre Air Control System 2025*, Royal Australian Air Force, 2015.

3 Royal Australian Air Force, Australian Air Publication 1001.3—*The Air Force Approach to ISR*, Air Power Development Centre, 2011, par. 2.4.

4 Ibid., xiii.

time to emerging threats and opportunities. Although we may be able to cope with a peer adversary in the opening phase of a conflict based on pre-planning, one could expect that both our actions and that of the peer adversary reshape the battlefield in such a high tempo that pre-planning cannot keep up. We need to be agile; ready to resort to high degree of dynamic (re-)tasking to out-pace and out-manoeuvre the adversary. This puts extraordinary strain on the real-time link between Air C2 and ISR to achieve and maintain decision superiority.

Rationale for the Paper

Both the RAAF and the RNLAF will significantly transform during the next decade. One of the driving factors for the transformation is the introduction of the F-35 Lightning II. This 5th Generation aircraft will open up new ways of achieving information superiority and creating kinetic and non-kinetic air power effects. In order to employ the F-35 effectively and efficiently, we will have to look critically at how we operate and apply new concepts beyond those applicable to current generation fighters such as F-18 and F-16. Alongside the F-35, there are many more new capabilities on the horizon. For RAAF, systems like the E/A-18G Growler electronic warfare aircraft, the P-8A Poseidon maritime surveillance and response aircraft, the high altitude MQ-4C Triton unmanned aircraft, and the Vigilare air surveillance system are setting the stage for future operations. For RNLAF, the Medium Altitude Long Endurance Unmanned Aerial Vehicle (MALE UAV), the National Air and Space Operations Centre (NASOC), the Air Command and Control System (ACCS) and the Netherlands Operational ISR Services (NOIS) will, alongside the F-35, drive that change.

With those changes comes the need for organisational transformation and aspiration. Both RAAF and RNLAF have captured those aspirations in transformation plans: Plan *Jericho* for the RAAF and CLSK 3.0[5] for the RNLAF. Both plans acknowledge the necessity for transformation and innovation to keep pace with the rapidly changing world we live (and fight) in. Both plans aspire to ensure that RAAF and RNLAF deliver air power that matters, now and in the future. Both plans depict themes along which the transformation is shaped. The scope of this paper is linked to the common theme that focusses on innovation to enhance combat potential.

In Plan *Jericho*, that theme is worded as 'Harness the combat potential of a fully integrated force.' The theme revolves around 'force integration … essential for superior decision

5 At the time this fellowship paper was published, the RNLAF had released the brochure '5th Generation Air Force', which captures the transition towards a 5th Generation force more explicitly than CLSK 3.0.

making and delivery of effect.'[6] Here, decision superiority is directly linked to this theme. In CLSK 3.0, 'realising … 100% situational awareness' through 'enhancing C4ISR capabilities' links to the strategic aim 'renewal of the operational domain.'[7] In their plans, both organisations (explicitly or implicitly) acknowledge that decision superiority is the number one objective for Air C2; both understand that this requires information superiority (with ISR as a major contributor).[8] Also, both organisations spend billions of dollars/euro's on new capabilities to enhance their combat potential. Therefore, they both have a vested interest in understanding how current and planned Air C2 and ISR systems and concepts support exploiting the RAAF and RNLAF combat potential to the max. They furthermore share the interest in new concepts of Air C2 and ISR related to F-35 employment in a future 5th Generation Air Force to achieve the required agility in operations at the tactical, operational and strategic level.

Paper Outline

Chapter 2 sets the scene for this paper by explaining specific terms, concepts and processes that are relevant for this paper. It aims at creating a common understanding of the terms, concepts and processes within the context of this paper. Chapter 3 aims at giving RAAF and RNLAF insight how well Air C2 and ISR are linked (or integrated) now and in the near term once planned Air C2 and ISR programs, projects and associated capabilities have been implemented. These insights are linked to anticipated F-35 employment. Chapter 3 predominantly addresses the technical and tactical level of air operations in a complex and dynamic environment. It identifies strong and weak points within each organisation associated with Air C2 and ISR linkage/integration. In doing so, Chapter 3 identifies best practices within either of the organisations that may benefit the other. This chapter also recommends to both RAAF and RNLAF how to strengthen the Air C2–ISR linkage to help them achieve their aspirations. These recommendations may lead to opportunities for RAAF and RNLAF to cooperate. The findings of Chapter 3 should not be seen as new aspects of Plan *Jericho* or CLSK 3.0 per se, but as a different way of looking at the innovation and transition which these programs pursue.

Chapters 4 and 5 stimulate an international discussion on 5th Generation Air C2 and ISR by exploring new concepts for Air C2 and ISR related to F-35 employment that could enhance agility in air operations. These chapters address a broader spectrum of air operations, from the tactical via the operational to the strategic level. Chapter 4 looks

---

6 Royal Australian Air Force, *Plan Jericho Program of Work*, Canberra, 2015.

7 CLSK 3.0 Masterplan, CLSK, Chapter 2, Strategic starting points, July 2015.

8 The *RNLAF Knowledge and Innovation Plan 2017* explicitly refers to the importance of decision and information dominance.

at the concept of distributed control as a function within Air C2, which ultimately aims at more flexibility at the tactical edge through better use of F-35 capabilities. Chapter 5 discusses the command aspect of Air C2 at the operational and strategic level, also aiming at enhancing employment of F-35. The findings of Chapters 4 and 5 are not explicitly part of Plan *Jericho* or CLSK 3.0. Although the new ideas offered in these chapters go beyond the current scope of these plans, they are implicitly in line with the vision behind the plans: 'Harness the combat potential of a fully integrated force' and 'realizing 100% situational awareness through enhancing C4ISR capabilities'. The sixth and last chapter summarises and concludes the paper.

2. Setting the Scene

This paper is written for an audience with a coherent knowledge of Air C2 and ISR and conceptual knowledge of the F-35 as a combat system. Nonetheless, before diving into the matters, it is important to explain specific terms, concepts and processes used in this paper. In order to create common understanding of the scope, this chapter talks about Air C2, ISR, Intelligence Requirements Managements & Collection Management (IRM&CM), collaboration, Information and Communication Technology (ICT) and F-35 employment and 5th Generation.

Some of the terms, concepts and processes used in this paper may not completely fit RAAF or RNLAF doctrinal views. However, when addressing specific matters for either RAAF or RNLAF and formulating recommendations, a good doctrinal fit is pursued.

Air Command and Control

Air C2 has many aspects. Although specific Air C2 arrangements for RAAF and RNLAF will be different, the same aspects can be identified and the method followed to establish the specific arrangements is largely similar. The Australian Air Publication 1001.1 *Command and Control in the Royal Australian Air Force*[9] gives a good doctrinal overview all these aspects. It states that (Air) 'C2 binds the people, systems and processes necessary for the Air Force to make capability, policy and operational decisions, and prepare forces for joint operations in order to achieve national objectives. (…) Air Force's C2 architecture is designed to enhance its effectiveness in preparing for and conducting its principal core competency – warfighting.' Within this broad scope, this paper views Air C2 more narrowly. It looks only at Air C2 as an aspect of air operations planning and execution as it is applied by a Joint Forces Air Component Commander (JFACC), an Air Operations Centre (AOC) and the Tactical Air Control System (TACS).

Air C2 at the tactical level is all about the cycle of planning, tasking, execution and assessment of air operations. This cycle is structured into the Air Tasking Order (ATO) cycle, consisting of six steps: (receiving) objectives, effects & guidance, target development,

9 Royal Australian Air Force, Australian Air Publication 1001.1—*Command and Control in the Royal Australian Air Force,* Air Power Development Centre, Canberra, 2009.

weaponeering & allocation, ATO production & dissemination, execution planning & force execution and assessment.[10]

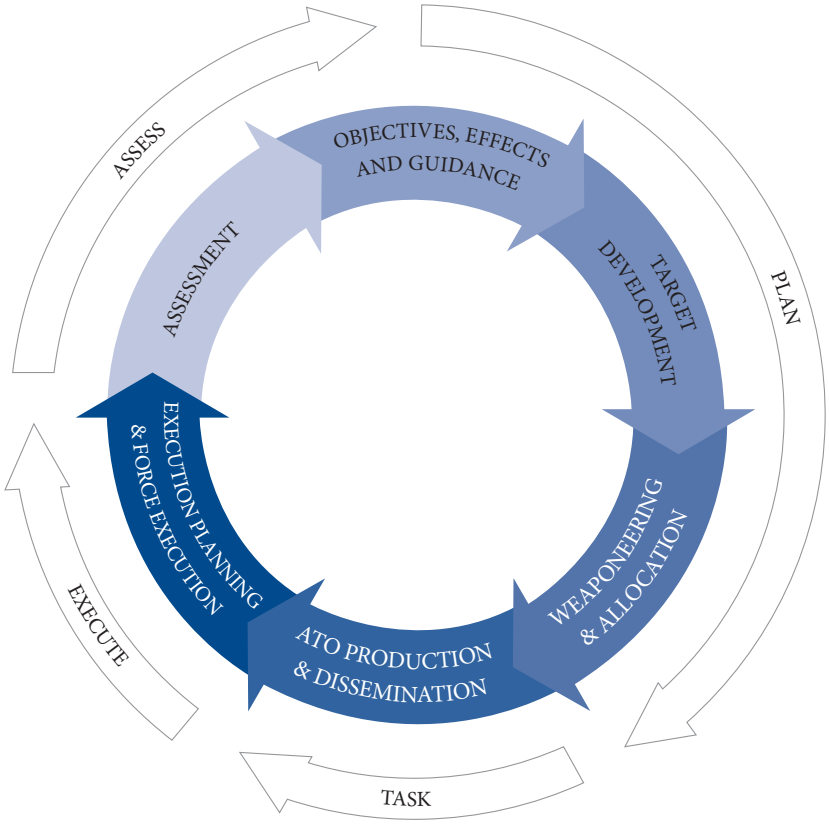


Figure 1: Air Tasking (Order) — cycle

At the operational level, Air C2 is structured through air operations planning, which aims at translating strategy (from the strategic level) to task (at the tactical level). The operational level exercises command over the execution by setting objectives, effects and guidance. It exercises control though oversight and guidance, and assesses if the results of air operations meet the overall objectives. If required, operational and tactical adjustments will be made. Air C2 may not be very tangibly visible at the strategic level. Air C2 at the strategic level could be seen as a command-activity by setting the air strategy and assessing whether the air strategy still lines up with the joint strategy. A way to visualise Air C2 as

10 Joint Publication 3–30, *Command and Control of Joint Air Operations*, US Department of Defense, 10 February 2014, p. III-21.

it is applied at and between the tactical, operational and strategic level is by using three interlinking Observe – Orient – Decide – Act (OODA) loops (Figure 2).[11]

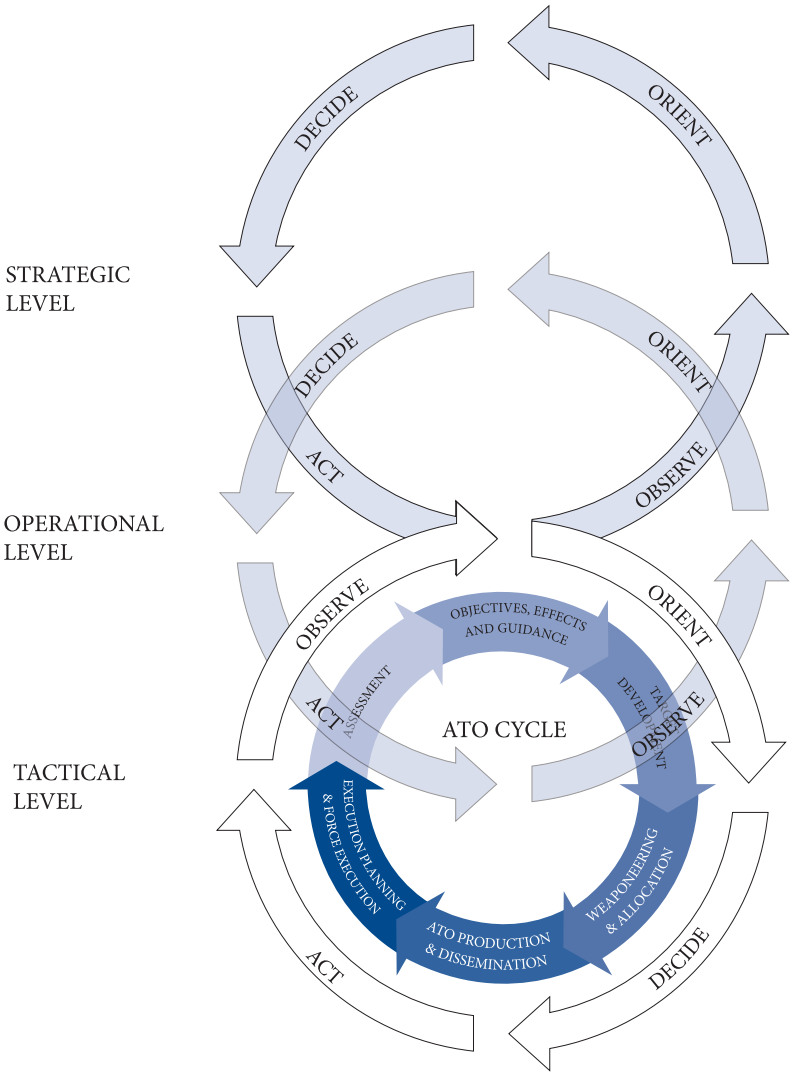


Figure 2: Air C2 at and among the three levels

As we move along the hierarchy from the tactical via the operational to the strategic level, approaching Air C2, ISR and F-35 employment for the purpose of this paper from a single-service perspective instead of a joint perspective may be considered an increasingly self-centred and superfluous exercise. A joint perspective is specifically required within the

11 Based on a presentation from NATO Allied Air Command HQ on AirC2 Systems, 5 September 2016.

context of a high-end conflict against a peer enemy that will undoubtedly have a joint character at all levels. Therefore, this paper also touches on joint aspects at the operational and strategic level to give Air C2, ISR and F-35 the joint context it deserves. Nonetheless, if our Air Forces are able to enhance the effectiveness of air power in that seemingly isolated air context, we still pay joint operations good (or even better) service.

For purpose of this paper, the goal of 5th Generation Air C2 and ISR is to adjust military actions better as the situation unfolds and thus reach better and quicker effects and objectives. In other words, achieve a higher degree of agility. In 'Understanding Command and Control',[12] Alberts and Hayes make the case that traditional command and control approaches lack the agility required for 21st century missions, that are simultaneously more complex and more dynamic. These authors conclude that C2 approaches that are agile and take full advantage of all the available information and assets, are better suited. In their research they define three key factors that can be thought of as the dimensions of a C2 approach towards an edge (agile) organisation (see Figure 3). These dimensions are:

- Allocation of decision rights
- Distribution of information
- Patterns of interaction among the actors

Although Alberts and Hayes take a slightly different approach through this decomposition of C2, they implicitly acknowledge the importance of new (Air) C2 and ISR concepts to achieve a higher degree of agility. After all, the fundamental function of ISR is to distribute information ('getting the right information and intelligence, to the right people, in the right format, at the right time'[13]) and Air C2 is predominately about making decisions. By adding patterns of interaction among actors as the third dimension (see Figure 3), they stipulate the importance of collaboration.

This decomposition gives an opening to explore the utility of current and new systems (including the F-35) and processes for distribution of information (ISR) and their ability to collaborate with each other. Furthermore, decomposing (Air) C2 the way Alberts and Hayes do, gives opening for a discussion on allocation of decision rights that is relevant in relation to the introduction of the F-35. The F-35 will supply pilots with an, until now, unprecedented situational awareness through the use of on-board ISR capabilities

12 'Understanding Command and Control', Alberts and Hayes, CCRP 2006.

13 Royal Australian Air Force, Australian Air Publication 1001.3—*The Air Force Approach to ISR*, Air Power Development Centre, 2011, par. 2.4

(sensors). This leads to a greater ability to adjust actions upon the situation as it unfolds. In order to capitalise on this ability, F-35 may require more freedom to act. In other words, allocation of more decision rights at the tactical (F-35) edge may be required to enhance operational agility.

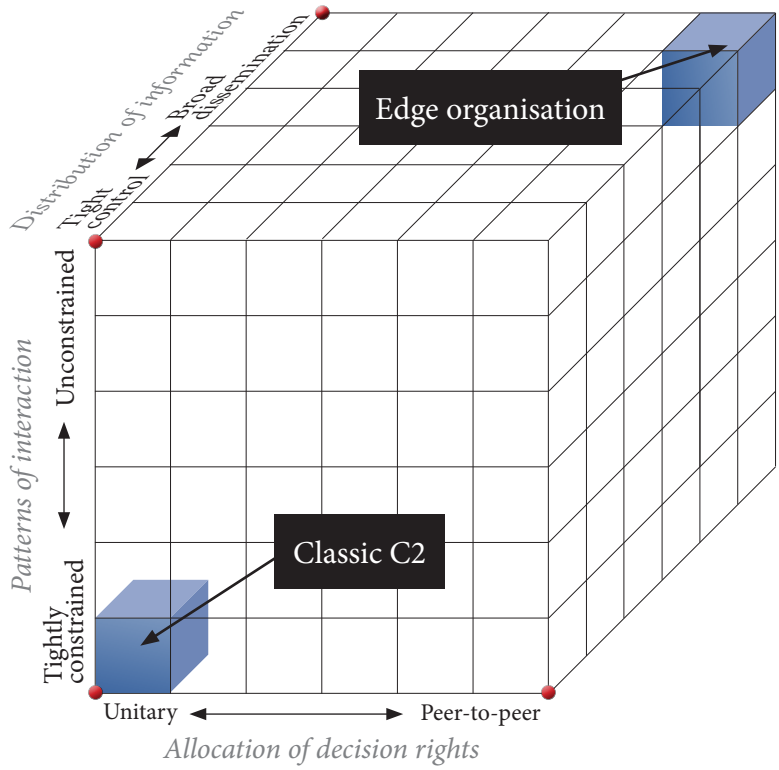


Figure 3: C2 approach space by Alberts and Hayes

Both RAAF and RNLAF (when operating within NATO) follow the Task Organisation C2 structure framework at the operational level, in which a Joint (Task) Force(s) Commander (JFC or JTF Commander) has delegated the operational authority over the assigned air forces to an (Joint Forces) Air Component Commander, the (JF)ACC. The JFACC executes Operation and Tactical Command and Control (OPCOMD, TACOMD, OPCON & TACON) on behalf of the JFC. RAAF and (for RNLAF applicable) NATO Air C2 doctrine define OPCOMD, TACOMD, OPCON and TACON in similar terms, which in detail are not relevant for this paper.[14] Relevant for this paper, and in particular when studying

14 See Australian Defence Doctrine Publication 00.1 *Command and Control* for the definitions. The NATO definitions are captured in a classified procedure.

alternatives for centralised control, is the fact that these definitions facilitate the delegation of these Air C2 functions to a lower level.

The Air C2 process is predominately executed at the tactical and operational level. These levels are not strictly separable. There is a certain degree of osmosis between the tactical and operational level in an Air Operation Centre (AOC). Similar to that, there is osmosis between the operational and strategic level. A good example is that of the JFACC, the operational-level commander, formulating the air strategy for air operations, which strictly taken is a strategic activity. This is also the level where Air C2 is absorbed by (joint) C2. Furthermore, although both command and control are executed at all levels, in practice, command associates more with activities at the strategic and higher operational level and control more with activities at the lower operational and tactical level. Command is about setting of conditions (intent), assessment of the situation and changes to the intent,[15] which are typical activities of the JFACC and above. Control is about staying within the bounds established by intent,[16] typically an activity executed by the AOC and subordinate units. This paper keeps this pragmatic demarcation largely intact because the study area of command at the higher levels, and control at the lower levels, offers plenty of substance without fundamentally short-changing the doctrinal approach of (Air) C2 at the various levels of military operations.

Intelligence, Surveillance and Reconnaissance

There are many ways to describe ISR. Depending on the context, it can be seen as a process, a function, an activity, an enterprise, a capability, etc. RAAF defines ISR as 'An activity that synchronises and integrates the planning and operation of sensors, assets, and processing, exploitation and dissemination systems in direct support of current and future operations'.[17] RNLAF follows the NATO definition of Joint ISR: 'A set of intelligence and operations capabilities, to synchronise and integrate the planning and operations of all collection capabilities with the processing, exploitation, and dissemination of resulting information in direct support of the planning, preparation and execution of operations.'[18] Within this paper, I did not deem it necessary to position ISR as either a process, function, activity, enterprise or capability; this paper assumes ISR to entail all of that.

---

15 David Alberts & Richard Hayes, *Understanding Command and Contro*l, CCRP, 2006, p. 57.

16 ibid., p. 59.

17 AAP 1001.3—*The Air Force Approach to ISR*, p.2-2.

18 NATO AJP-2.7, 'Allied Joint Doctrine for Joint ISR, Edition A Version 1, July 2016, p. 1-2 .

Two models are given to narrow down the study area at the tactical level. The first, taken from the AAP 1001.3 'The Air Force Approach to ISR' is very generic and stipulates ISR to be the intersection of intelligence and operations functions[19] (see Figure 4).

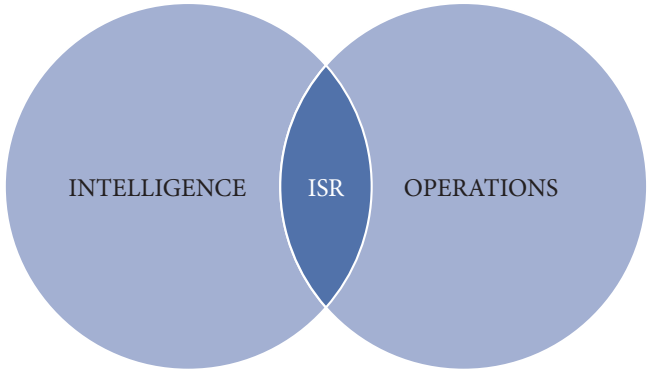


Figure 4: ISR—The intersection of intelligence and operations functions

In this model, ISR could be envisioned as a front-office activity and intelligence as a back-office activity. Although doctrinally not 100 per cent correct, it does create a helpful mindset for this paper.

The second model is derived from the Joint ISR Model designed within the MAJIIC[20] program. It takes a process view of operations, ISR and Intelligence cycles, and how they interact. The model shows the dependencies between the three cycles and also stipulates the difference interactions or flows between them (see Figure 5).

19 AAP 1001.3—*The Air Force Approach to ISR*, p.2-7.

20 MAJIIC stands for Multi-intelligence All-source Joint ISR Interoperability Coalition, a 9 (NATO) nations applied research and development program aimed at the interoperability and collaboration aspects of Joint ISR.

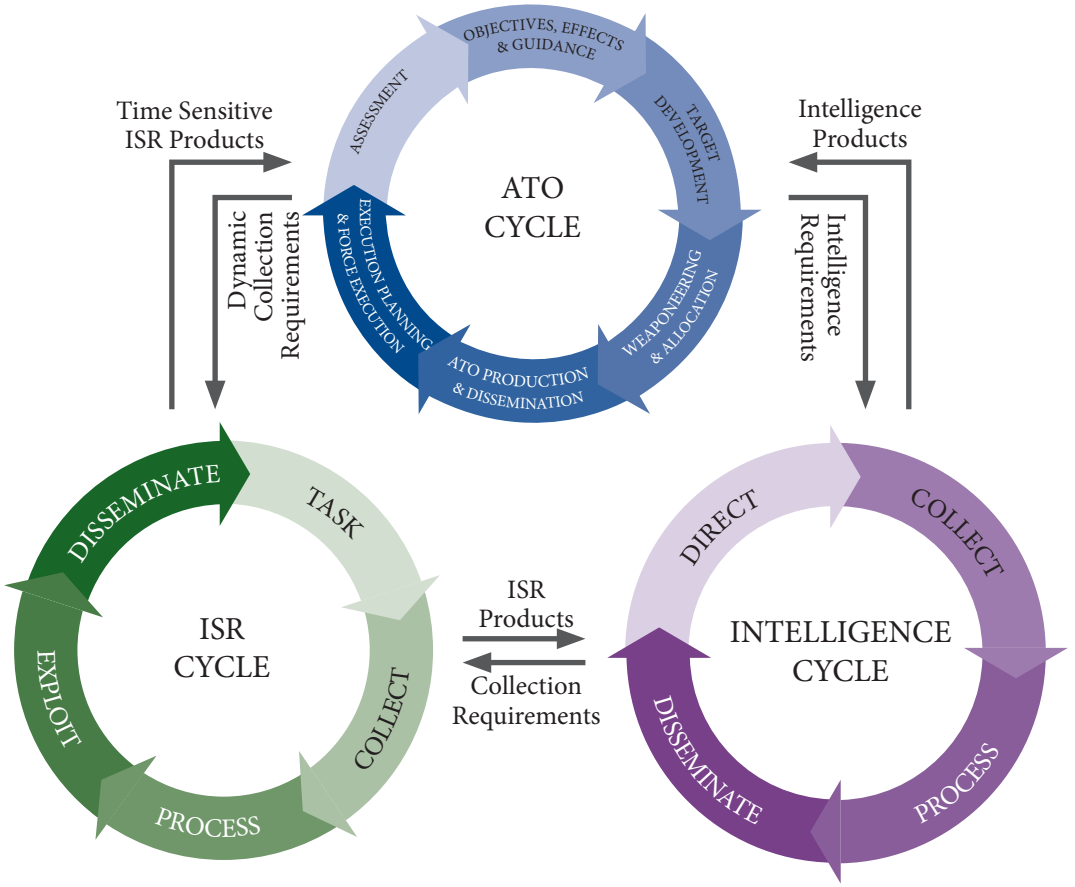


Figure 5: MAJIIC Joint ISR model

The model specifically aims to illustrate the work field of real-time interaction between Air C2 and ISR (Air C2 – ISR integration) at the tactical level, as this was one of the focus areas of the MAJIIC program.[21] Chapter 3 focuses on the time-sensitive (real-time) interaction between the operations and ISR cycles. To make the operations cycle more tangible in this chapter, it is replaced by the ATO cycle which, in this case, does not fundamentally change the model (Figure 6). This paper does not address the steps in the ISR cycle (Task–Collect–Process–Exploit–Disseminate; TCPED). It considers the ISR process a black box.

21 Specifically in the MAJIIC 2 program.

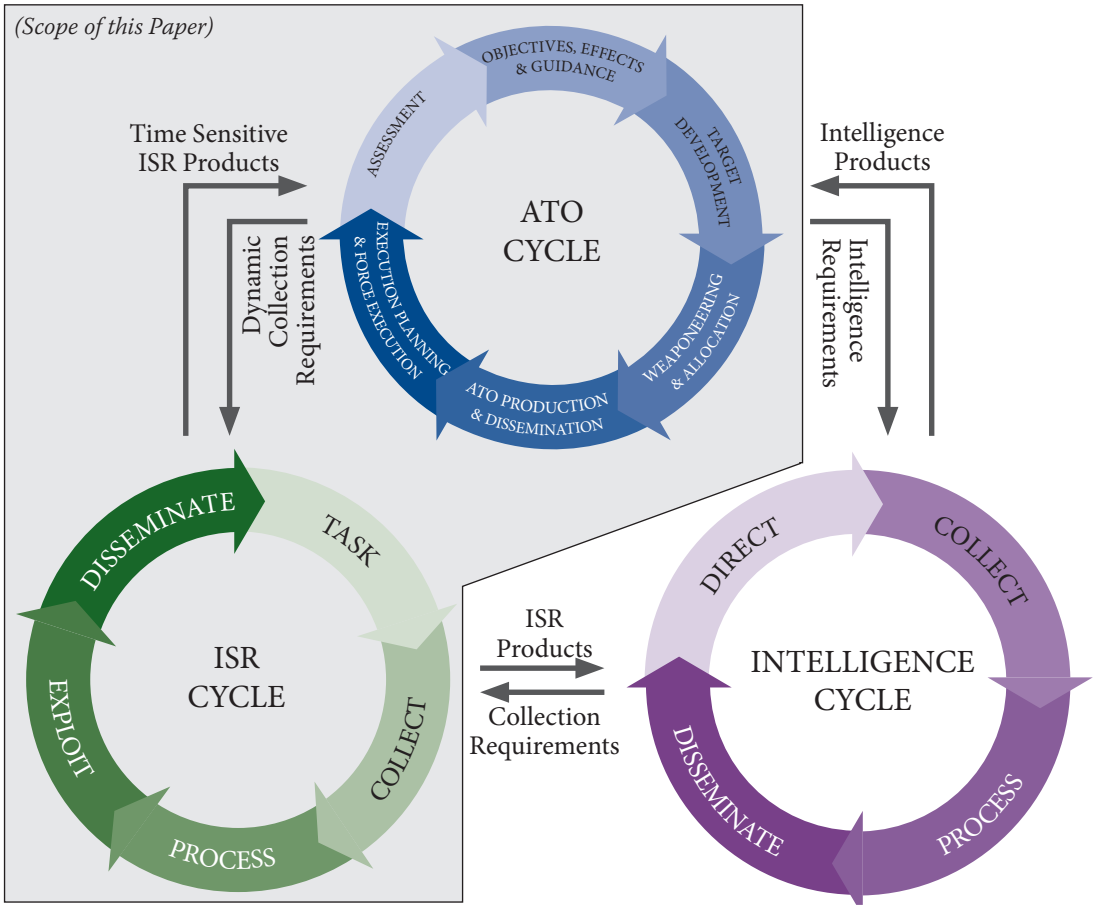


Figure 6: Joint ISR model at the tactical level

As we move up the military levels towards the operational and strategic level, the distinctive interactions between the operations and ISR cycles on one side and the operations and intelligence cycles on the other become less noticeable. From the viewpoint of the operations cycle, the ISR cycle and intelligence cycle start to functionally converge until they overlap (see Figure 7). The reason for this convergence could be found in that there is less time-sensitive Air C2 interaction between ISR assets and commanders at the operational level, and traditionally almost no time-sensitive interaction of this kind at the strategic level. As I will show in this paper, this does not mean there is no value in that real-time interaction.

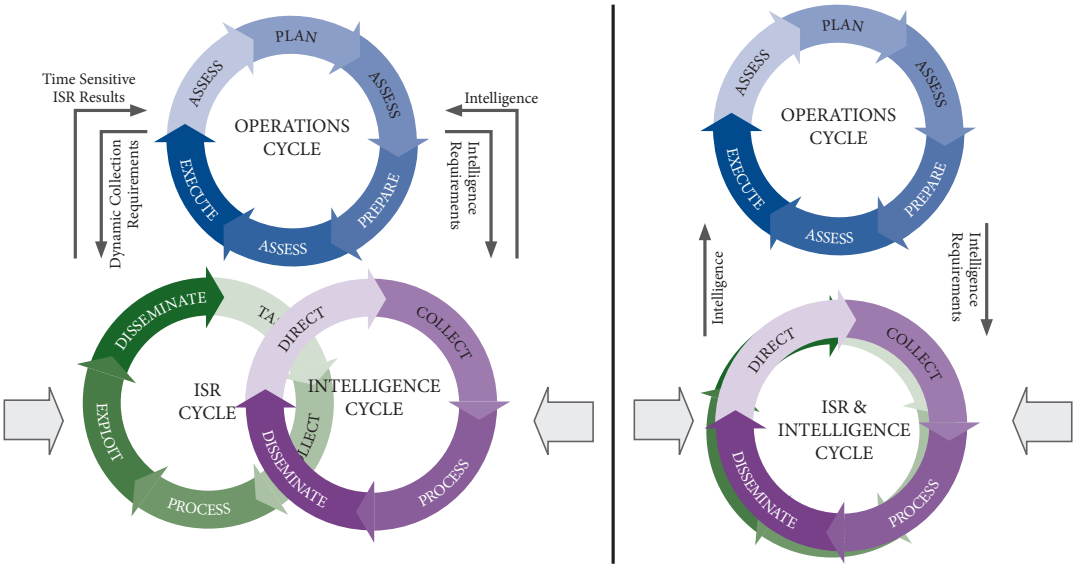


Figure 7: ISR and Intelligence cycles convergence

The ISR and intelligence cycles deliver different products. In general, the products of the ISR cycle can be described as information and single-source intelligence. This paper describes this as the 'ISR result', in line with the NATO-Allied Joint Publication 2.7 'Allied Joint Doctrine for ISR'. The (all-source) products of the intelligence cycle are defined as intelligence.[22] There can be confusion or discussion about denomination of information provided by sensors like Air Defence radars and targeting pods as ISR results. This paper assumes that any type of sensor information can be used as ISR result, regardless of whether the ISR cycle provides tasking for these sensors or not. However, that does not suggest that these sensors are classified strictly as ISR sensors, as this could quickly digress into a (in this paper, and often for operations) futile discussion of tasking authority, priority and ownership.

Intelligence Requirements Management and Collection Management (IRM&CM)

IRM&CM is one of the supporting processes of the operations cycle. It ensures that information and intelligence requirements are properly articulated and answered and all available collection capabilities are focussed and prioritised. IRM&CM plays an essential role in connecting Air C2 and ISR at the tactical, operational and strategic level. It can also be related to Alberts and Hayes' C2 model because IRM&CM is about facilitating

22 RNLAF frequently uses the term 'validated intelligence' to articulate the often multi-source analysis-process that is associated with the products of the intelligence-cycle.

distribution of information and collaboration in support of decision making. Because IRM&CM is not yet well-known outside the ISR/intelligence community, I provide a high-level overview of IRM&CM as described in the NATO AJP 2.7 'Allied Joint Doctrine for Joint ISR' is provided. Although RAAF does not use this publication, the basic description of IRM&CM agrees enough with RAAF procedures to support this paper.

The IRM function validates, refines and prioritises both standing and emerging Intelligence Requirements (IRs). IRM also determines if these IRs can be answered by already available ISR results or intelligence, ensures quality control of the outputs, and oversees dissemination of the ISR results and intelligence. IRM is supported by CM in satisfying those IRs that cannot be answered by already available ISR results or intelligence. The CM function converts these IRs to Collection Requirements (CRs) and prioritises them. CM tasks the collection capabilities (such as ISR assets), monitors the results and re-tasks collection capabilities as required. To do this, CM considers the available assets, sensor coverage, environmental conditions and communication capabilities to make the best use of the collection capabilities. Within CM, two functions can be distinguished: Collection Requirements Management (CRM) and Collection Operations Management (COM). CRM involves planning CM, COM involves mission integration of CM into the overall air operation, including integrating pre-planned, ad hoc and dynamic ISR tasks into the ATO cycle. So, IRM&CM is first and foremost an enabler of collaboration between the operations cycle and the ISR and Intelligence cycles. Furthermore, IRM&CM could also be seen as a TCPED-focussed version of the Air C2 cycle of planning, tasking, execution and assessment.

Collaboration and ICT

As mentioned in the paragraph on Air C2, this paper also addresses collaboration as an important element of 5th Generation Air C2 and ISR. The role of collaboration (working together for a common purpose) is a cornerstone of any (Air) C2 approach. It is one of the factors that most strongly differentiates industrial age from information age approaches.[23] Living and fighting in the information age, we all understand how important ICT is. What we also must face that the importance of ICT will grow as we depend more on collaboration to achieve decision superiority. Often, ICT is seen as an enabler for successful operations. However, it may be safe to claim that a lack of robust ICT is a catastrophic disabler when striving for decision superiority, making it much more than 'just' an enabler. For this reason, this paper considers related aspects of ICT.

---

23 David Alberts & Richard Hayes, *Understanding Command and Contro*l, CCRP, 2006, pp. 185–186.

F-35 Employment and 5th Generation

Currently, RAAF and RNLAF have limited knowledge on F-35 employment. However, it is understood is that operating the F-35 will be much more than a one-on-one replacement of current RAAF and RNLAF fighters. This requires new (operating) concepts beyond those used for current generation fighter employment. After all, if we apply existing concepts on 5th Generation platforms, we will not be able to optimize the employment of the F-35 to its maximum abilities and merely use it as a stealth F-18 or F-16. This paper considers Air C2 and ISR as part of those new concepts, in which the F-35 will play an important, innovative and integral role. This is not just about exploiting F-35 derived ISR-results in combat, this is about changing the way RAAF and RNLAF train and fight with F-35.

This paper is unclassified. This prohibits going into technical detail, specifically where it concerns the F-35; I am left therefore to relatively shallow technical analysis. However, it does leave enough room for a conceptual analysis of F-35 employment within the scope of Air C2 and ISR. This potentially widens the scope of the recommendations of this paper to other 5th Generation platforms. If this may lead to the need for a more technical analysis above the current level of classification, this could easily be accomplished as a follow-on classified study to this paper.

The term '5th Generation' has a strong foothold in both RAAF and RNLAF. Although the term is more and more associated with Air Force transition, the term was originally only associated with the generations of (jet) fighter aircraft. In a RAAF Pathfinder article, 5th Generation aircraft was described as by design nose-to-tail low observable through application of stealth technology, having improved situational awareness through all-aspect multi-spectral sensors and being 'born' networked. A 5th Generation aircraft will be able to '(…) create decision superiority leading to battlespace dominance.'[24] Although this may very well be true in a local arena against non-5th Generation aircraft, for this paper, this seems a somewhat too powerful statement. However, as I will show, employing the first 5th Generation aircraft by RAAF and RNLAF does bring unprecedented opportunities for situational awareness and the application of 5th Generation concepts for Air C2 and ISR. Together with the introduction of F-35, these concepts may very well become essential stepping stones towards creating a 5th Generation Air Force. 'A readily available, synthesised appreciation of the battlespace and the ability to share it with others are key characteristics of the 5th Generation. Taken to the force level, one can begin to see a 5th Generation Air Force emerge.'[25]

---

24 'Five Generations of Jet Fighter Aircraft', *Pathfinder* Issue 170, Air Power Development Centre, January 2012.

25 Air Marshal L. Davies, AO CSC, '5th Generation Air Force', address to RUSI Conference, London 2015.

3. Air C2—ISR Integration at Tactical Level

If we want to out-pace and out-manoeuvre a peer adversary in a very complex and highly dynamic environment, we need to resort to a high degree of dynamic (re)tasking. For that, we must be able to constantly adjust our plans based upon situational awareness. At the tactical level, we will be confronted with real-time threats and opportunities. Our ability to cope with these may very well be the decisive factor between victory and defeat. This counts as much for our ability to cope with these treats and opportunities in a local arena, at the tactical edge, as at the theatre-wide aggregated level. Coping with emerging threats and opportunities is core business at the tactical level. Although we rigorously plan the execution of air operations, adjusting the plan based upon occurring events is common practice. This is where the interaction between Air C2 and ISR has to be fast. This is the working field of Air C2 – ISR integration.

In this chapter, I approach this topic as a bi-directional avenue, based upon the MAJIIC JISR model. The first direction concerns the integration of ISR into the Air C2–process. This direction feeds the Air C2 process with ISR results in order to gain and maintain battlespace situational awareness and act upon the situation as it unfolds. The second (or reverse) direction concerns the integration of Air C2 into the ISR process. This direction feeds (or, maybe better directs) the ISR process with information requirements (IRs) and collection, processing and exploitation tasking to fulfil these requirements. Both directions are facilitated through IRM&CM, ensuring the fulfilment of the IRs and efficient and effective management of the ISR cycle. Because most, if not all, of the activities on this bi-directional Air C2 – ISR avenue are not pre-planned and are mostly time-sensitive, real-time collaboration between the actors involved is essential to ensure successful integration of Air C2 and ISR. This again is predominately facilitated through IRM&CM.

This chapter goes deeper into these three aspects: integration of ISR into the Air C2 process, integration of Air C2 into the ISR process, and collaboration at the tactical level. I consider specifically the effect of and on F-35 employment, both from a process and a systems perspective. The aim is to formulate recommendations to enhance Air C2 – ISR integration at the tactical level, both generically related to Air C2 – ISR integration, and specifically related to F-35 employment.

Integration of ISR into the Air C2 Process

As explained in Chapter 2, the ATO cycle at the tactical level follows four phases: plan, task, execute and assess. The relationship between Air C2 and ISR is different for each phase. Therefore, the integration of ISR with the Air C2 process will be different in each phase as well. This paper assumes that the Air C2 process at the tactical level is executed by the AOC and the TACS.[26] TACS consists of units that form the Air C2-extension of the AOC and are predominately responsible for control of air assets.

During the planning phase, target development is (highly) dependant on the provision of (non-real-time) intelligence. In this phase, intelligence is used to support the selection and prioritisation of targets and to develop target folders that detail (eg, geographical and structural) information about targets. This type of pre-planned targeting it is also known as deliberate targeting. Generally speaking, there is little or no direct interaction between deliberate targeting and the (real-time) ISR process, only indirect interaction via the intelligence cycle. Another ellement of targeting is creating a framework for dynamic targeting, commonly referred to as the Time-Sensitive-Target[27] (TST) matrix. In the planning phase, this involves only developing the framework and not actually applying it. Therefore, developing the TST matrix does not depend on real-time ISR information. Although target development predominately depends on intelligence, this does not mean that target development should not benefit from available real-time ISR results to gain and maintain understanding of the tactical situation as it unfolds. Furthermore, access to real-time ISR results could be pursued to support on-going target development. We need to remember though that a certain level of intelligence appreciation of the provided ISR results remains desired or even required in the planning phase. This appreciation is usually provided by intelligence personnel who are part of the Air Operations Centre (AOC), Combat Operations Division and/or the ISR Division.

In the next step of the planning phase, the Master Air Attack Plan (MAAP) is developed wherein available resources are tied to targets and effects. As with target development, intelligence is an essential source of information. As developing the MAAP is a step closer to the execution phase, we could expect that the influence of ongoing execution exists. After all, because the MAAP under development will be executed in the following 24 hours of the ATO cycle, current developments are likely to impact upon how commanders plan. Information on those current developments is available through the ISR process.

---

26 Within NATO, the term Air Surveillance and Control System (ASACS) is used.

27 The dynamic targeting process aims at prosecuting Time-Sensitive-Targets (TSTs), which are defined as those targets that require immediate response because the pose (or soon will pose) a danger to friendly operations or are highly lucrative, fleeting targets of opportunity (NATO AJP 3.9). Although TSTs can be prosecuted using the deliberate targeting-process, they are mostly prosecuted using the dynamic targeting process.

Intelligence personnel in the Combat Operations Division and/or the ISR Division will be responsible for facilitating the use of ISR results that comprise current developments. In any case, as MAAP development is still part of the planning phase, a good balance between reacting on real-time developments and sticking to the plan is essential. Otherwise, an over-reaction based upon interpretation of real-time ISR results is lurking.

The tasking phase consists of the production and promulgation of the ATO and other related tasking documents, such as the Airspace Control Order (ACO) and Specialised Instructions (SPINS). The ATO is the translation of the MAAP into tasking for subordinate units; this is the last step before the execution phase. The influence of ongoing execution is increasing compared to the previous planning phase. Although the MAAP has been set by the commander and the ATO should reflect just that, in practice, the ATO frequently reflects changes that are driven by current execution. For that reason, the Air Tasking Order Production Team (part of the Combat Plans Divisions within an AOC) liaises closely with the Combat Operations Division after writing the ATO. Again, the use of ISR results will be facilitated by the intelligence personnel within the Combat Operations Division and/or the ISR Division.

In the execution phase of the ATO cycle, the AOC and the TACS are responsible for executing the ATO. In this phase the availability of ISR results is essential to keep up the situational awareness required to apply Air C2 on the assets as they execute the plan. The execution phase is also where dynamic action is required to cope with unplanned and emerging situations, both opportunities and threats. This is the phase where the dynamic targeting process is executed and TSTs[28] are prosecuted. Because of the real-time occurrence of this type of mission, it often relies heavily on ISR results that show battlespace developments in real-time, such as Full Motion Video (FMV) feeds. One can expect that during the course of a very complex and highly dynamic conflict the share of missions based on the dynamic targeting will increase compared to the share of missions based upon the preplanning in the deliberate targeting process. Dynamic targeting often requires ISR results that are obtained via dynamic re-tasking of ISR assets to enable quick action towards prosecuting the TSTs and time-compress the so-called kill-chain. This chain consists of six steps that lead towards creating effect against targets.[29] The steps are Find, Fix, Track, Target, Engage and Assess (F2T2EA).[30] Within dynamic targeting, ISR results are used in real-time to support all steps, with a focus on Finding, Fixing and Tracking TSTs and Assessing the effect after engagement. Both the AOC and subordinate TACS

---

28 This paper refers from here on to TSTs that are prosecuted through dynamic targeting.

29 Although the kill-chain is often only associated with prosecution of TSTs during dynamic targeting, this chain is within NATO doctrine also applicable for deliberate targeting.

30 NATO AJP 3.9 defines a seven-step chain: F2T2E2A, where the second 'E' stands for 'exploit'.

need access to these ISR results in real-time to make informed decisions and subsequently exercise effective Air C2 on the assigned units. Furthermore, recent conflicts have shown that real-time access to ISR results is also highly beneficial for weapon platforms as they play their role in the kill-chain.[31]

The last phase is the assessment phase. In this phase, ISR results are used to support the (intelligence) assessment of the effects that have been achieved during ATO execution (Battle Damage Assessment, BDA). This is predominantly aimed at creating understanding what objectives have been achieved and what the start-point is for the next ATO cycle. However, assessment can also be done real-time during the execution phase. This may lead to a decision to act upon the assessment within the current execution cycle, and for instance re-attack a prioritised target.

Integration of Air C2 into the ISR Process

ISR results are gathered by ISR assets[32] or by other assets that have sensors that can provide ISR results (so-called non-traditional ISR). To assure that the collection efforts of the ISR assets meet the information requirements in an effective and efficient manner, employment of ISR assets is managed through IRM&CM. As this is a theatre-wide function, most of the work involves pre-planning at the operational level. As mentioned earlier, dynamic targeting may occur more frequently during the course of a conflict. As a result of this, the need for ISR results to support dynamic targeting will increase, often calling for a change of plans. This requires IRM&CM to handle dynamic IRs in support of Air C2 and assure effective and efficient (re-)tasking[33] of planned ISR assets. Depending on what type of ISR assets this involves (AOC-assigned or operational/ strategic level ISR assets), this may require collaboration between the AOC ISR Division and Collection Management Authority at the operational level or even strategic level. In any case, IRM&CM will have to take into account the IRs that will not be fulfilled due to the re-tasking of ISR assets in favour of a dynamic CR.

Besides the above mentioned Air C2/IRM&CM efforts in support of assuring the availability dynamic ISR results, there is also the management aspect of physically

---

31 M. Kometer, *Command in Air War: Centralized vs. Decentralized Control of Combat Airpower*, MIT, 20 May 2005, p. 184.

32 NATO AJP 2.7 defines a JISR-asset as 'An individual, detachment, unit, sensor, or platform, which can be tasked by respective authorities to achieve JISR results.'

33 NATO AJP 2.7 defines three types of tasking: deliberate, ad-hoc and dynamic. Deliberate tasking occurs during standard mission planning and is concluded with an approved Collection Task List (CTL) and mission order finalisation. Ad hoc tasking integrates emerging and urgent CRs in an already released CTL and prior to mission execution. Dynamic tasking allows integration of emerging CRs requiring immediate satisfaction into current collection operations.

integrating the ISR assets into the airspace, both pre-planned and real-time. Pre-planning is done through the ATO. During execution, both the AOC and TACS are tasked with providing real-time Air C2 to all airborne assets, including ISR assets. These tasks include air space management, flight-path de-confliction, datalink management, dissemination of the air picture and threat warnings.

Air C2—ISR collaboration at the Tactical Level

Effective collaboration between Air C2 and ISR actors is essential for effective mission execution. The ATO, aimed at orchestrating all Air Component efforts for a 24 hours period, provides a good basis for that collaboration. Theoretically, as long as everything goes as planned, there is relatively low need for additional collaboration. However, in practice (1) the ATO is neither by far detailed enough to preclude the need for collaboration nor does it aim at that; the ATO (2) assigns assets to cope with emerging opportunities and threats (in other words: plans for the unplanned) which requires real-time collaboration and (3) things simply don't go as planned.

To be successful in the very complex and highly dynamic operational environment we must be able to take advantage of emerging opportunities. That means we must be able to complete the kill-chain within dynamic targeting within hours or even minutes versus days in deliberate targeting. Without a proper way of real-time collaboration among all actors involved, the opportunity to engage a TST may be long gone before the kill-chain was completed.

The collaboration effort in support of dynamic targeting in itself is very dynamic. A typical flow to prosecute a TST could be as follows: First, the information that a TST has emerged must reach the proper level of authority (typically coordinated by the Duty Commander in the Combat Operations Division in the AOC) to decide to prosecute it. Meanwhile, the target must be found (if not already) and tracked by available ISR assets. This could require the IRM&CM process to facilitate dynamic ISR tasking, coordination and management, mostly through ISR Processing-Exploitation-Dissemination (PED) units, to re-task and cross-cueing sensors on different assets. Once the decision is taken to prosecute the TST, the dynamic targeting cell within the AOC will coordinate with various teams of the Combat Operations Division. Once the find, fix and track of the target is done, the actual targeting process starts. The desired effect must be associated with an available asset capable of creating that effect within the desired timeframe. The commander requires positive identification of the target, a weaponeering solution and an associated collateral damage estimate, if that has not yet been established. This requires constant coverage of the target, and again may require cross-cueing of sensors. The commander and the TST cell require sensor feeds to get a contextual view of the target to support decision

making. He may also use other available information, such as all-source intelligence and additional ISR results. If everything is in place, the engagement will commence, followed by a real-time assessment of the result. During all of this, the TACS will provide control to all airborne assets involved. To sum it up, this collaborative effort involves the AOC, TACS, Intelligence, ISR assets and other airborne assets/effectors that can be thousands of kilometres apart. The success of dynamic targeting and prosecuting TSTs is heavily dependent on an expeditious IRM&CM process and real-time collaboration between all the actors.

Air C2 – ISR Integration: System View

In the previous paragraphs, Air C2 – ISR integration during mission execution has been looked at from a process perspective. In order to be able to formulate recommendations to improve this integration within RAAF and RNLAF, this paragraph will explore the most relevant systems that play a role in Air C2 – ISR integration at the tactical level within RAAF and RNLAF.

A helpful framework to describe the relevant Air C2 and ISR systems with reasonable consistency and without going into too much detail can be found in the NATO C3 Classification Taxonomy.[34,35] Using this, the system functionality of operational capabilities can be tied to information products or services. For the scope of this paper, the following information services are taken from the taxonomy:[36]

- Plans
- Tasking and orders
- Situational awareness
- Resource status
- Request and response

This taxonomy also helps to drill down to what can be considered as fundamental to enhancing Air C2 – ISR integration: interoperability of information exchange between processes and the used systems by the various actors. Figure 8 gives a very basic schematic of the actors and the interactions that is described in the following paragraphs. The

34 NATO C3 Classification Taxonomy Baseline 0.9, NATO ACT, 5 December 2011.

35 The taxonomy provides a generic framework for service decomposition within the operational context. It is not necessarily tied to NATO (capabilities), thus also useable for RAAF.

36 Other services are IA Information, SCM Information, Intent and Guidance and Rules and Measures. These are considered not or less relevant at this stage, as they are more tied to the strategic and operational level and less (or not) tied to the tactical level.

interaction between TACS and PED units is dotted, as the units do not necessarily directly interact. This is more done on an ad hoc basis when the need occurs.

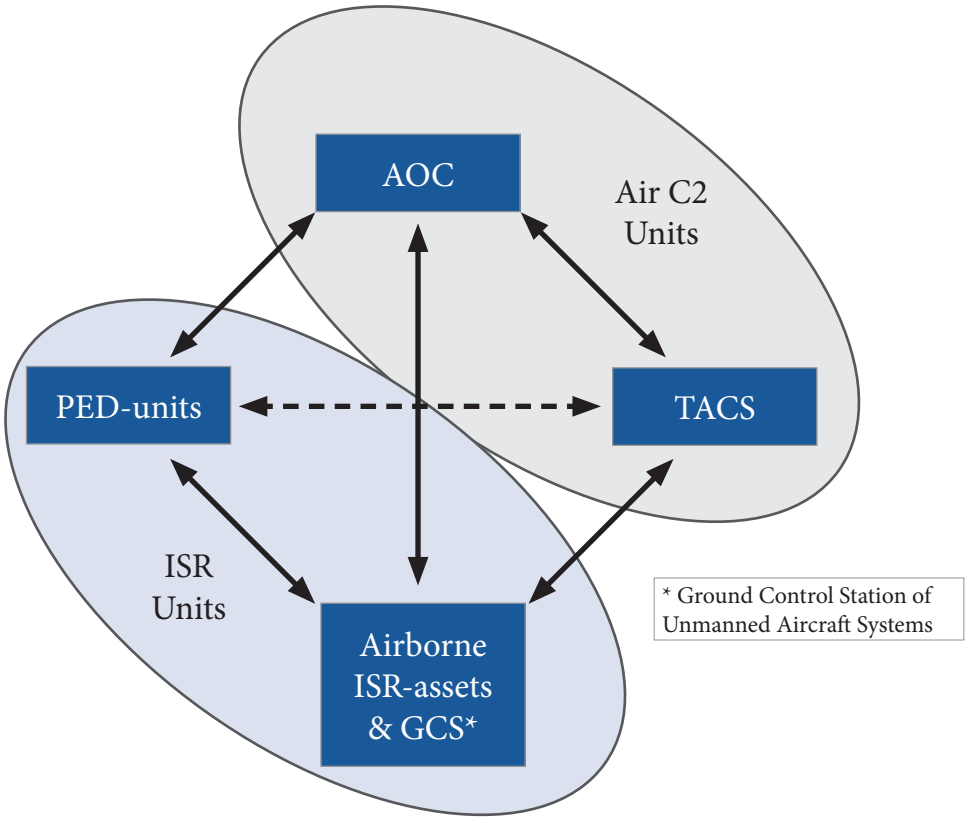


Figure 8: Interactions among Air C2 and ISR units

RAAF

RAAF uses the Tactical Battle Management Core System (TBMCS) at the AOC level to support the steps of the planning process, to disseminate tasking and orders and to support mission execution. TBMCS runs as an application in a Microsoft Windows environment and interfaces with various external units, databases and gateways to support all the above mentioned information services. The RAAF TACS ground sites use Vigilare Command and Control system to build the Recognized Air Picture (RAP) to support situational awareness. The RAP is distributed via a gateway to TBMCS in the AOC and to other systems and units via data-links. Vigilare is also used to receive tasking and orders, report resource status, support requests and response and perform control of airborne

assets. In the early 2020s, Vigilare will be replaced with an open and scalable C4I suite for homeland and expeditionary operations to support Air Battle Management, Electronic Warfare Battle Management and Missile Defence functions. Part of the requirements for this program (AIR6500) is to significantly increase machine-to-machine integration and automation, resulting in less dependence on manual/oral transfer of information via radio, telephone, email and chat. This will enhance the ability for TACS to process tasking and orders, report resource status and support requests and response. Moreover, the capability aims at substantially enhancing situational awareness, moving to a Common Tactical Picture (CTP) incorporation all environments (air, land, maritime and EM spectrum). RAAF airborne TACS (E-7A Wedgetail) connects to ground TACS via data links to exchange situational awareness (RAP). TACS additionally uses radio, telephone, email and chat for internal and external communications.

The current RAAF ISR enterprise consists of the Heron Unmanned Aerial System (UAS) and the AP-3C Orion. RAAF is standing up a centralised PED capability with the Distributed Ground Station Australia (DGS AUS) and has personnel embedded within a USAF MQ-9 Reaper unit. Furthermore, the E-7A Wedgetail Airborne Early Warning and Control (AEW&C) and EF-18G Growler, although not purely an ISR platforms, are able to provide Electronic Support Measures (ESM) to TACS and other units, both real-time and post-mission. With the planned introduction of P-8A Poseidon (2016), MQ-4C Triton (2021) and a Medium Altitude Long Endurance (MALE) UAS (timeframe t.b.d.), ADF is building a robust ISR enterprise. Although the P-3C Orion, P-8A Poseidon and the MQ-4C are first and foremost acquired for maritime ISR and response, all the ISR results will flow through DGS AUS, making these platforms valuable assets from both a joint and a RAAF perspective. DGS AUS uses various PED tools to deliver ISR results in support of situational awareness. There is no specific tool to support resource status. A tool called JDOCS is used to exchange request and response; JDOCS is not much more than a web-based spreadsheet. Other means to support these services include data-links, radio, telephone, email and chat.

Collaboration between the AOC and ISR assets is done with DGS AUS and the platform units for ISR tasking and via TACS for on-task battle management (as part of tasking and orders) of assigned units. DGS AUS and platform units are able to receive the ATO (tasking and orders) through TBMCS from the AOC and view the RAP (situational awareness). There is no tool to support IRM&CM other than JDOCS. Collaboration to support dynamic targeting (tasking and orders, situational awareness, resource status and request and response) between the AOC, DGS AUS and platform units happens mostly on-the-fly via chat, radio, telephone and email. As the PED activity of DGS AUS is currently limited to supporting just one ISR line (or feed), this is still manageable. However, once multiple lines have to be managed by DGS AUS, the IRM&CM process should be supported by a better

tool to structure the collaboration for tasking and orders, and resource status and request and response between the AOC, DGS AUS and the platform units. Joint Program 2096, which is executed and governed within the Chief Information Officer Group (CIOG), aims at delivering a joint information management enterprise to support Distribution, Storage Archival & Retrieval (DSAR) of ISR results to enhance situational awareness.

Improving Air C2 – ISR integration and collaboration, is implicitly an essential to Plan *Jericho*. Within its program of work, Plan *Jericho* defines C4 (Command, Control, Computers & Communication) and distribution of the Common Operational Picture (COP)[37] as two of the 16 projects. In the short term, they aim to enhance operational capabilities and address known deficiencies in the transition towards a 5th Generation Air Force. Through these programs, RAAF will work the interoperability and information exchange aspects of Air C2, Communication and Information Systems (CIS), and dissemination of situation awareness through the COP/CTP (including distribution of the COP to joint forces), which also apply to the longer term. While ISR is not associated explicitly with any project, the situation awareness gained from ISR is integral to the future COP/CTP. With the development of DGS AUS to include a deployable element, the in house development of the ISR exploitation capability 'ELIIXAR' and the introduction of new ISR platforms and those with an ISR capability, the ISR enterprise will be significantly boosted. Lacking an IRM&CM tool deserves attention, as the complexity of managing the intelligence requirements and the resulting collection efforts will grow rapidly as the whole ISR enterprise grows. Using TBMCS, RAAF also ensures that (application-level) AOC Air C2 interoperates with the US, the primary coalition partner, and the tooling provided in TBMCS continues to develop. However, that does not ensure that RAAF requirements for new TBMCS functionality are facilitated.

At the joint level, a C4ISR Design Authority (DA) has been appointed. Its task is to assure joint effort and interoperability through setting C4ISR policy. The C4ISR DA is working on a defence-wide C4ISR architecture, based on operational capabilities, processes and Information Exchange Requirements (IERs). Together with operational requirements, the C4ISR policy will serve as a framework for capability development and acquisition. The requirements' approval and appropriation process has recently been centralised at the joint (Vice-Chief of Defence) level to assure a joint approach. While this process is new and should prove itself in the near future, it is a significant step forward from the previous single-service requirements and appropriation system. The fact that RAAF's deployed ICT is, in many aspects, different from the ICT used by RAAF within Australia is felt as a hampering factor towards enhancing Air C2 – ISR integration. The expeditionary ICT

37 Conceptually, the COP is the operational-level equivalent of the CTP. The COP aims to augment the CTP with additional information (-layers). However, the CTP will maintain the essential base-layer.

contains different hardware and software from that used inside Australia. Also, there are different accreditation requirements and governance structures. Deployed ICT is facilitated through the Command and Intelligence Systems Support Office (CISSO), which resides under the Capability Acquisition Support Group (CASG). ICT within Australia is facilitated by the Communications and Information Officer Group (CIOG). This difference in ICT leads to interoperability issues when a deployed contingent is supported by reach-back capabilities, such as DGS AUS or the AOC, in Australia. Furthermore, it leads to integration challenges when a unit with unique hardware and software is deployed and their tooling has to be integrated into the deployed ICT.

RNLAF

RNLAF TACS[38] will start using the ACCS within the next few years. It will also be used in NATO AOCs and TACS. At the AOC, ACCS will be used to support most steps of the ATO cycle.[39] Through ACCS, the AOC will receive situational awareness in the form of the RAP and resource status of subordinate units. ACCS is also used to communicate requests and response and to disseminate tasking and orders. Of particular interest here is that the primary means for data communication follows a unique ACCS standard, called AWCIES. This precludes units that are not an ACCS node from exchanging data with the AOC other than via ACCS-external means (eg, data-link, telephone, radio, email and chat). Besides ACCS, the AOC will use the FAST-tool (Flexible, Advanced C2 Services for NATO (Joint) Time Sensitive Targeting) for coordination and collaboration in support of dynamic targeting (tasking & orders, resource status and request & response). FAST does not support IRM&CM functionality. Within TACS, ACCS is used to receive tasking and order from the AOC and interact for request and response. TACS also uses ACCS to exchange situational awareness (RAP) with neighbouring ACCS nodes and the AOC, and reports resource status to the AOC. In order to compile the RAP, exchange the RAP with non-ACCS nodes and to perform control of airborne assets and Ground Based Air Defence (GBAD), TACS uses external communication such as data-links, radio, telephone, email and chat. RNLAF plans to develop a National Air and Space Operations Centre (NASOC) that will likely combine the current TACS functionality with a limited AOC capability to support national operations and augment a coalition AOC. Using ISR results to augment situation awareness, both in air and space, is a cornerstone of the NASOC concept. ACCS will most likely remain in use in the NASOC.

RNLAF has limited ISR assets. Currently, RNLAF employs the RecceLite pod on the F-16. RNLAF also uses sensors on non-ISR platforms to collect ISR results. A recent example

38 The Air Operations and Control Station (AOCS).

39 Targeting is supported by the NATO Joint Targeting Systems (JTS) that has a data-base connection with ACCS.

involves using the AH-64 Apache in Mali in an ISR role by exploiting the recorded FMV for intelligence purposes. Furthermore, RNLAF contributes in the European Partnership ISR Enterprise (EPIE) with manpower to conduct Processing, Exploitation and Dissemination (PED) of airborne ISR (FMV). RNLAF plans to acquire the MQ-9 Reaper and a R&D program aimed at launching and operating a miniature satellite (cube-sat) in space. RNLAF is developing a federated PED capability so that such activities can be executed and synchronised at the various future ISR asset locations. This PED capability will employ MAJIIC Coalition Shared Databases (CSD)[40] and an IRM&CM software suite. The joint program Netherlands Operational ISR Services (NOIS) should deliver networked ISR services within the next few years. NOIS will support a myriad of intelligence and ISR tasks, such as single-source and all-source analysis, Distribution – Storage - Archival - Retrieval (DSAR) of products, video streaming, and data management and exchange. The federated PED capability could be considered as a first and a partial RNLAF instantiation of NOIS. The primary means to support situational awareness with ISR results, and report resource status and exchange request and response will be the CSDs including the IRM&CM functionality. Other means will include data-links, radio, telephone, email and chat.

Collaboration between the AOC, TACS and ISR capabilities will be severely hampered by the lack of data exchange between Air C2 and ISR systems. As mentioned, data-exchange within ACCS is limited to ACCS nodes using AWCIES. There is currently no plan to develop an ACCS module aimed at connecting ISR assets. The RAP available in ACCS will not be distributed to ISR systems, thus precluding ISR crews from having good situational awareness of the air situation. This will also hamper cross-cueing of sensors. ACCS is also not capable of ingesting and geographically displaying ISR results to augment the COP situational awareness, other than the very limited ISR results contained in Link 11 and Link 16. Lastly, no ACCS functionality is associated with IRM&CM, nor is it possible to link the planned RNLAF IRM&CM functionality with ACCS, thus limiting the exchange of request and response. The collaboration between Air C2 and ISR within RNLAF will be limited mainly to radio, telephone, email and chat. An additional precondition for email and chat is that network connectivity between the AOC, TACS and ISR-assets allowed with respect to the security-domains. Overall, Air C2 and ISR will not be supported by one system, they require stand-alone solutions. Combining and correlating information between these stand-alone Air C2 and ISR systems in an AOC operations room can

40 MAJIIC developed a standards-based ISR capability named the Coalition Shared Database-Bravo (CSD-B) and the associated work flows that enable sharing imagery, FMV, Ground Moving Target Indication (GMTI), Electronic Support Measures (ESM), Human Intelligence (HUMINT) and Signals Intelligence (SIGINT). It furthermore enabled automated IRM&CM collaboration and data-exchange. The CSD also supports exchange of a limited amount of Link16 messages and chat.

be manageable to support collaboration and decision making. However, sharing the aggregated informational context of a specific decision and the overall situational awareness outside that particular AOC is not possible as it simply does not exist in any one system. However, this may be of great value or even required by adjacent and higher command levels or other units that the AOC has to collaborate with.

Similar to Plan *Jericho*, improving Air C2 – ISR integration and collaboration is an implicit element of the CLSK 3.0 vision. With the NASOC concept, the development of a federated PED capability to MAJIIC standards, the RNLAF effort in EPIE and eventually NOIS, good steps are made to fulfil that vision. However, with the adaptation of ACCS, and its inherent very limited ability to integrate Air C2 and ISR, this has the potential to be a significant constrain for RNLAF to achieve that vision. Because configuration management of ACCS is shared with 24 NATO nations, based on consensus for NATO-funding or individual funding of unique requirements, and different nations have different ACCS priorities, the opportunity for RNLAF to facilitate enhancing Air C2 – ISR integration and the associated collaboration through ACCS improvements and -upgrades may prove difficult and protracted. The joint project iCommand, aimed at creating a joint C2 platform by bringing together various single-service C2 systems in a Service Oriented Architecture (SOA), could solve this problem. However, funding of iCommand is rather limited and may very well preclude development of an adequate solution. Lastly, NOIS and various other ICT projects, aimed at network RNLAF and the other services, are managed at the joint level. This ensures capturing Defence enterprise-wide requirements and by policy joint and coalition interoperability. However, funding priorities and shortage of project manpower currently hamper the timely execution of these projects.

Relation to F-35 Employment

Now how does this relate to F-35 employment? As mentioned, the F-35 will be able to collect ISR data in places where other platforms cannot be employed, such as high-threat areas. ISR results based on this data, either by on-board F-35 or off-board fusion and/or analysis, are potentially of very high value to air operations, not only at the tactical level. Furthermore, this information could have immediate implications on mission execution. For instance, locating and identifying high-priority fleeting targets could instigate the dynamic targeting process. Detection of new parameters of a threat system could alter defensive actions and the routing of assets that are simultaneously employed in a different area. Electronic indication of TBM-launch preparation should trigger warning and preparation for defence actions in friendly territory. Also, F-35 could be used to fulfil a collection requirement that is worked through IRM&CM. The examples can be stretched as far as our imagination, all attesting to the value of F-35 ISR results, including that for (real-time) Air C2. Hence, it is interesting to see how employing the F-35 can enhance

Air C2 – ISR integration. Even so, how Air C2 – ISR integration could enhance F-35 employment.

This paper does not deliberate whether the F-35 should primarily be employed in the 'alone and unafraid' method, deep into enemy territory with no connectivity to other actors besides the F-35 formation elements and other 5th Generation stealth players. I also do not discuss whether F-35 should be employed as a 5th Generation ISR platform that leads the way for other 5th and non-5th Generation package members while pushing out ISR results real-time for broader use. I assume in this paper that either employment method could be pursued or effective, depending on the situation and the desired effects, keeping in mind that enhancing Air C2 – ISR integration will be affected by the choice of employment method. Furthermore, employment of the F-35 in a strict ISR role may be difficult for both RAAF and RNLAF, as they have very limited numbers available. Both Air Forces will likely require the F-35 to be available to create kinetic and non-kinetic effects. Another aspect that is not addressed is the non-real-time use of F-35 ISR results. Although I acknowledge that this will also benefit air operations greatly, this is more tied to ISR in support of the intelligence process and therefore out of scope. Information on the non-real-time use of F-35 ISR data and products can be found in Whitehall Report 1-16, 'Maximum Value from the F-35' by the Royal United Service Institute research fellow, Justin Bronk.

Examples of how F-35 ISR results could be used real-time during mission execution boil down to sharing information over that bi-directional avenue to improve collaboration, situational awareness and subsequently the decision-making process, leading to more operational agility. The previously illustrated dynamic targeting flow can serve as a good example in order to go into a bit more detail on how that would work with F-35. Within that TST flow, several ISR assets with different sensors and platforms, which can create the desired effects, each play a role in the consecutive steps of the kill-chain. The essence of Air C2 – ISR integration including IRM&CM is to facilitate collaboration between the ISR assets, effects bearers and the commander in the AOC to combine all the information and take a decision. Owing to the combination of sensors used in the F-35 in combination with the capabilities for data-fusion and the ability to create kinetic and non-kinetic effects, it is reasonable to assume that the F-35 is able to fulfil all the parts of the kill-chain, thus alleviating the 'burden' of collaborating with various assets across the globe. However, it is not as simple as just sending out F-35s on a mission and prosecute TSTs while they are at it. This is met with technical, tactical, security or Air C2 challenges, or a combination of them. I will look at some examples of these challenges.

First, some technical challenges. Within our TST example, all information is accumulated at the AOC to support the decision process to prosecute a TST. The collaborative effort needs to be supported by data communication between all actors, involving the

distribution of ISR information and results,[41] and not just between the F-35 at play. The F-35 currently has very limited capabilities of sharing ISR results outside its own formation. Technically, a small amount of ISR results can be forwarded via Link16. However, Link16 is not designed to pass ISR results and has very little bandwidth, limiting the applicability of Link16 to pass ISR results significantly. Furthermore, the F-35 currently has no capability to communicate beyond-line-of-sight (BLOS, eg, satellite communication). That limits the range to transfer information to line-of-sight, which may be out of range of the AOC, TACS or relay platform. This may also hamper the cueing of F-35 in case a TST is detected by other means (eg, HUMINT or space-based sensors) and its prosecution initiated by the AOC. Solutions to this technical challenge can be found in various ways, such as gateways and forward relay.[42] Providing a track with positive identification may technically be relatively easy. However, providing a contextual view around that track to support the targeting and decision process in the AOC will require relatively high bandwidth, which is technically a significantly bigger challenge.

Second, the required communication between the F-35 and the AOC presents tactical challenges. An F-35 on a stealth mission will obviously looses part of its tactical advantage upon using non-stealth means of communication, such as UHF/VHF voice or Link16. While solutions such as gateways for, and relay of, waveforms designed for stealth operations are feasible, they are yet to be introduced. Mission complexity is another tactical challenge. Because most F-35 missions will be complex, requiring rigorous pre-planning (deliberate targeting) and mission rehearsal to ensure a high success rate. Nominating these missions for additional dynamic targeting may make the missions too complex to assure a high success rate. In this case, tasking F-35s dedicated for prosecution of TSTs, for instance in a Strike Coordination Armed Reconnaissance (SCAR) role, could be a choice to lower the overall tactical complexity. However, that could be met with apportionment concerns at the operational level, specifically during conflict against a peer adversary. At such times, the F-35 could be considered a too scarce and valuable asset to be send on a mission without dedicated targets, versus missions with pre-planned targets (eg, used as in support of gaining control of the air).

Third is the security challenge. The ISR results within the F-35, or at least a portion of it, is classified at high level and compartmentalised for security reasons, both within and among nations. This also pertains to specific F-35-derived ISR results. Hence, sharing this information outside the F-35 environment to support Air C2 – ISR integration will face security classification restraints or could, in some cases, even be prohibited outside

41 Although doctrinally contested by some members of the intelligence community, the F-35 is conceptually able to automatically fuse data from the various on-board sensors and produce ISR-results.

42 Justin Brock, *Maximum Value from the F-35*, Whitehall Report 1-16, RUSI, February 2016.

a Special Access Program Facility (SAPF) or Secret Compartmented Information Facility (SCIF). To safeguard information security, this must also be considered before creating any gateway, cross security domain solution or relay solution that facilitates sharing F-35 originated ISR results. This in turn may be in direct conflict with the need to the real-time distribution of ISR results and sharing of situational awareness within a coalition AOC and other units to support enhancing Air C2 – ISR integration.

Thus far, the illustrated challenges were predominantly associated with the real-time information exchange between F-35s and the AOC and its tactical ramifications. What if this real-time deep-into-enemy-territory communication was not necessary to prosecute a TST, because the F-35 is given a broad mandate to act in isolation? After all, a formation of F-35s is perfectly capable of taking care of its own inner-flight real-time Air C2 – ISR integration to enhance operational agility at the tip of the spear. When acting upon emerging threats, there is no debate that F-35s (as any weapons platform) is authorised to act. So why not delegate the appropriate decision rights to them to act upon emerging opportunities? Why not distribute control from the AOC down to where the ISR results and the effectors meet? This gets us to the fourth challenge of enhancing Air C2 – ISR integration in relation to F-35 employment: that of the current tenet of Air C2. Centralised command and control, decentralised execution explicitly precludes distributing control. This is not only a tactical level challenge but also involves the operational level, where centralised control is retained. The next chapter looks more deeply into this challenge.

Conclusion and Recommendations

Both RAAF and RNLAF put effort in enhancing Air C2 – ISR integration and collaboration at the tactical level. The effort is, to a certain extent, directly tied to Plan *Jericho* and CLSK 3.0, but also part of joint capability development. Although in the end, it is the result that counts, it makes sense to unite the various efforts to assure coherence. For ADF and RAAF, this is done through the C4ISR DA under VCDF. For Netherlands Defence and RNLAF this is a responsibility of joint (MOD) level, too. Netherlands Defence uses a strong governance framework of ICT projects defence-wide. It merges requirements, prioritisation, project execution and policy at the highest level. To a large extent, this framework assures synchronisation among the various projects. However, because personnel and financial resources are scarce, much effort goes into prioritising our projects. There is a risk of losing the importance of assuring coherence out of sight. Furthermore, there is neither an explicit C4ISR DA appointed, nor any defined C4ISR plan. Netherlands Defence/RNLAF may consider similar authoritative C4ISR governance to assure coherence among the various joint and RNLAF C4ISR projects. Likewise, to improve coherence between static and deployed ICT, ADF/RAAF may consider an ICT-governance framework similar to that of Netherlands Defence.

Looking at specific challenges for RNLAF, one element is dominant and deserves fitting attention: ACCS. First, ACCS does not support IRM&CM or machine-to-machine data exchange with the ISR enterprise beyond that of Link16 via TACS, which has very little value as a means to exchange ISR results. Second, ISR-enterprise applications, such as IRM&CM tools, are not allowed to be hosted on ACCS. Third, any update to ACCS to work these ISR-related challenges will likely be a costly and protracted process, primarily because ISR-related updates are currently not part of the planned and funded ACCS updates.

Although much debate has occurred within the RNLAF Air C2 community as to whether ACCS should have been embraced at all, proposing to abandon ACCS does not answer these challenges. After all, ACCS will facilitate NATO-wide interoperability for Integrated Air and Missile Defence (IAMD) for decades to come. As much as ACCS is a part of the problem, it must also be part of the solution. So, although it is most likely a costly and protracted process to enhance Air C2 – ISR integration through ACCS upgrades, this process must be considered. As the (ISR-related) ACCS challenges are not unique to RNLAF, they do not stand alone in this. Within the ACCS community, Royal Norwegian Air Force (RNOAF) and Royal Danish Air Force (RDAF) are two F-35 partners that experience the same ISR-related challenges within ACCS. Likewise, the RAAF Air C2 – ISR systems analysis in this chapter showed that RAAF experiences similar challenges, which are worked through AIR6500 and Plan *Jericho* projects 4 and 5. Because RAAF is not an ACCS user, solving the challenges will be different. However, the requirements that drive the solution are likely very similar to those of RNLAF, RNOAF and RDAF working ACCS, specifically if they are F-35 related. Developing and validating these requirements within an international Air C2 – F-35 forum has great potential for all four organisations. Such a forum would facilitate sharing knowledge and working coalition interoperability, and unifies argumentation and leverage within the respective programs to fulfil requirements.[43]

Another solution could be to make ACCS part of a larger SOA-based environment through software-emulation as part of the Netherlands Defence iCommand program. This is not unlike what was done by emulating the NATO Air Defence Ground Environment (NADGE) into the Multi-Aegis Site Emulator (MASE) system, currently still in use in various NATO TACS, including that of RNLAF. Taking a similar approach, ACCS would 'under the hood' stay as is while providing the ACCS services through a new operator interface. RNLAF (and other affected NATO nations) could then focus on adding other services that are not provided through ACCS, such as IRM&CM and CSDs. While this

43 At the time of writing, a first (inaugural) meeting of an international 5th Generation Air C2 – F-35 Working Forum has been agreed to take place in November 2016. This forum, consisting of Air C2 and F-35 specialists from RAAF, RNLAF, RNOAF and RDAF, is an early result of the research for this paper. RNLAF has proposed to include Air C2 – ISR requirements development into the Program of Work of this forum.

would not improve Air C2 – ISR integration of ACCS under-the-hood, it would improve that for the larger SOA-based environment. Again, this could be worked in a F-35 coalition context by the same four nations with similar benefits. The group could even cooperate in developing specific Air C2 – ISR integration services and share the costs.

Although RAAF completely controls AIR6500 and thus developing Air C2 systems and their integration with ISR within TACS, RAAF still depends on TBMCS within the AOC. As the US is the primary coalition partner of RAAF, the choice for TBMCS is obvious. RAAF implements versions of TBMCS as they are released by the USAF. The influence of RAAF on working new requirements within TBMCS seems rather limited. TBMCS functionality that facilitates Air C2 – ISR integration is currently not very prominent. For instance, there is no IRM&CM functionality within TBMCS. However, hosting other applications on the same system as TBMCS is allowed within accreditation limits. This enables operators to correlate information between different applications or systems. This may provide a workable solution for now but it does not enhance the Air C2 – ISR integration required for agile operations. As developing TBMCS is a continuous process and the need for Air C2 – ISR integration is also understood by the USAF, it is likely that future version of TMBCS will in some way enhance Air C2 – ISR integration. It would nonetheless be opportune for RAAF to more significantly influence requirements for updates of TBMCS in general, and towards enhancing Air C2 – ISR integration in particular.

Considering the ISR enterprise, RAAF seems to be in a particularly good shape. New platforms, DGS AUS, JP2096 and a C4ISR DA to assure coherence, will significantly boost RAAFs ISR capability. An important missing element is a structure and tool for IRM&CM. This happens to be a particular strong point of the rather limited RNLAF ISR enterprise. By choosing an IRM&CM tool that adheres to MAJIIC standards and using MAJIIC CSDs to facilitate DSAR of ISR results, RNLAF fundamentally progresses towards coalition interoperability for their ISR enterprise. MAJIIC has been identified by RAAF, VCDF and CIOG as a potential technology to pursue in support of JP2096. As an early result of research for this paper, RNLAF has facilitated the transfer of MAJIIC program and technical information to ADF, opening the door for RAAF to use MAJIIC within their ISR enterprise. Further cooperation between RAAF and RNLAF related to the use of IRM&CM tools and CSDs will enhance ISR interoperability.

Besides exchanging information on ISR plans and programs, RAAF and RNLAF could investigate the possibility of mutually simulating and testing ISR interoperability using multi-national distributed simulation. In their paper on applying USAF Distributed

Mission Operations (DMO) for RAAF,[44] Lucien Zalcman and Jon Blacklock endorse the potential benefits of distributed simulation, including Live Virtual Constructive (LVC). Stretching ISR-enterprise interoperability simulation and testing to future use of F-35 ISR results by RAAF and RNLAF would give additional reason to pursue multi-national distributed simulation among F-35 partners.

After considering the role of the F-35 in enhancing Air C2 – ISR integration and ultimately increasing our agility, I find it clear that sharing information at and with the tactical edge to support collaboration will make a big difference. It will enable a quicker kill-chain. Collaboration could also keep mission complexity at a manageable level for the F-35 when confronted with an emerging opportunity. Currently, the ability to do so is rather limited because of technical, tactical and security challenges. Solutions to them can be found both within and beyond the F-35 program. Within the F-35 program, choices have to be made to manage future upgrades of the F-35. The various required upgrades compete for funding and must subsequently be prioritised. Ultimately, funding to improve information sharing and collaboration may have to compete for funding with integrating a new type of munition. These are hard choices to be made. Choices that may boil down to the vision we and our F-35 partners have to what the F-35 is supposed to accomplish, with at one end of the spectrum 'alone and unafraid' stealthy weapons platform and the other end the ISR (and perhaps C2, see the Chapter 4) node at the tactical edge that leads the way. For Air Forces with limited resources, such as RAAF and RNLAF, the choice will not be on either side of the spectrum, it will be somewhere in the middle. However, the influence of RAAF and RNLAF on the selection of upgrades is limited, so perhaps a more outspoken preference for enhancing information sharing and collaboration would increase our influence. That is, if that is what RAAF and RNLAF wish to accomplish within the F-35 program. The aims of Plan *Jericho* and CLSK 3.0 do point in that direction.

As I previously mentioned, any upgrades to the F-35 alone are not enough to cope with the challenges associated with F-35 employment. Sharing information and collaboration will start to pay off once we can accomplish that between F-35 and the other Air C2 and ISR actors. A promising new concept to enable this is the so-called combat cloud. A basic technical perspective of the combat cloud is given by Hostage and Broadwell[45] who describe it as a federation of airborne and ground-based systems (nodes) that gather, process, store and disseminate information; a cloud of nodes that connect and disconnect as required

---

44 L. Zalcman and J. Blacklock, *USAF Distributed Mission Operations, and ADF Synthetic Range Interoperability Model and an AOD Mission Training Centre Capability Concept Demonstrator – What Are They and Why Does RAAF Need Them?* DSTO-TR-2463, DSTO Air Operations Division, October 2010.

45 Gilmary M. Hostage III and Lary R. Broadwell, *Resilient Command and Control: The Need for Distributed Control*, US Joint Forces Quarterly no. 74, 3rd Quarter 2014.

without any node or nodes being vital to the cloud. As nodes are added to, or disconnected from, the combat cloud, its information steadily builds or gracefully degrades. In his article, 'Evolving Technologies and Warfare in the 21st Century: Introducing the Combat Cloud,'[46] Deptula gives an additional technical perspective, such as wave-form independence, cross-domain solutions and jam resistance. But more importantly, Deptula describes the combat cloud in much broader sense: '…an operating paradigm where information, data management, connectivity and command and control are core mission priorities'. The unit-to-unit relations from Figure 8 would disappear, the information sharing and collaboration being facilitated through the combat cloud (see Figure 9).

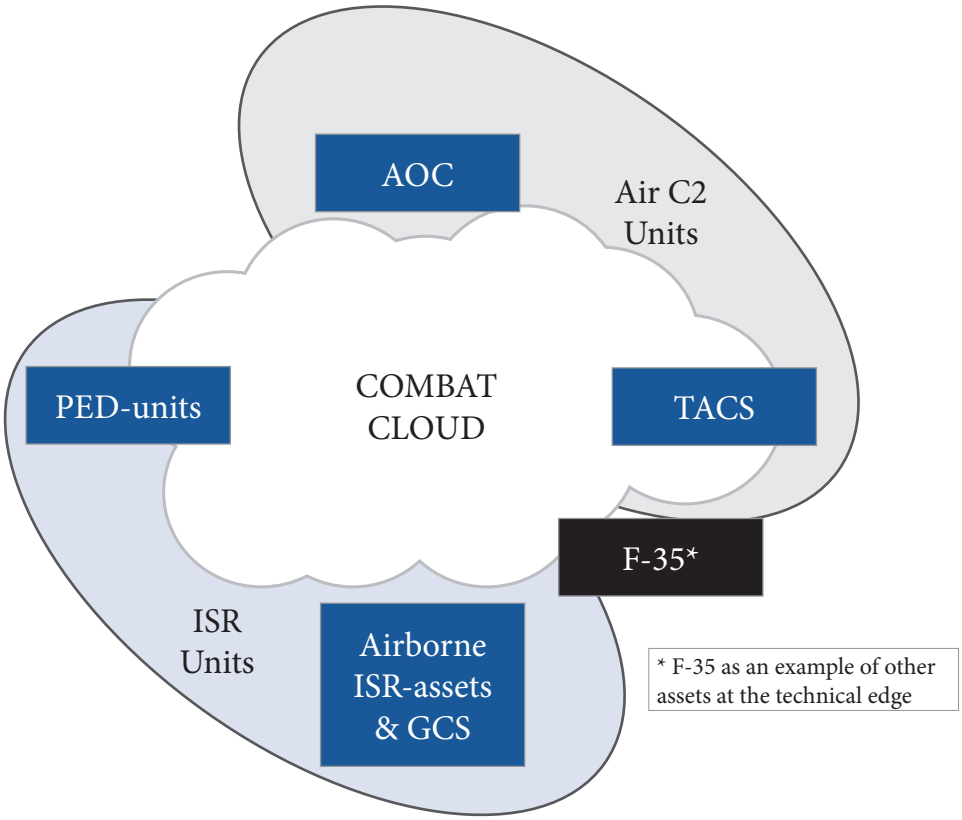


Figure 9: Combat Cloud

46 David S. Deptula *Evolving Technologies and Warfare in the 21st Century: Introducing the Combat Cloud*, Mitchell Institute Policy Papers Vol. 4, September 2016, p. 1.

Deptula repeatedly mentions the importance of allied interoperability related to making a combat cloud work, specifically mentioning E-7A Wedgetail and F-35. While developing a combat cloud will not be easy or cheap, the question is whether RNLAF and RAAF can afford not to get involved in its development. Even if it takes decades before the combat cloud comes to full fruition, the conceptual though behind it is likely of great influence on the way we operate as a national and within a coalition, and the way we employ the F-35 specifically. Considering the ambitions of both RAAF and RNLAF, this seems to be a good time to seriously evaluate the concept of the combat cloud. Combining RAAF and RNLAF research and development efforts in this area is worth valuing.

4. Distributed Control: Discussion on a Primary Tenet of Air C2

There has always been, and will always be, discussion about how to best apply Air C2. For quite some time, centralised command and control, decentralised execution has been a primary tenet of Air C2. There is a fundamental difference in insight between Air Force and Army organizations or components on the control aspect. In a nutshell, Army uses a form of distributed control to enable local commanders to direct their assigned forces in accordance with central (mission) command. This is deemed effective because of the geographical separation in operations areas of local Army commanders so that the influence of the local Army commander at theatre level is limited. Because of the theatre-wide or even global reach of Air Power, history has thus far proven that distribution of control over airpower negates the advantages of speed and concentration of force. Basically, air assets should be seen as theatre-level assets and therefore be controlled at theatre level, hence centralised control.

The discussion about centralised versus distributed control has been renewed in various articles and future operating concepts and, this time, predominately from an air perspective. Part of that discussion involves the notion that centralised control was required in the industry-age platform-centric approach to air warfare, where mass was crucial for success. It then took many different types of aircraft up to days or even weeks to complete the kill-chain. Now, in the information age, this can be accomplished within minutes by a single platform.[47] This does not only create the opportunity to rethink our approach to Air C2, it may even require a new approach to uphold the high operational tempo. Also, centralised control may have worked in recent conflicts where we operated in a (air and information) permissive environment. However, the same approach will most likely not work in a highly contested environment, where our C2 efforts are of constant strain under enemy action, both in the physical and in the information domain. The most recent USAF future operating concept talks about 'Dynamic Command and

47 David S. Deptula, Evolving Technologies and Warfare in the 21st Century: Introducing the Combat Cloud, *Mitchell Institute Policy Papers,* Vol. 4, September 2016, p.2-3.

Control' and permitting 'fluid transitions between (….) centralized control and distributed coordination'.[48] Although this does not explicitly say distributed control, it does imply some form of it. The Northrop Grumman article 'Integrating 5th Generation system requires 5th Generation C2'[49] makes this concept very explicit: 'emphasizing the shift from centralized 'control' at the Air Operations Centre to centralized 'command' with 'control' distributed to subordinate entities'. Figures 10a and b illustrate Northrop Grumman's view.

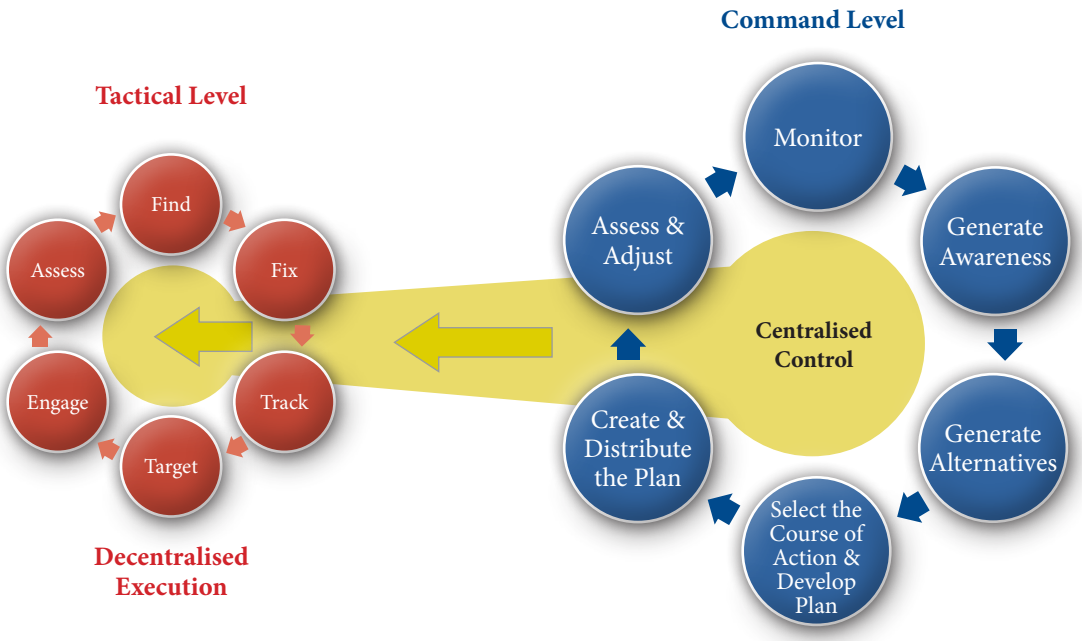


Fig. 10A: Legacy Command and Control (Northrop Grumman)

48 United States Air Force, *Air Force Future Operating Concept: A View of the Air Force in 2035*, September 2015, p. 10.

49 'Integrating 5th Generation systems requires 5th Generation C2', Northrop Grumman, NIDV-magazine NR.3, November 2015. https://www.nidv.eu/wp-content/uploads/2015/07/NIDV_magazine_2015_3_LR.pdf The NIDV is a Dutch non-profit organisation aimed at developing military industry.

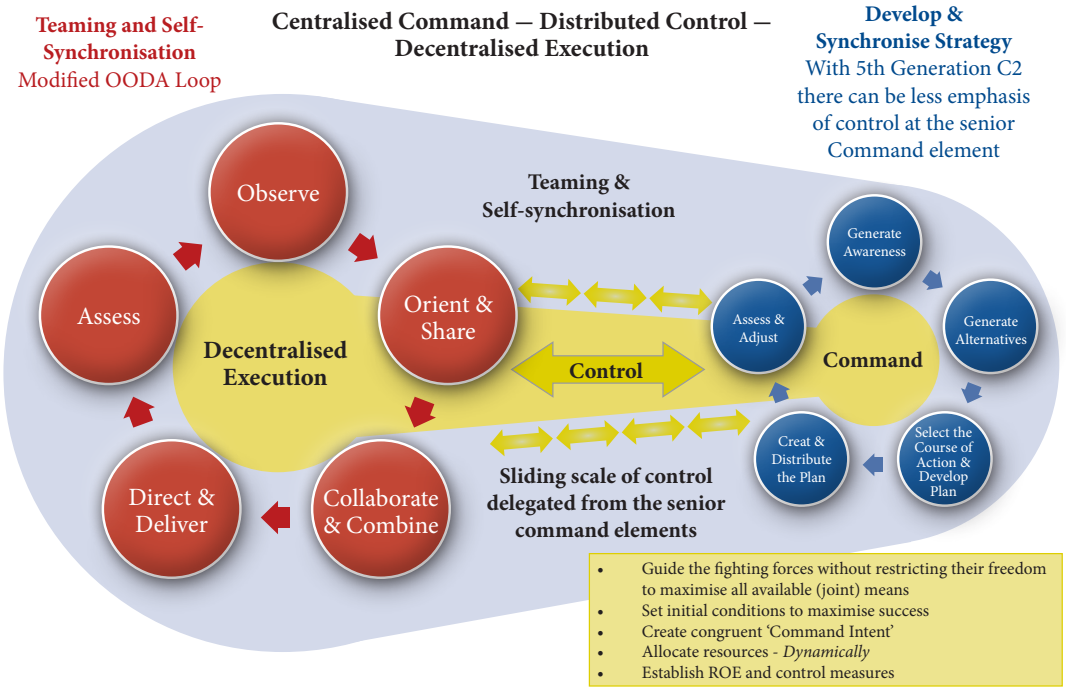


Fig. 10B: 5th Generation Command and Control (Northrop Grumman)

Northrop Grumman ties these new concepts directly to the RNLAF C4ISR vision and the introduction of F-35, in line with the fourth challenge of the previous chapter: that centralised control withholds decision rights that the F-35 needs to act upon emerging opportunities at the tactical edge. Looking at the RAAF and RNLAF transition efforts to becoming 5th Generation Air Forces, we must thoroughly discuss centralised command and control, decentralised execution as a primary tenet of Air C2. After all, this tenet is fundamental to the application of Air Power and therefore to RAAF and RNLAF. Northrop Grumman emphasises more new concepts related to Air C2, such as a different approach towards the ATO cycle, including deliberate and dynamic targeting. Although these concepts are worth considering more broadly, this paper takes the current ATO cycle as a given and now explores the idea of distributed control as put in the previous chapters. To do so in this chapter, we look more closely at the question: if and, if so, how, control can be distributed to levels below the AOC. Please do not expect a definite 'yes' or 'no' as the answer will likely be, 'it depends'. More than seeking finite answers to these questions, this chapter aims at stimulating international discussion on the matter in relation to F-35 employment.

Distribution of Control

Before approaching this topic, an explaination of what is meant by distribution of control in this paper. Control is defined by Alberts and Hayes as a function '… to determine whether current and/or planned efforts are on track. If adjustments are required, the function of control is to make these adjustments if they are within the guidelines established by command. The essence of control is to keep the values of specific elements of the operating environment within the bounds established by command, primarily in the form of intent.'[50] RAAF defines control in a stricter military sense in AAP 1001.1 as 'The authority exercised by a commander over part of the activities of subordinate organisations … which encompasses the responsibility for implementing orders or directives. All or parts of this authority may be transferred or delegated.'[51] When approaching the air component's efforts as a single, aggregated, theatre-wide system or process, the control function should also be approached as being single, all-encompassing, theatre-wide function, and thus centralised. However, we can also approach the air component's efforts as a system-of-systems (or process-of-processes). In this approach, each and every sub-system should logically have its own control function. If not, it would not be a subsystem, but merely a task and thus controlled at an aggregated level. Within the system-of-systems approach, the centralised control function would be partly distributed over the subsystems while retaining a degree of centralised control focused on the coherence among the subsystems within the aggregated system.

In some respects, distribution of control within Air C2 is a paradox or even an oxymoron, as the authority (commander) that distributes control stays in control of that distribution. After all, the commander can distribute a specific control function to subordinates but can also rescind this distribution. Control is then de facto centralised at that command level. All the commander does is tell subordinates how to execute the mission, and allows them certain freedom to achieve the desired effect. It is hard to distinguish where control ends and execution begins within this tenet of Air C2 without going into the semantics of control. A dogmatic approach would be to better distinguish a dividing line between control and execution to avoid confusion between commanders at the operational level and those who execute tasks at the tactical level. In search for answers on the questions if and, if so, how, control could be distributed to levels below the AOC, this paper avoids the semantics and a dogmatic approach as much as possible to leave more creative room to explore the possibilities of distributed control.

---

50 David Alberts & Richard Hayes, *Understanding Command and Contro*l, CCRP, 2006, p.59.

51 AAP 1001.1 *Command and Control in the Royal Australian Air Force*, p.2-1.

Control of Air Power in Operations 1991–2003

An excellent starting point to look for answers is USAF LtCol Michael Kometer's MIT thesis 'Command in Air War: Centralized vs. Decentralized Control of Combat Airpower'. He analyses the way airpower was controlled from an Air C2 perspective during Operation *Desert Storm* (1991), Operation *Allied Force* (1999), Operation *Enduring Freedom* (2001–2002), and Operation *Iraqi Freedom* (2003). During the timeframe that these conflicts cover, a significant shift is apparent in using more dynamic rather than deliberate targeting and increasingly using precision weapons. The importance of real-time ISR results to support the tempo and precision of the operations was also increasing. This connects well with the basis of our question raised in Chapter 3 about fighters prosecuting TSTs, and the broader focus of this paper, of exploring new concepts for Air C2 (and ISR) related to F-35 employment.

Kometer structures his research around four questions:

1. How has the information age affected command and control of combat Air Power?
2. Have these changes affected how the military adheres to the doctrinal tenet of 'centralised control and decentralised execution'?
3. Is there a general formula that better characterises command and control of the system?
4. Where are these changes headed?

In answering the first question, Kometer attests that, 'a combination of political, organizational and technological developments has brought the military to a point where it is more vital than ever for commanders to intentionally balance empowerment and accountability'[52] (of subordinates). This declaration is: political, because of the high expectations of air power to get the job done with surgical precision and at relatively low cost (budget and lives); organisational, because of the influence of strategic constraints on command relationships, leading to more control and less empowerment at the operational level; and technological, because of the increased ability for both the operational and tactical level to achieve a high level of situational awareness leading to distribution of tasks associated with dynamic targeting.

Regarding the second question, Kometer argues that, 'commanders must realize that the way to cope with the uncertainty involved in military operations is to build depth in command relationships; focussing on specific details rather than these relationships have the unintended consequence of making lower levels unresponsive to directives and unable

52 M. Kometer, *Command in Air War: Centralized vs. Decentralized Control of Combat Airpower*, United States Air Force, MIT, 20 May 2005, p. 234.

to adapt to opportunities.'[53] He explains depth in command relationships as '…a measure of the extent to which diverse players at the scene of battle can be coordinated, prioritized, and re-directed when the situation calls for it. It is not simply pushing information and authority down, but extending the spiral of empowerment and accountability so the decisions made on the scene are consistent with the larger strategy. With sufficient depth, commanders can make deliberate decisions about when to allow them complete independence.'[54]

Kometer concludes with the answer to his third question that overall the 'centralized control and decentralized execution is still an excellent philosophy'.[55] He sets a general formula for control that commanders at any level should follow:

1. Set goals for the organisation that are unified under his command.
2. Empower subordinates to come up with plans for their respective parts.
3. Enter a bruising, running dialog to critique and correct the subordinates' plans, essentially making them his or her own and ensuring the different parts are coordinated.
4. Create depth in command relationships by defining authority and providing situational awareness in the places where diverse organisations need to coordinate.
5. Use people and technology to create a 'directed telescope'[56] to track the actions and hold subordinates accountable.
6. Assess effectiveness of the actions and the need for a change in plans.[57]

Finally, Kometer extends his analysis somewhat into the future to answer where these changes are heading. Based on his research, he expects that ongoing technological development will initially enhance a commander's ability to direct details of ongoing operations. Then, once the benefits of that technology become more apparent, it will enhance the ability to push more authority downwards. However, Kometer claims that commanders should always stay in control of tying the strategy to tactical action. He explains that, as the concentration on emerging dynamic targets increases in lieu of pre-planned deliberate targets, it has become increasingly difficult to determine what has

---

53 Ibid., p. 236.

54 Ibid., p. 31.

55 Ibid., p. 240.

56 The term 'Directed Telescope' comes from Martin van Crefeld's book 'Command in War'. The directed telescope aims at gathering information to inform command decisions without burdening the troops.

57 To give his conclusion and the formula more nuance, and to give commanders a better idea of the trade-offs, Kometer points out where current practices agree and disagree with the general formula and what the trade-offs are. See p. 239-246.

happened, much less how successful it was. Therefore, it becomes harder at the aggregated level to determine whether and how specific tactical action helps to achieve operational and strategic success. Then again, Kometer also states that if, in the future, all systems are capable of accessing the same information, we would have 'the kind of depth in the command relationships for which we are searching'.

Kometer's bottom line is that, 'even if technology becomes available to give the commander perfect information, he cannot always act on it. Command and control must balance the need to empower people to adapt and overcome new situations with the need to hold them accountable. The way to do this is by developing depth in command relationships that tie people together. Technology has enhanced the visibility of this imperative, making it increasingly important to make decisions about who can make decisions'[58]. And perhaps that is exactly what should drive us to rethink Air C2 upon employing F-35. After all, Kometer's research stops in 2003, a time where the only 5th Generation aircraft employed was the B-2 Spirit, and that was limited to strategic application based on deliberate planning. This opens up the door to continue beyond his conclusion that centralised control is still an excellent philosophy.

Control of Air Power in Operations in 2011

Control of Air Power during Operation Odyssey Dawn (OOD), and later Operation *Unified Protector* (OUP) in 2011, changes from where Kometer left of. The Combined Force Air Component (CFAC) empowered the AOC to honour the tenet of centralised control and decentralised execution.[59] For the opening stage, this seemed to work fine when the air operation consisted of deliberate targeting of Libyan Integrated Air Defence System (IADS), establishing a preliminary no-fly zone and to halt the Libyan regime forces attacks around Benghazi.[60] When dynamic targeting came more in play, things changed. Because of the initial lack of TACS and ISR assets, fighter and bomber aircrew had to complete the entire kill chain in isolation.[61] In a way, this contradicts exercising centralised control, and was even a step further than distribution of control; it came close to autonomy. However, as more TACS units like E3 AWACS and E-8A Joint Stars and ISR assets became available, control arrangements became better aligned. Although the AOC was still exercising centralised

---

58 M. Kometer, *Command in Air War: Centralized vs. Decentralized Control of Combat Airpower*, United States Air Force, MIT, 20 May 2005, p. 253.

59 D. Matlock, Command and Control in Africa; Three Case Studies before and after Tactical C2, *Air & Space Power journal*, July-August 2014, p. 124.

60 K. Mueller (ed.) *Precision and Purpose; Air Power in the Libyan Civil War*, RAND Corporation, 2015, pp.123-124.

61 D. Matlock, Command and Control in Africa; Three Case Studies before and after Tactical C2, *Air & Space Power Journal*, July-August 2014, p. 121.

control, the CFAC staff realised that this should not become a recipe for micromanagement nor stifle subordinates' initiative when they deal with combat's inevitable uncertainties.[62] This led the AOC to exploit opportunities through delegation of decision-making to the lowest level, such as the targeting/engagement authority to TACS units and individual fighter aircrew.[63,64] This delegation included using a TST matrix with collateral damage estimate restriction which, combined with the ROE, could be applied by aircrew on SCAR missions. Nonetheless, compiling the TST matrix itself was tightly controlled at CFAC level to uphold the (OUP) North Atlantic Council (NAC) mandate of zero civilian casualties and damage to civilian property.[65] National representatives where involved in the targeting process to ensure various national caveats were honoured; this involvement also contributed to the (political) requirement of centralised control of air operations. In conclusion, OOD and OUP showed some application of distributed control by empowering TACS and fighters at the tactical edge to take decisions to cope with the dynamic environment. However, distribution of control was only applied within tightly controlled limits.

Evolution of Control of Air Power

A way to explore future control of Air Power is to tie Kometer's conclusions, and those gained from OOD/OUP, to the C2 approach space model of Alberts and Hayes to see where we stand regarding distributing control. The starting point of this model is a classic C2 approach, which can be tied to the current tenet of Air C2 of centralised command and control, decentralised execution. The Alberts and Hayes model defines three dimensions: allocation of decision rights, distribution of information and patterns of interaction. They depict how the Air C2 approach could become more agile (see Chapter 2). These authors state that the dimensions are interrelated. Kometer's work supports that statement. His bottom line (see previous page) in this respect resonates: 'even if technology becomes available to give the commander perfect information, he cannot always act on it. Command and control must balance the need to empower people to adapt and overcome new situations with the need to hold them accountable. The way to do this is by developing depth in command relationships that tie people together.' Superimposed on the three dimensions of the (Air) C2 approach space model, Kometer's conclusion can be interpreted as the requirement to balance the three dimensions of Alberts and Hayes' model. Within that balance, the distribution of decision rights should not be stretched beyond the limits

62 Ibid., p.125.

63 Ibid., p. 125.

64 The authors consider this part of decentralized execution. Later in the article they relate this to bridging the operational-tactical seam, which within the context of this paper is considered distribution of control.

65 Todd R. Phinney, Reflections on Operation Unified Protector, *Joint Forces Quarterly*, Issue 73, 2nd Quarter, 2014, p. 89.

of the other two dimensions. As I note later in this chapter, distribution of decision rights beyond those limits leads to autonomy without the means to hold people accountable.

One of the main reasons why Kometer concludes that centralised control is still an excellent philosophy is his observation that the AOC has become the 'centre of calculations' and best-suited to support commanders making real-time decisions. At the AOC, the time required to execute the dynamic targeting process has significantly decreased through using ISR and ICT, along with new organisational procedures. This can only happen inside the AOC, as that is where all the (ISR and other) information is present. This information is not (yet) brought together or fused into one system or COP. It is presented across different systems at the AOC. For that reason, only those present in the AOC can view all the information required for decisions; this was no different in OOD/OUP. Kometer does give a few examples where decision rights were allocated to lower levels. One example is that of the development of a TST matrix during Operation Iraqi Freedom, where the JFC allowed the JFACC in the AOC to prosecute specific types of TSTs under specific circumstances; within the context of this paper, not a very significant step in distributing control. In another example, AWACS was required to run TST-like missions because it was the quickest way. This last example gives leeway for Kometer's outlook that perhaps in the future it will be possible to distribute control down to the TACS level, as they may have the same level of situational awareness as the AOC and are in direct contact with the actors at the tactical edge. As such, TACS would be capable of creating deeper command relationships. Kometer goes even further stating that TACS will not be the final word in developing deeper command relationships, as airborne TACS will not be capable to operate in high-threat environments: 'As technology matures, there should also be plans to reproduce a portion of this capability into more tactical aircraft. For example, there may be a need for fighter aircrew to lead a flight of UAVs on a mission in enemy territory where coordination with ground forces is involved.'[66] Kometer may have been ahead of his time with this 2005 prediction: the 2015 USAF Future Operations Concept, describing Air Force core missions in 2035, brings this concept to live in a scenario called 'Human-Systems Integration at the Tip of the Spear', in which a flight of F-35s is teamed with a formation of Multi-Mission Long-Range (MMLR) uninhabited aircraft on a high-threat mission.[67]

So, for arguments sake, if we were able to create command relationships all the way to the tactical edge, supported by a network that enables unprecedented and shared (F- 35) situational awareness and flawless collaboration, nothing should hold us back from distributing control to the tactical edge and become a true 'edge' organisation, right?

---

66 M. Kometer, *Command in Air War: Centralized vs. Decentralized Control of Combat Airpower*, United States Air Force, MIT, 20 May 2005, p. 250.

67 United States Air Force, *Air Force Future Operating Concept: A View of the Air Force in 2035*, September 2015, p. 22.

Not so! There is an aspect that Alberts and Hayes' model does not account for, nor is intended to, but is apparent in Kometer's work and the experience of OOD/OUP. It is that the choice of strategy introduces constraints on the C2 approach of the edge (operational) organisation. This choice can be linked to the type of conflict that we are involved in. It is safe to say that all contemporary conflicts that RAAF and RNLAF, and which most of the free Western world have been involved in, are conflicts of choice. Without going into moral or diplomatic discussion, one could claim that we have joined these conflicts out of free choice. Also, we were able to step out any time before reaching a strategic end-state without suffering consequences for our national security or sovereignty. We have not been involved in a war of necessity since World War II, which included an existential threat against our homeland; except for the Cold War, which was never fought on the physical battlefield. Also, we (specifically, air forces) are not used to, or have not been trained to lose a war, or even a battle, in the traditional military sense, in which we suffer great losses and are forced to withdraw in defeat. This significantly affects how we fight wars and subsequently the Air C2 arrangement that we have to establish. In his work *On War*, Karl von Clausewitz argues that the more limited the war, the more the political interference. To apply this theory, the black-and-white classification of 'conflict of choice' and 'war of necessity' doesn't suffice; a gradual scale to classify conflict fits better. A suitable scale can be derived[68] from the spectrum of conflict (Figure 11) as described by Dr Sanu Kainikara in *The Bolt from the Blue*.[69]

Conflict on the left hand side of the spectrum will generally be accompanied by a strategy of political constraint, wherein risk avoidance is considered more important than optimising military effectiveness. Peace keeping operations, like Operation *Deny Flight* (Bosnia, 1993–95), are an example for the type of conflicts and the political constraints associated with them. No matter how deep the command relationships in such an operation, centralised control remains a requirement to uphold the political constraints. If we would be involved in a conflict in the middle of the spectrum, like peace enforcing or Responsibility to Protect (R2P) operations, a different strategy should be chosen. That strategy should give more leeway to the military in achieving goals without the level of political constraint that is imposed on a peace-keeping operation. In a war of national survival, the strategy should be completely aimed at reaching the primary military objective: national survival.

---

68 In *The Bolt from the Blue*, the 'war of choice' is depicted as a separate type of conflict towards the right end of the spectrum. As in this paper a certain level of free choice is tied all conflicts besides the war of survival, the war of choice is here not depicted as a separate type.

69 Sanu Kainikara, *The Bolt From The Blue: Air Power in the Cycle of Strategies*, Air Power Development Centre, 2013, p. 10.

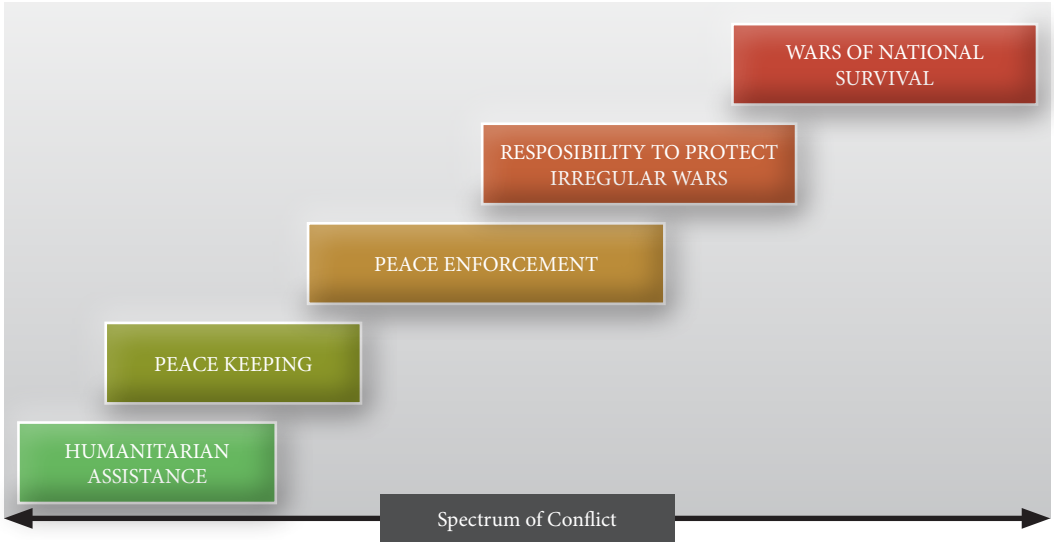


Figure 11: Spectrum of Conflict

Kometer's thesis and the experience in OOD/OUP show that it is not always the case that the choice of strategy fits the type of conflict. Although both Operation *Allied Force* and OOD/OUP were framed as a R2P operation, these conflicts were still met with great political constraint, forcing the JFC to centralised control. In the transition from Operation *Enduring Freedom* to Operation *Iraqi Freedom*, both framed as operations in the middle of the spectrum of conflicts, the strategy moved towards one more aimed at achieving military objectives. This opened the door for (although still very limited) distribution of control, based on the depth of the command relationships. At the far right of the spectrum, is a war of national survival where the very existence of our nations is at stake. One can only hope that, in such a case, all (political) gloves are off and the military are allowed to do everything in their power to win, giving even more room for distribution of control. If everything else fails and our lives depend on it, autonomy at the tactical edge could even be acceptable, regardless of the depth of the command relationships.

Kometer showed that the deeper the command relationships, the more room to distribute control to subordinates. However, during the time of his research this was not executed as commanders were politically constrained, making centralised control necessary. Without considering those constraints, the relationship (from a qualitative perspective) should be relatively straightforward (see Figure 12).

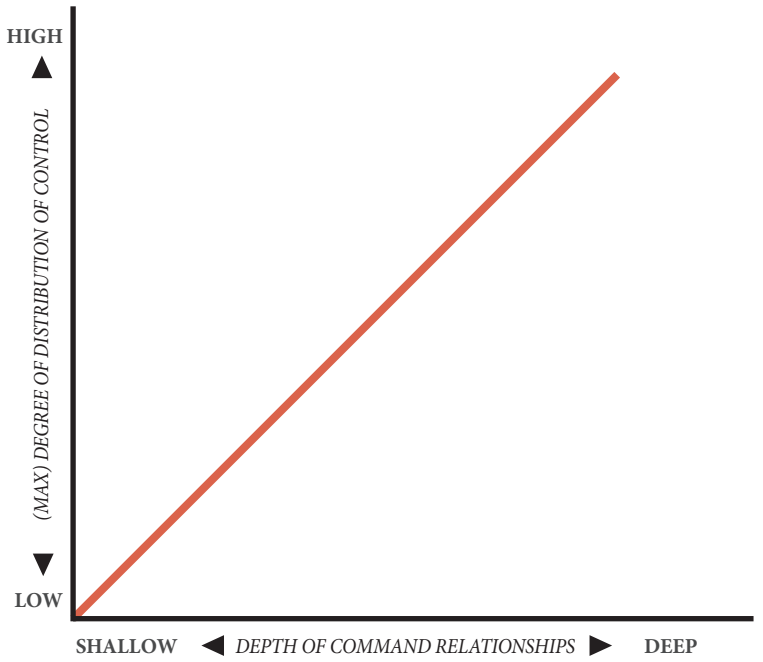


Fig. 12: Relationship between the depth of the command relationships and the (maximum) degree of distribution of control

In searching for possibilities to distribute control, the impact of the choice of strategy on the relationship, as shown in Figure 12, is investigated. We could thus build a model that shows in which situations control can be distributed. The model will be built using a stepped approach beginning with the relationships in three types of conflict (peace keeping, R2P, and war of national survival) separately before combining them into one model. I note that the types of conflicts are no more than three exemplary markers in the continuum from the smallest confrontation of absolute free choice to a devastating war of national survival that is brought upon us.

First, in peace-keeping operations (see Figure 13) the distribution of control is predominately limited because the strategy is bound by political constraints, even in a situation when the depth of the command relationships would theoretically allow more distribution of control. The degree of distribution of control in Figure 13 depicts a maximum. A commander can always choose to retain more control at his or her level. The space below the line can be seen as a trade-space for the commander in which s/he has to balance pros and cons of distributing control. The choice can be either setting a level of distribution of control across the whole operation or distributing control in specific situations while retaining a higher level of centralised control in others. The latter choice

is more flexible as it allows a contextual distribution of control. This paper will re-address this trade-space and the commander's choice further down this chapter.

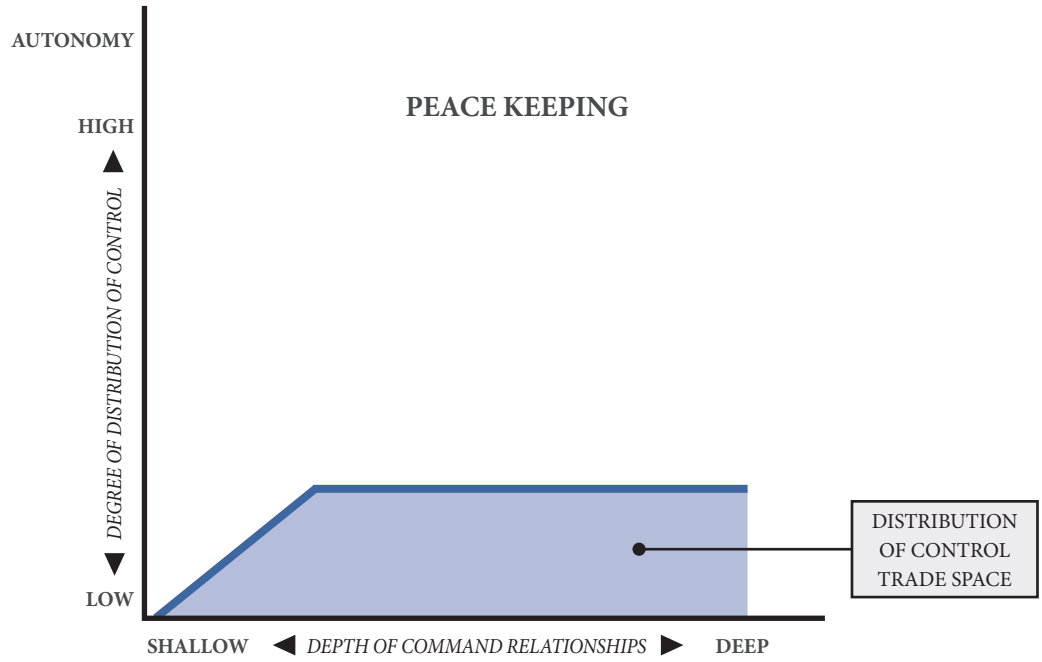


Fig. 13 Relation between degree of distributed control and depth of command relationships for peace keeping operations

In an R2P-operation (see Figure 14), where the strategy shifts from political constraints to military objectives, the degree of distribution of control is predominately bound by the depth in the command relationships, although political constraints still limit the maximum distribution of control. Again, below the line is the 'distribution-of-control' trade space for commanders.

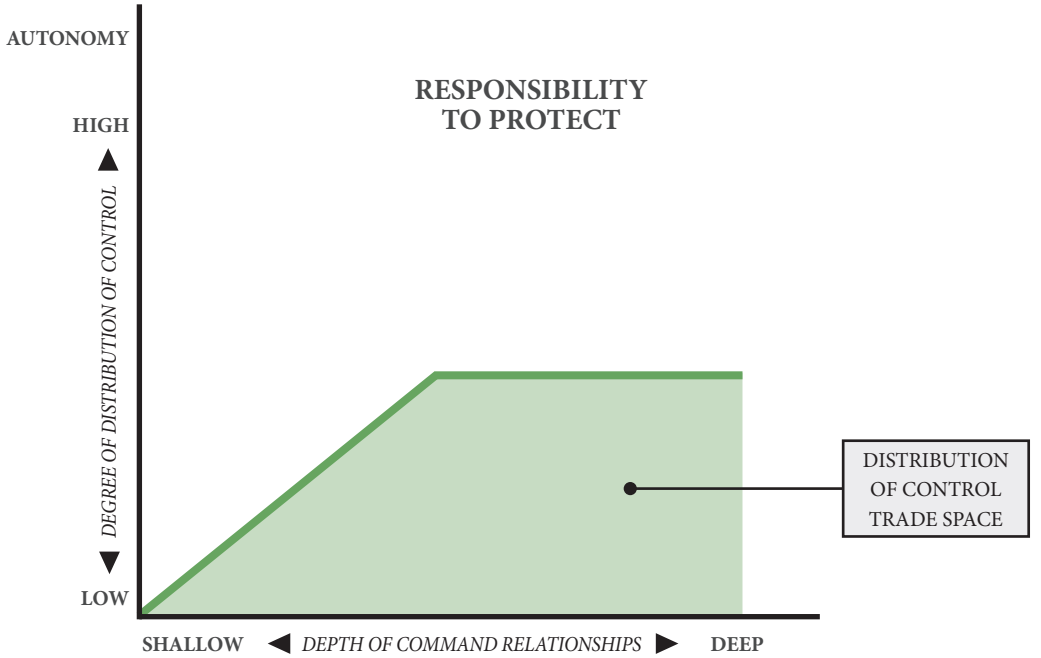


Fig. 14: Relation between degree of distributed control and depth of command relationships for R2P-operations

The third situation is that of a war of national survival (see Figure 15). Because this is an extreme situation, asking for extreme measures, the strategy should be focused purely on achieving military objectives. The degree of distribution of control is not capped by political constraint; it is even possible that control is distributed beyond the depth of the command relationships. When, in a war of national survival, the depth of the command relationships is degraded below the level that commanders need to control their forces (for example, when critical C2 nodes have been destroyed), the tactical level can be tasked to operate autonomously. This could result in a very high degree of distribution of control without (any) depth in command relationships. This is not purely theory; within NATO's Standing Defence Plan, a system for distributing Tactical Battle Management Functions (TBMFs) is in place that aims to distribute control without depth in the command relationships during

emergencies.[70] This is in fact a system of distributing control without depth in command relationships, leading to very limited, or no, means of holding subordinates accountable (see earlier in this chapter). The trade space below the line defining the options for the commander to distribute control should also be shaped differently, because autonomy is not necessarily driven by a commander's choice but more by the unfolding situation, within which the commander has fewer options to retain a level of central control.

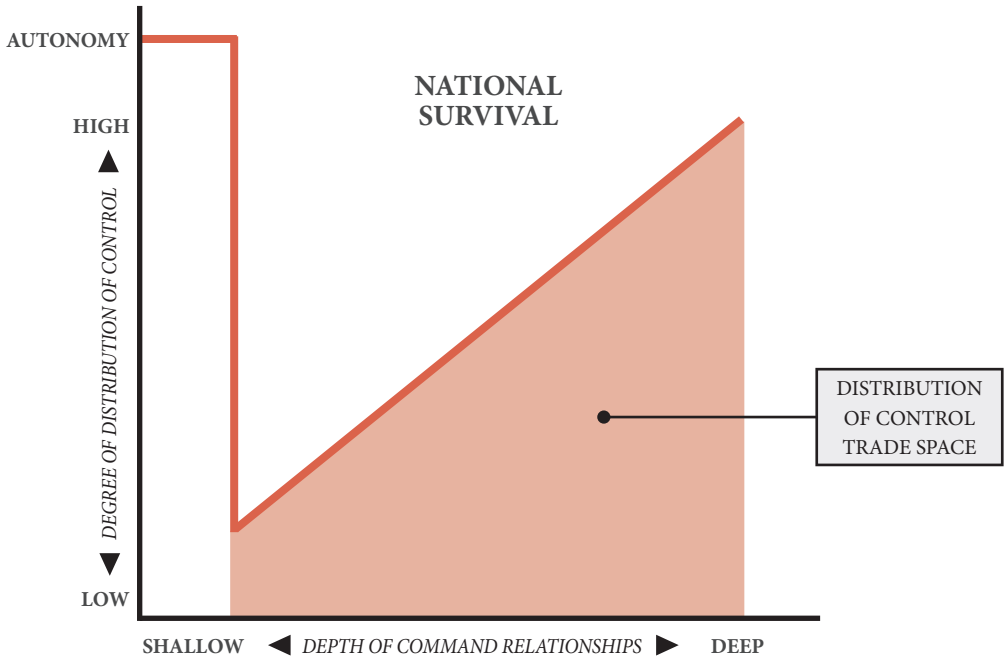


Fig. 15: Relation between degree of distributed control and depth of command relationships for a 'war of national survival'

The three types of conflict are used as examples in the analysis of the trade space a commander has to distribute control. As said, the type of conflict should be seen as a

70 During the Cold War, NATO was prepared for massive battle in Europe against the Warsaw Pact forces. The tenet of Air C2 was also centralized command and control, decentralized execution. However, contingencies have been built into the NATO Standing Defence Plan (SDP) to overcome the outage of the NATO Air C2 structure. The SDP provides a system of Tactical Battle Management Functions (TBMFs, 13 in total) that defines specific means of control and the Air C2-level where every TBMF is retained and the lowest level it can be delegated to in order to cope with the unfolding military situation. Examples are identification authority, engagement authority and the authority to manage Combat Air Patrols (CAPs). Some of the TBMFs could be delegated down to the weapons platform; some not lower than the TACS.

continuum and not as three separate classes. Combined in one figure, it illustrates the shift of that trade space as a conflict changing its characteristics. It is not only that different conflicts have different characteristics requiring a different strategy. Even within any specific conflict, the characteristics can and most probably will change over time as events happen and circumstances change. That means that a commander may have to cope with different strategies within a specific conflict, which changes the trade space he can use to retain or distribute control. Figure 16 combines Figures 13, 14 and 15 to illustrate these shifts in conflict and trade space.

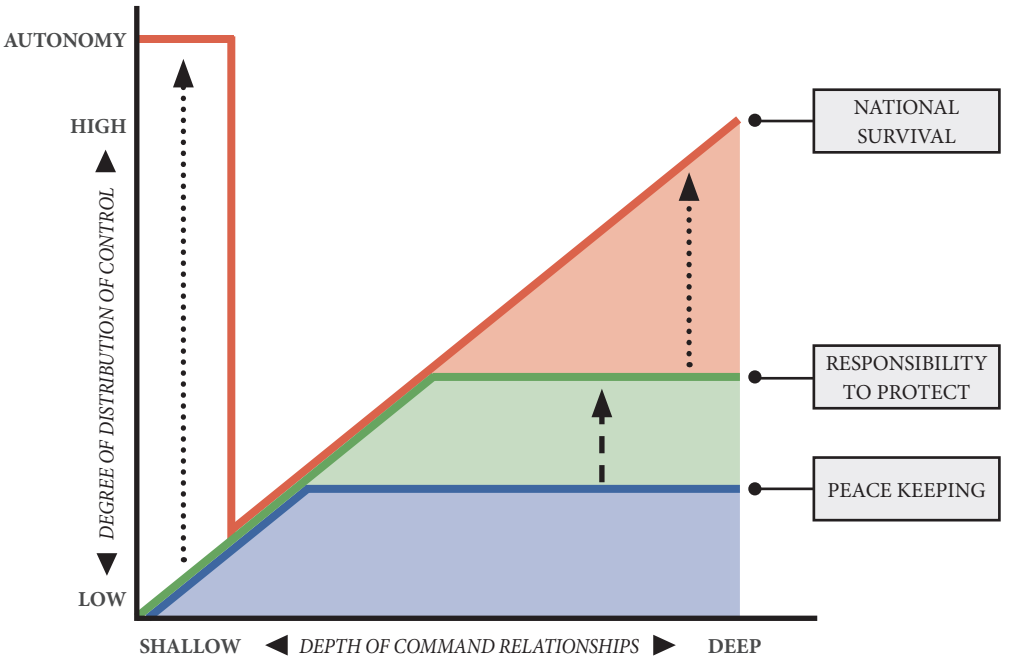


Fig. 16: Shifts in trade space for distributing control relative todepth of command relationships and type of war

Contextual Distribution of Control

Documents that describe the future military environment, like the US Joint Operating Environment 2035, clearly state that the balance of power is changing. Greater parity among a range of international actors will allow potential adversaries to more effectively

challenge (USA) global interests.[71] This could mean that potential adversaries could pick a fight, leaving us no choice but to meet the threat. It is arguably that we are not already involved in such conflicts of necessity, like the war against Islamic State. Walking away from that war may significantly affect national security because the (then) non-contested foundation for terrorist attacks may cascade into economic and financial insecurity. Although individual nations are currently able to disengage in the military sense from such a conflict under the safety umbrella provided by the international alliance, we should not bank on this remaining achievable or even desirable in future conflicts of 'choice.'

While the previous paragraph shows that conflicts of necessity manifest themselves as conflicts on the far right hand side of the spectrum of conflicts, they do not always have to be existential wars of national survival. However, to give the military the required freedom of operations to prevent defeat in combat, the strategy should be dominated by military objectives and not limited by political constraints. The trade space for the commander to retain or distribute control will be bound only by the depth of the command relationships. This allows the commander to strive for agility by harvesting the benefits of distributing control. As encouraging as this sounds, it is still not an easy task. The commander must first understand what the available trade-space is and then choose how best to use it. Both the amount of trade space to distribute control and the choices that a commander makes about using it will not be constant factors; they are influenced by the unfolding events.

First, let's look at how the trade space for distribution of control is defined and how it can change. If we return to the system (or system-of-systems) approach advocated earlier in this chapter, we can picture the commander being part of an Air C2 system consisting of people, procedures and technology. This Air C2 system[72] will inherently have a certain level of agility. This level is gained and maintained by raise, train and sustain personnel, the C2 arrangements, and the systems that support shared situational awareness and collaboration (distribution of information and patterns of interaction, see Alberts and Hayes). Once the Air C2 system is activated to provide Air C2 in a conflict, the system will adjust to the circumstances and then try to settle itself in the operational environment it has to function in. However, that environment is very complex and highly dynamic, thus constantly reshaping. It requires a high operational tempo of the Air C2 system to gain and maintain the advantage over the opponent, specifically in the case of a peer opponent, who will seek and exploit weaknesses in our Air C2 system. Without appropriate measures, the Air C2 system will be unable to settle and start to degrade. This will inevitably decrease

---

71 *Joint Operating Environment 2035: The Joint Force in a Contested and Disordered World*, US Chiefs of Staff, 14 July 2016, p. 52.

72 Kometer used the term Combat Air Operations System to model the behavior of the (complex) system with respect to the question how control is accomplished in M. Kometer, *Command in Air War: Centralized vs. Decentralized Control of Combat Airpower*, MIT, 20 May 2005, p. 67.

the depth of the command relationships within and beyond the Air C2 system, and subsequently decrease the trade space for distribution of control. Hence, the Air C2 system has to apply more centralised control. A vicious circle becomes apparent where the Air C2 system cannot cope with the increased demand of centralised control and subsequently loses grip of the situation to a level where units are forced to operate autonomously as a last resort. To avoid this, the Air C2 system must constantly improve to maintain or gain agility.

Kometer stipulates the need to create a learning organisation to cope with the complexity. He ties this to assessment of effectiveness of actions and the need for a change of plans.[73] He further concludes that 'At every level, the more decision makers tried to (…) manage the details of subordinates' actions, the less those subordinates were able to act like a learning organisation.' In line with this thought, the opposite is logical as well: the more subordinates are empowered though distribution of control, the better they can act like a learning organisation and the more they are able to cope with complexity. This raises another vicious circle, but this time relating to more depth of the command relationships and subsequently an increase in the trade space for distribution of control, all driven by a learning organisation. Figure 18 illustrates the consequences of degrading on one hand and learning on the other of the Air C2 system in terms of the available trade space for distributing control. The effects are most noticeable in a war of survival, in that the trade space for distribution of control is bound only by the depth of the command relationships and not capped by political restraints.

73 Alan Docauer, Peeling the Onion, *Air and Space Journal*, Volume 28, No.2, March–April 2014, p. 39.

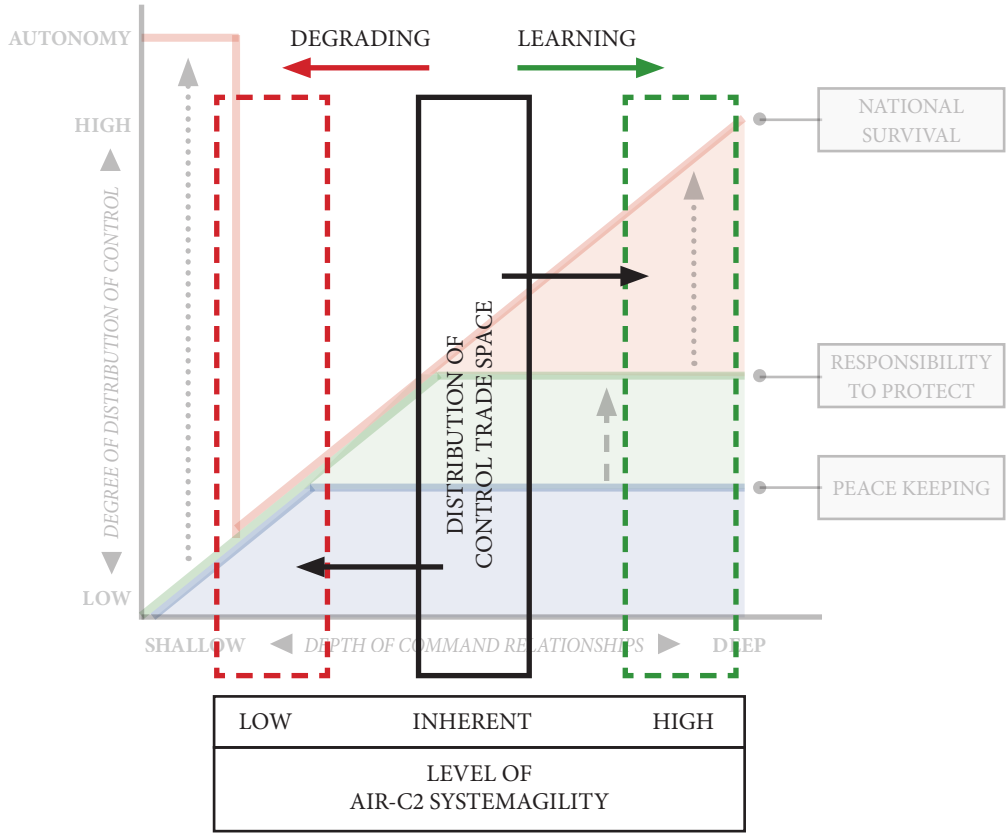


Figure 17: Level of Air C2-system agility and available trade space for distribution of control (war of national survival)

The next step is making choices about how to best use the available trade space to distribute control. Making these choices is not an exact science. Many factors drive the commander's choices, most of which can be tied to the specific context for which the choice has to be made. Factors like task, resources, tempo and area, etc. For instance, even if the command relationships are deep, it is thinkable that a commander would choose to retain more centralized control when the impact of a mission is directly tied towards reaching a strategic objective. This is specifically so if the commander has the ability to use a 'directed telescope' to gain a high degree of real-time situational awareness at the tactical edge. On the other hand, the commander may distribute control to a flight of highly capable 5th Generation platforms that he understands will be best able to achieve the desired effect if fully empowered to exercise control at the tactical edge. At the same time he may retain centralised control over a mission that is executed by less capable (4th Generation) aircraft. In another case, a commander may choose to maximise the distribution of control in an area or time where the operational tempo is relatively low,

freeing up (centralised) Air C2 capacity to support times and areas of higher operational tempo. A commander may choose sometimes to distribute control, while in other cases he is no longer in full control and simply has to distribute it to maintain tempo at the tactical edge. Furthermore, a commander has choices about to which function(s) he wishes to apply distribution of control. Functions like identification, airspace control, emission control, position and tasking of supporting assets, etc. For instance, he could choose to distribute airspace control and position and tasking of supporting assets during a high-risk mission where the chance is high of friendly aircraft being shot down so that the need for re-tasking assets for a Combat Search and Rescue (CSAR) mission is likely. By distributing control of these functions ahead of the actual occurrence of such missions, the assets at the tactical edge can act instantly on the incident. They can rapidly create a situation best suited for a successful CSAR using superior situational awareness and direct collaboration within the local area.

The choice to use the trade space for distribution of control implicates a commander will not always distribute control to the extent that is warranted by the depth of the command relationships. His choice can result in underusing or disempowering the capabilities of specific subordinates. This is not without consequences. First and foremost, Kometer points out that underutilization of capability leads to a suboptimal operational tempo. As stated in the previous paragraph, a high degree of centralised control also makes it harder for subordinates to act like a learning organisation and cope with complexity. Furthermore, highly capable subordinates tend to become less responsive to the occurring situations when they feel powerless. Lastly, Kometer points out the risk called practical drift. This occurs in circumstances where highly capable platforms are disempowered, leaving the risk that they start to deviate from standard procedures and apply what they consider practical (local) improvements or procedural shortcuts. This has the potential for problems (so-called system accidents) caused when such platforms need to cooperate closely with other units that do adhere strictly to the standard procedures, or have been engaged in their own version of practical drift. All in all, the commander should be aware of these consequences of underusing the trade space to distribute control upon making his choices to distribute control.

The options a commander has to distribute control could be seen as tools in the 'toolbox of distributed control'. A commander would select the tool (function and degree of distribution of control) that best fits the job (context) while understanding risks (underusing the capabilities of specific subordinates by disempowering them). The words 'option' and 'select' may have a positive connotation, as they are intuitively tied to free choice. However, the toolbox should also contain tools to be used in case the depth of the command relationships is degraded to a level that requires subordinate units to be autonomous beyond the choice of a commander.

There are some basic ideas what such a toolbox should look like, although these are mostly aimed at coping with degraded Air C2 capabilities. In his article 'Peeling the Onion', USAF LtCol Alan Docauer calls for a system that serves as a risk mitigation measure, needed in a conflict in which an advanced enemy can challenge decision making by denying assured access to distributed communications and battlespace awareness. This system would be used to continue the fight when critical links are lost as well as countering the enemy's pace and initiative.[74] Docauer presents a sample matrix of command and control decentralisation, much like the earlier mentioned NATO system of delegating TBMFs.

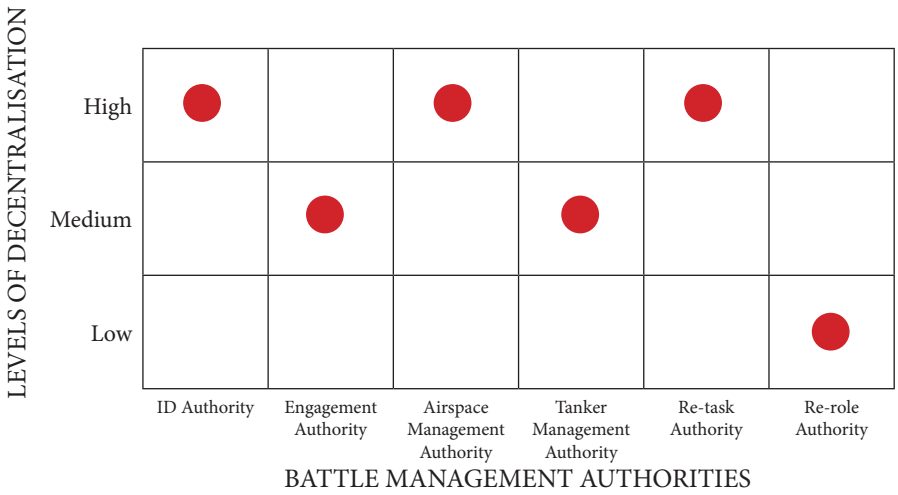


Figure 18: Sample tactical C2 decentralisation matrix[75]

In their article 'Resilient Command and Control; The Need for Distributed Control', Hostage and Broadwell[76] also give examples of distribution of control used to 'overcome varying levels of isolation or confusion associated with fighting in an Anti-Access/ Area-Denial (A2/AD) environment'. Again, the motivation to distribute control seems predominately out of a negative incentive. However, Hostage and Broadwell go way beyond that: 'Airmen empowered with trusted autonomy are more likely to seize initiative by assuming control authorities implicitly rather than waiting for those authorities to be delegated explicitly. The ability to maintain initiative and act in the throes of combat is key to putting combat airpower over friendly forces or taking it to the enemy. To enable

74 Ibid., p. 39.

75 Ibid., p. 40.

76 Gilmary M. Hostage III and Larry R. Broadwell, Jr, 'Resilient Command and Control: The Need for Distributed Control', *Joint Forces Quarterly*, no. 74, 3rd Quarter 2014.

this initiative, the commander must have clearly expressed his intent to subordinate commanders and their units. From this initial direction, subordinate commanders and units are able to intelligently conduct distributed control as well decentralized execution in support of the commander's principle goals and objectives and in absence of direct contact.' As we have been operating for the past decades in permissive environments under very tight (political and military) control supported by robust and unthreatened Air C2 networks, they also make a (good) case that we need to change doctrine, organisation, Tactics, Techniques & Procedures (TTPs), training and exercises to be able to apply distributed control.

Relation to F-35 Employment

The argument in this chapter points towards further exploring the possibilities to apply distributed control to air power. This is particularly relevant for employment of F-35. Where currently multiple systems are used to gain the required situational awareness to support a decision and subsequently create the desired effect and do BDA, and the orchestration of those systems is done at an AOC hundreds or thousands miles away, the F-35 conceptually has the capability to do this all by itself. In some cases, the F-35 will operate alongside other platforms that bring additional capabilities to the fight. When empowered by distribution of the right level of control, the synergy among these platforms will enable a high degree of self-synchronisation[77] at the tactical edge. This would facilitate a higher operational tempo because synchronisation would happen real-time at that tactical edge without an AOC having to intervene by executing centralised control. This needs to be taken at heart, because employing the F-35 without creating the circumstances for the system to reach full potential would negate much of the advantages the F-35 brings to the fight. Furthermore, the generic principles or concepts that work for F-35 probably also work for other 5th Generation capabilities.

As explained earlier in this chapter, the allocation of decision rights should not be stretched beyond the limits of distribution of information and the patterns of interaction, required for a deep command relationship. Translated to F-35 employment, this implies that distribution of control requires shared situational awareness and collaboration. In Chapter 3, the current technical limitation of F-35 related to sharing information and collaborate outside the F-35 flight was pointed out. However, fixing these technical challenges for the F-35 is only a first step to a solution. It is not just a matter of enabling

77 Self-synchronisation is defined as the ability of a well-informed force to organise and synchronise complex warfare activities from the bottom up. ('Network Centric Warfare: Its Origin and future', A. Cebowski and J. Gratska, Proceedings Magazine, January 1998 Volume 124/1/1,139). In 'Understanding Command and Control', Alberts and Hayes claim that self-synchronisation leads to dramatic increase in both agility and effectiveness.

the F-35 to communicate with other players, either line-of-sight or beyond-line-of-sight. Shared situational awareness and collaboration at the tactical edge requires new workflows supported by a networked philosophy. This is not unlike what has been talked about in Chapter 3. In this respect, much can be learnt from the efforts to enhance collaboration through the IRM&CM process and the approach to ISR interoperability within the MAJIIC program. Hostage and Broadwell tie the concept of the combat cloud to distribution of control.[78] Using the philosophy behind IRM&CM and ISR interoperability, and adapting existing workflows to support shared situational awareness and collaboration beyond that of the traditional Air C2 and ISR enterprises, could prove a pragmatic and viable approach towards creating more depth in the command relationships. This in turn would create the opportunity to distribute control to the tactical edge and get the best out of the F-35, or any future (5th Generation) capability that supports operational agility in a very complex and highly dynamic environment.

Traditionally, where an AOC operates as the 'centre of calculation' exercising centralised control, decisions are made by the commander based on advice by a team of operators of diverse backgrounds. When presented with a virtual representation of the battlespace, these operators interpreted that representation differently based on their background and then advise the commander using their interpretation. The commander will make a balanced decision based upon the various interpretations. Distributing control down to the tactical edge implies that the decisions are made by operators who do not have a similar diverse background as the AOC-team. The more complex and dynamic the situation becomes, the harder it will be for that operator to cope with all the information and make a balanced decision. This 'complexity' challenge of F-35 missions was pointed out in Chapter 3. On the other hand, according Alberts and Hayes, the more complex and dynamic the situation becomes, the more we need to operate as an agile fighting force and allocate decision rights to lower levels. Quite a dilemma! Part of the solution may be found using the combat cloud to facilitate collaboration functionality. This shifts the decision-making from the isolation of a flight of F-35s to making it a decision-of-peers at the tactical edge. Perhaps more important is the way we look at operators at the tactical edge and raise, train and sustain him or her. The understanding that the F-35 is much more than a one-on-one replacement of F-16 and F-18 has well sunken into our minds. The question remains to what extent we are willing and able to fundamentally change the way we 'breed' 5th Generation operators. We may have arrived at a point where ISR analysis and airborne battle management required for distributed decision-making are as equally important tasks for the F-35 operator as creating kinetic and non-kinetic effects and flying the jet. We may subsequently have to rethink our RTS efforts. Until then, the trade space

78 Gilmary M. Hostage III and Larry R. Broadwell, Jr, 'Resilient Command and Control: The Need for Distributed Control', *Joint Forces Quarterly*, no. 74, 3rd Quarter 2014.

for distributing control may be smaller than is required to be agile and cope with complex and dynamic environments, simply because our operators do not (yet) have the required skillset to execute control at the tactical edge.

At the AOC, distributing control can kill more than one bird with one stone. First, it will enable more agility at the tactical edge and enhance effective and efficient employment of scarce capabilities like the F-35. Second, it will elevate some of the control burden of the AOC, preventing it from becoming overtasked. Third, it prevents capable platforms like the F-35 from being underutilized and subsequently becoming less responsive and engaged in practical drift (see earlier in this chapter). Lastly, in a situation where the AOC would become degraded through hostile action, resorting to autonomy would be relatively easy for capabilities that have already been allocated decision rights through distribution of control. These are positive incentives for an AOC to use the trade space to distribute control. However, besides the fact that we currently still work under the premise of centralised control, the trade space to distribute control has been rather small because of the type of conflict we have been engaged in, and the political constraints associated with it. Subsequently, current AOC procedures and training are not tailored towards distributing control.[79]

From an AOC perspective, distribution of control entails giving up a part of the control it currently has and trusting subordinate units, all the way down to the tactical edge, to act in concert without things going 'out-of-control'. This may be very hard to do, as it seems to go against our military way of organising ourselves. The Dutch saying 'Trust is good, control is better' illustrates this. Because control involves 'staying in control' and exercising authority, distributing control may be seen as losing authority and subsequently going 'out-of-control'. As the AOC can currently be considered the centre of calculations, there is probably some truth in that. However, under the propositions that we will become better in sharing situational awareness and collaborating with, and at, the tactical edge, the AOC may be broken up in to 'nodes of calculation' created to exercise distributed control over a specific event, area or timeframe. This would require new workflows and training at the AOC and possibly new skillsets. Perhaps even more important and simultaneously more difficult, is that this could require a different 'breed' of personnel in the AOC: 5th Generation operators and commanders that believe that control is fine, but trust is much better.

This does not mean that an AOC should always distribute control in favour of any and all F-35 missions, or any other 5th Generation capability. The toolbox for distribution of control should also provide the means to retain centralised control. Sharing F-35

79 An exception to this is the occasion where NATO CAOCs train to the NATO Standing Defence Plan in the delegation of TBMFs to cope with degradation of their Air C2 capabilities.

situational awareness with the AOC, or potentially even with the JFC at a Joint Operations Centre, enables a commander to use the directed telescope and exercise real-time control of specific missions. This type of high-level control right down to tactical edge is often met with great debate. It is referred to as micro-management by using the commander's 2000-mile-screwdriver. There are plenty of examples from past missions where high-ranking commanders have used, and probably misused, this type of control, often with best intentions but nonetheless hampering mission execution and decreasing operational tempo. Often, their best intentions have been associated with political constraints in conflicts of choice. However, it is not unlikely that, in a future conflict against a peer adversary, unanticipated situations occur that require specific theatre or national command approval, specifically if this means seizing strategic opportunities that require tactical action on the edge or beyond the implemented ROE or the commander's guidance. In these cases, the ability to exercise centralised control from the highest level, supported by situational awareness down to the tactical edge, could in fact be considered a blessing, as without it, valuable context and time would be lost along with that fleeting strategic opportunity. Again, trust plays a role in using and accepting this type of control. From the commander's perspective, it is important to refrain from applying micro-management in cases where the 5th Generation operators at the tactical edge are perfectly capable of creating the desired effects in line with ROE and commander's guidance. From the tactical edge operators' perspective, it is important to cherish and assist this type of control in those situations where a commander is willing to modify his or her guidance to seize an opportunity.

If it comes to a point that we're able to distribute control to highly capable assets at the tactical edge enabling a high degree of agility through self-synchronisation, we should still ensure that the AOC (and levels above it) is able to keep track of what is happening. As we are actively re-shaping the battlespace at the tactical edge, we need to understand what distributing control means for the overall air operation and how we can adjust our actions to continue to create the right effects for that reshaped battlespace. This is tied to the assessment of effectiveness of actions, which in turn means creating a learning organisation that can cope with complexity (see earlier in this chapter). This again comes back to the importance of collaboration (patterns of interaction) and sharing ISR results (distribution of information) as two out of three dimension of the (Air) C2 approach to becoming an edge organisation. This could very well be another application or service within the combat cloud, facilitating not only contextual information sharing and collaboration at the tactical edge, but also between the tactical edge and the AOC, making the AOC more a collaboration partner in a situation of distributed control, and less an Air C2 authority.

Conclusion and Recommendations

The answer to the questions 'if and, if so, how control can be distributed to levels below the AOC' is indeed 'it depends'. There is a broad range of factors that need to be taken into account before applying distributed control. These factors vary from the type of conflict we are engaged in; the political constraints associated with it; and the specific situation or context to which we want to apply distributed control using doctrine, organisations, technology and TTPs all the way to culture and RTS of personnel. In some cases, we may have to distribute control, or allow autonomy, when things go bad, our Air C2 system is degraded, and we are 'out-of-control', regardless of these factors. However, we do need to consider the full range of factors before we distribute control out of free choice.

Within the prospect of a future conflict against a peer adversary, with a high operational tempo in a very complex and highly dynamic environment, perhaps the better question to answer is: should we consider sticking to centralised control as a tenet of Air C2 and not pursue distribution of control? Our ambition towards becoming 5Th Generation Air Forces and this chapter's analysis, leads to a more finite answer: No.

First, it will be highly lucrative to empower F-35 and other highly capable platforms at the tactical level to impose a high operational tempo on an adversary by seizing emerging opportunities without delay. Second, as mass has become less a requirement for successful air operations, we are not necessarily bound by theatre-wide centralised control. Third, if we underutilize our capabilities at the tactical edge, such as F-35, it will be harder for our forces to act holistically as a learning organisation and cope with the complexity. Also, underutilization increases the risk of practical drift. Fourth, if we cannot keep up with a high operational tempo forced upon us and subsequently our ability to exercise Air C2 degrades, we may have to resort to a certain degree of autonomy. We would be better prepared to handle and overcome such a situation if distributed control is standard operating procedure, even without a degraded Air C2 ability. In summary, we should pursue distributed control based on both positive and negative incentives. Nonetheless, the range of factors mentioned above, tied to the 'it depends' of distributed control, remain at play.

Looking at F-35 employment, we understand that we have to apply new operating concepts to avoid the pitfall of employing the F-35 as a stealth F-18 or F-16. Maintaining old concepts will (inevitably) hamper F-35 operational abilities. Given the limited number of F-35 they plan to employ, RAAF and RNLAF cannot afford this. However, we should avoid placing F-35 too much in the centre. We need to apply new concepts beyond just F-35 employment to create the circumstances where the F-35 and other future 5th Generation capabilities are able to perform to their max abilities. This includes considering new concepts for Air C2 from a broader Air Power perspective.

Applying new concepts of Air C2, in this case distributed control, is inextricably linked to the distribution of information and patterns of interaction[80] or, in other words, sharing information to enhance situational awareness and collaboration. It is no surprise therefore that the technical solutions that support enhancing Air C2 – ISR integration at the tactical level, as described in Chapter 3, are equally required to enable distribution of control. To that effect, Hostage and Broadwell and Deptula all tie new concepts for Air C2 to the combat cloud,[81,82] even more reason why RAAF and RNLAF should take it to heart. Deptula puts the combat cloud in a much broader perspective than a technology enabler. He ties it to a transition from industrial-age platform-centric methods of force employment to an interconnected, information-driven model of C2. This transition '(…) will require a doctrine, organization, training, materiel, leadership and education, personnel, facilities and policy (DOTMLPF-P) approach (…).'[83] DOTMLPF-P may very well be a good framework to approach the factors that need to be considered before applying distributed control (see above in this paragraph).

This chapter aims at stimulating the international discussion on distributed control related to F-35 employment. It does not give a recipe or roadmap for applying the concept. It merely gives an analyses of the possibilities and reasons to pursue it. A next step could be to do a multi-national DOTMLPF-P analysis to holistically understand what would be required to apply distributed control. A good vehicle to facilitate this analysis could be the international 5th Generation Air C2 – F-35 Working Forum, referred to in the recommendation in chapter 3 (see footnote 43).

In Chapter 3, I looked at enhancing Air C2 – ISR integration at the tactical level, and the relation with F-35 employment, to increase agility in air operations. In this chapter, I focused on the control aspect of Air C2 and its relationship with F-35 employment, by considering distributed control to (further) increase agility at the tactical and (lower) operational level. The application of Air C2 is commonly associated with the tactical and lower operational level. However, the command aspect of Air C2 reaches into the higher operational and strategic level as well, where commander's intent and guidance are formulated. Chapter 5 explores the relation between the command aspect of Air C2 and ISR at the higher operational and strategic, and its relationship with F-35 employment, in our quest to become an agile fighting force.

---

80 David Alberts & Richard Hayes, *Understanding Command and Contro*l, CCRP, 2006, p. 57.

81 Gilmary M. Hostage III and Larry R. Broadwell, Jr, 'Resilient Command and Control: The Need for Distributed Control', *Joint Forces Quarterly*, no. 74, 3rd Quarter 2014.

82 David S. Deptula, 'Evolving Technologies and Warfare in the 21st Century: Introducing the Combat Cloud', *Mitchell Institute Policy Papers,* Vol. 4, September 2016,

83 Ibid, p. 9.

5. An Operational and Strategic Level perspective

It is safe to say that even more than Air C2, ISR has a tactical connotation to most of our Air Force members. Although the knowledge of ISR within our Air Forces has grown comprehensively over the last decades, for many, it may be most tangible in the form of imagery and FMV to support ongoing mission execution. Perhaps that is because the majority of our war fighters perform at the tactical level, where the 'rubber hits the mat'. At the same time, all involved would acknowledge that ISR is much more than just a tactical enabler. We fully appreciate the importance of ISR to support decision making above the tactical level, as this is also part of 'getting the right information and intelligence, to the right people, in the right format, at the right time enabling battlespace awareness, information superiority and decision superiority' .

In the same fashion, we can all appreciate the fact that decision superiority is an aspect of the tactical, operational and strategic level. Stronger than that, isolated tactical successes are futile if these are not based on sound operational and strategic objectives and decisions, supported by information and intelligence. After all, strategic and operational planning are the start point for execution of air operation at the tactical level. Strategic and operational planning are not single efforts or events that happen after which execution 'runs the show'. There is constant feedback and feedforward between the levels of air operations to align and re-align strategic and operational intent and guidelines with tactical tasks and results. Because of this inter-relationship, one can expect that the tempo of operations at the tactical edge will be influenced by the tempo at the operational and strategic level. If a high operational tempo at the tactical level is not met with a similar paste at the operational and strategic level, execution will inevitably slow down. Our best efforts to create higher operational tempo at the tactical edge could possibly be negated by a lack of operational and strategic level to quickly make the right decisions based upon the situation as it unfolds. Again, the relationship between information superiority (through ISR) and decision superiority (though Air C2) becomes apparent. Again, this can be tied to agility, in this case at the operational and strategic level.

With the introduction of F-35 it becomes increasingly important to look at assets employment and agility above the tactical level. First, because the (stealth) F-35 is conceptually able to create operational and strategic effects in a contested air environment.

Second, because the F-35 is able to do BDA and (covertly) acquire other ISR results in that same contested environment. Third, because the F-35 has those capabilities, our Air Forces should become more aware of the possibilities F-35 employment brings to create operational and strategic effects and support agility at that level. The previous chapters looked at creating that agility by integrating Air C2 – ISR and distributing control at the tactical and lower operational level. This chapter explores the relation between the command aspect of Air C2, ISR and F-35 employment at the higher operational and strategic level in our efforts to become an agile fighting force. Even more than the previous chapter, this one does not aim at giving a finite answer to a proposition. It aims at giving an operational and strategic perspective to Air C2, ISR and F-35 employment to invigorate discussion on a terrain that requires and deserves our attention on our path of transition.

Operational Level

To understand the context of command at the operational level and to support exploring the connection with ISR and eventually F-35 employment, this paragraph starts by giving a high-level overview of how air operations are conducted at the operational level. This overview is based on the US Chiefs of Staff Joint Publication 3.30 'Command and Control of Joint Air Operations'[84] which generally is similar to how RAAF and NATO (in case of RNLAF) conduct air operations at the operational level.

At the operational level, the JFACC and his or her staff conduct the operations planning process for air prior to commencing operations. This seven-step process[85] results in an approved Course of Action (COA) representing JFACC's plan to accomplish the assigned mission. Within that COA, one or more Lines-of-Operations (LOOs) are depicted that each link effects and tasks to the air objectives, which are derived from the joint and strategic objectives. This leads to a joint air operations plan used to compile the Air Operations Directive (AOD). The AOD defines objectives, effects and guidance which in turn, together with the results of the joint targeting process, forms the basis for the air-tasking (order) cycle. Once air operations are commencing, the JFACC directs the execution of the planned air operations and, if required, makes changes to that plan. The JFACC then continually evaluates the results of air operations and provides assessment to the JFC for consolidation into the overall assessment of the current operations.

This continual evaluation of the results of air operations is mostly not a real-time activity. The higher operational level is generally not so much occupied with real-time execution,

---

84 Joint Publication 3.30 Command and Control of Joint Air Operations, US Joint Chiefs of Staff, 10 February 2014, Ch. III.

85 Step 1: Initiation; Step 2: Mission analysis; Step 3: Course of Action development; Step 4: COA analysis and wargaming; Step 5: COA comparison; Step 6: COA approval; Step 7: Plan or order development.

and consequently not with real-time results. They are more occupied with commanding air operations by setting the objectives, effects and guidance per AOD, the continued targeting process and collecting and interpreting the results of air operations. These aggregated results are measured by linking a Measures of Effectiveness (MOE) to each objective and effect within the COA/LOOs. Likewise, a Measure of Performance (MOP) is linked to each task that is defined under various effects. For the JFACC, MOEs are particularly important to understand whether the air operation is on track to achieve his objective(s) or if alternative action is required. Worse case, a MOE may even be an indicator that the selected COA is ineffective and the JFACC has to start part of his or her operation planning again. For of this paper, the collecting and interpreting results is particularly relevant. After all, collecting the results is mostly an ISR activity and interpreting the aggregated result an intelligence activity, tying ISR and intelligence to the command aspect of Air C2.

As described in Chapter 2, the ISR and intelligence cycles converge as we move up from the tactical level via the operational to the strategic level. It is not that they become one. After all, it is still the same ISR cycle that supports both the operations cycle and the intelligence cycle at the tactical level. However, MOEs reflect the state of the adversary as a whole system, which requires the cumulative effects of multiple actions, some of which may be based on ISR results. It takes time, effort and skill to discern the change of the system state in a very complex and highly dynamic environment. This implies that the information that the JFACC gets presented is not real-time. A change of system state can takes weeks or even months to achieve. In general, the JFACC does not use real-time ISR results to command air operations. An example of an exception to this is the circumstance where specific tactical action is directly aimed at reaching an operational or strategic effect. In this case, the JFACC may choose to monitor the mission in real-time through ISR coverage (eg, via a FMV-feed) and use his or her command authority to directly influence the mission at the tactical edge (the directed telescope). The JFACC will of course stay engaged with the operations as they are executed, either on the operations floor in the AOC or during various spot-briefs and daily updates. After all, the JFACC does not function in a vacuum. This way the commander can maintain a good sense of how the mission is unfolding and use that personal perspective when briefed on aggregated mission results. However, the JFACCs formal reaction towards a real-time development will be delayed because of the time required for the aggregation process and translating the results into a new AOD. Now what if a single event has such a big impact that it triggers a major change in the operation plan? One can hope and expect that the impact of the event would get recognised at the tactical level. This should subsequently lead to an accelerated reporting process that short-cuts the routine intelligence process tied to aggregating mission results. Usually, the JFACC specifies indicators that are tied to such major triggers. For instance, an ISR asset observing a first-time use of Weapons of Mass Destruction (WMD) could immediately trigger the JFACC (and JFC) to activate a branch

plan of the operational design. Next to monitoring specific missions at the tactical edge, this is also an example where a command decision by the JFACC can be directly tied to an (real-time) ISR product.

The above described flow at the operation level connects the JFACCs efforts to reach the operational objectives with the results of on-going air operations in an OODA loop style process: Observe (MOEs: 'Am I on track to reach my objectives?') — Orient ('What can I do to stay on track of, or get on track to, reaching my objectives?') — Decide (maintain or alter the operation plan) — Act (promulgate objectives, effects and guidance). The two examples also indicate that the JFACC at the operational level has ways to exercise command based on real-time information, such as ISR results, enabling his OODA loop to be expedited. John Boyd states that 'he who can handle the quickest rate of change survives'.[86] The above-described flow at the operational level may very well facilitate handling the rate of change in a conflict against an inferior adversary, where we more or less dictate the operational tempo. However, in a very complex and highly dynamic environment, where the operational tempo may very well be dictated by a peer adversary, staying on top of things will be more difficult. Furthermore, as the conflict progresses and the share of dynamic targeting increases relative to deliberate targeting, is may become increasingly harder to keep track of the results. To trust that the described JFACC OODA loop will lead to decision superiority through information superiority at the operational level would be quite a leap of faith. To shorten that leap, we should aim for new ways to tie real-time information, such as ISR results, to real-time command decisions at the operational level.

An additional challenge related to keeping track of the dynamic results is the logical assumption that, in a conflict against a peer adversary, we will not be able to deploy as many ISR assets as we are used to in conflicts against military inferior adversaries because of the high threat environment. In recent years we have come to rely on employment of layered ISR in a permissive environment, safeguarded by our ability to control the air. That layered ISR enables us to perform round-the-clock surveillance and reconnaissance. It provides theatre-wide ISR from very high altitude with space-based satellites and High-Altitude Long Endurance (HALE) UAS via regional ISR with Medium-Altitude Long-Endurance (MALE) UAS and manned platforms all the way down to detailed local ISR with tactical, small and micro-UAS and manned platforms, including helicopters. Once we are engaged with a peer adversary, we may have no control of the air and subsequently have to operate in a non-permissive environment. We then probably have to rely on only space-born sensors and 5th Generation platforms that are able to penetrate highly

86 F.B. Osinga, 'The Enemy As a Complex Adaptive System', in *Airpower Reborn: The Strategic Concepts of John Warden and John Boyd'*, Naval Institute Press, Annapolis, Maryland USA, 2015, p. 64.

contested airspace. This results in a significant decreased amount of assets that provide in-theatre ISR results, required for producing an aggregated mission result.

The challenges start to pile up: higher complexity, increasing dynamics, high operational tempo, a peer adversary, and fewer in-theatre ISR assets to assess how we are doing. As explained in the previous chapter, this could potentially turn into a situation where the depth of the command relationships decreases below the level required to maintain control over subordinate units, leading to the need for autonomy. Subsequently, this would affect the command function similarly at the operational level, when the JFACC would not be able to understand whether the air operation is on track to achieve his objective(s) or if alternative actions are required. In Boyd's line of thought, the JFACC would not be able to handle the rate of change and would not 'survive'.

Some ways to cope with these challenges can possibly be found using the C2 approach model of Alberts and Hayes. Applying it to command at the operational level could be quite similar to the approach outlined in Chapter 4, about the control aspect of C2 at the lower operational and tactical level. This is not surprising as, within this approach, command and control are inextricably linked and, in a sense, they are both captured in the dimension of 'allocation of decision rights' of the model (see Chapter 2). However, as command and control pertain to different activities (also explained in Chapter 2), the approach will lead to different solutions. The depth of the command relationships, as applied in Chapter 4, adds some useful nuance to the C2 approach of Albert and Hayes. This depth is not effected by simply pushing information and authority down, but by extending the spiral of empowerment and accountability so the decisions made on the scene are consistent with the larger strategy.[87] This could very well prove a powerful and far-reaching concept when applied at the operational level. It means that the operational level has to trust tactical assets, all the way down to the tactical edge, to make the right decisions when they confront challenges that may have operational or even strategic repercussions. Simultaneously, assets at the tactical edge have to be enabled to handle that trust and the accountability for their actions. This means that there should be deep understanding of operational air objectives and how they tie to joint objectives and strategy. It could ultimately require Creveld's directed telescope to be reversed so that assets at the tactical edge can (at will) observe the dynamics at the operational level and place their tactical challenge in the broader operational context.

Applying distributed control at the lower operational and tactical level will entail a huge leap that requires significant organisational, doctrinal, procedural, technical and cultural change. This application is bound to be resisted within our organisations and our

87 M. Kometer, *Command in Air War: Centralized vs. Decentralized Control of Combat Airpower*, MIT, 20 May 2005, p. 31 .

coalitions, as it means giving up proven concepts, moving into unfamiliar terrain, and taking decisions out of the hands of commanders who are currently very comfortable with their level of (centralised) control. Proposing that they should distribute command in a similar fashion is very likely a bridge too far, at least for now. Therefore, until we have a good grasp of what that would mean, we should use a crawl-walk-run approach. A good approach towards agility through Air C2-ISR integration at the operational level requires broad discussion and concept development and experimentation in order to get familiar with that new terrain. However, we have to remember that Alberts and Hayes' proposition that traditional command and control approaches lack the agility required for 21st century missions, which are simultaneously more complex and more dynamic. We cannot afford to put this warning aside for too long, we need to change in order to 'handle the quickest rate of change and survive'.

Strategic Level

The success or failure of a strategy depends on correctly connecting the ends (political objectives) via the ways (concept of operations) to the means (capabilities). The F-35 brings new 'means' to RAAF and RNLAF: a 5th Generation fighter with inherent ISR capabilities. It opens new prospects to connect the ends via the ways to that means. This is not to say that these new means should drive the strategy. However, we may be able to apply specific strategies more successfully by using those new means. In his book *The Bolt From The Blue*, Dr Sanu Kainikara ties the suitability (advantages) of specific functions of Air Power (means) to the different military strategies (ends) in what he calls the cycle of strategies.[88]

88 Sanu Kainikara, *The Bolt From The Blue: Air Power in the Cycle of Strategies*, Air Power Development Centre, 2013, p.13.

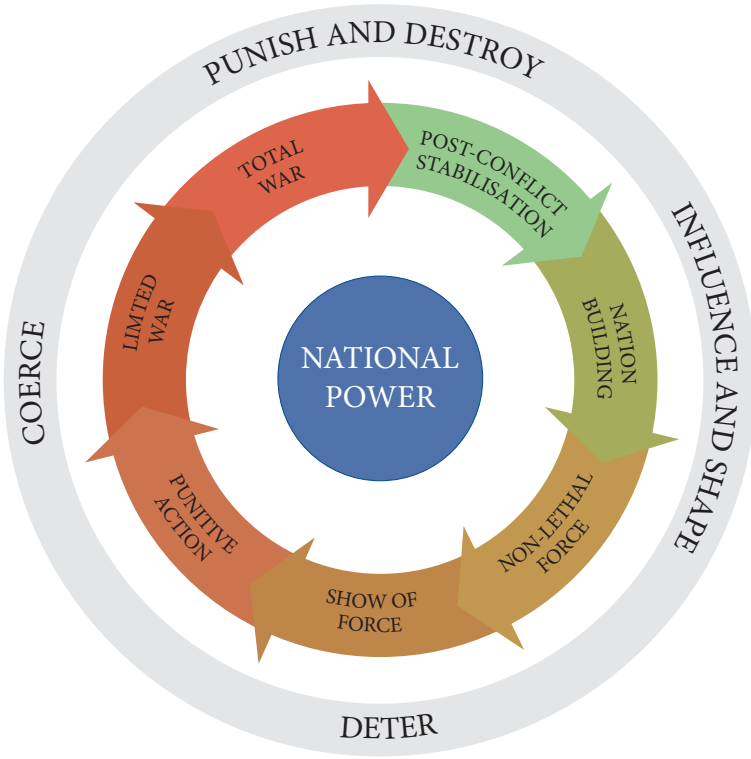


Figure 19: Cycle of strategies

The F-35 combines a traditional fighter capability with ISR and (by virtue of stealth) strategic attack capabilities into one platform, making the F-35 better suited for a variety of strategies compared to the F-16 and F-18 it replaces. The F-35 also complements other ISR assets, to create more strategic employment flexibility and sustainability, although the F-35 is not suited for persistent ISR tasks and most other ISR assets are not suitable for a non-permissive environment. Being the current state-of-the art weapons platform, the F-35 will project a credible threat against the nation or entity our strategy is aimed at. This makes the F-35, if applied in a politically credible manner, a credible strategic tool. The value of F-35 even goes beyond the level of military strategy. Kainikara explains that, in conflicts other than wars of national survival, it may be necessary to tailor the political objectives to ensure that the end-state is achievable by the available forces;[89] in other words, the 'ends' fit the 'means'. Again, the F-35 can be considered more of a 'Swiss-army knife' of Air Power than anything that RAAF and RNLAF currently have in their inventory. The F-35 now enables our nations to pursue political objectives that were beyond their reach without the F-35.

89 Ibid., p. 6.

A specific strategic benefit of the F-35 tied to its inherent multi-spectral ISR-capability is that it could be employed to gather strategic intelligence. This type of intelligence is mostly gathered without the observed party being aware of being observed through so-called covert observation. This can be a very powerful strategic tool. After all, the value of overt observation from the air for military operations needs no explanation. The same goes for the value of covert observation (eg, with submarines and Special Operating Forces [SOF]), specifically for strategic purposes. The F-35 will, even moreso once the technical challenges tied to sharing ISR results are overcome (see Chapter 3), be able to combine the advantages of observation from a high vantage point and covertness through stealth with speed, reach and flexibility. This means both RAAF and RNLAF will have an expanded information position which, in turn, will lead to better strategic awareness and agility. It will also lead to a better bargaining position in the international intelligence domain, where strategic intelligence is often exchanged between partners on a quid-pro-quo basis.

Similar to the need for assessment at the operational level, it is crucial for the strategic level to understand whether the chosen strategy continues to support reaching the desired end-state. Assessment at the operational level is an important source for assessment at the strategic level. Not every requirement for change at the operational level, based on successfully completing a phase in the operational design or the consistent lack of success, will motivate a change at the strategic level. However, in a very complex and highly dynamic environment, events at the tactical and operation level can have such a disruptive impact, that they will require strategic adjustment. And just as much as it counts at the operational and tactical level, 'he who can handle the quickest rate of change survives' also counts at the strategic level. It should not come as a surprise when a peer adversary understands and applies the Air Power theory of John Warden and aims at strategic paralysis on our side. We need to strategically out-pace that peer adversary in our OODA loop and prevent it from reaching its goals while ensuring we reach ours. We need to be agile by applying the C2 theory of Alberts and Hayes through enhancing collaboration and sharing real-time information, including measuring strategic success. This will enhance our ability to be strategically agile. If we are subsequently able to establish greater depth in the strategic command relationships, we may truly become agile.

The amalgamation of the ability to create kinetic and non-kinetic effects against strategic targets and an ISR-capability for strategic observation in one platform can be very powerful, when effectively employed. This caveat should not be underestimated. Strategic tasking requires strategic thinking and a supporting strategic framework that can set the conditions for success: a framework of strategic command and control, awareness, collaboration, ICT, and security etc. To complicate the matter, smaller air forces like RAAF and RNLAF do not have the luxury to designate part of their F-35 force as solely strategic assets. They must also fulfil other operational and tactical tasking. Perhaps, against a peer

adversary in a very complex and highly dynamic environment, all in one mission. This means that the strategic framework must be aligned with the operational and tactical frameworks, to set the condition for success at those levels. Both RAAF and RNLAF may be able to learn from their individual national experiences in strategic employment submarines and SOF and the way that strategic employment connects to operational and tactical employment. Nonetheless, employing the F-35 as a strategic air asset will introduce new and specific challenges to the existing strategic, operational and tactical frameworks. Meeting these challenges may require new Air Power thinking.

Relationship to F-35 Employment

Operational and strategic involvement in employment of the F-35 in coalition operations is of great interest for RAAF and RNLAF. As we all understand, the F-35 is not a one-on-one replacement of the F-18 and F-16. Hence, we should not employ it in a similar fashion. The way the RNLAF has been employing the F-16 in international operations illustrates this. RNLAF is accustomed to fully embedding their assets in coalition operations and limiting their involvement to a large extent to tactical execution of the ATO while leaving Air C2 at AOC level and above to the alliance. Being a relatively small air force, RNLAF representation at the AOC and upper command levels has traditionally been very limited in numbers. Furthermore, lack of experience at the operational and strategic level, and compartmentalization of information, has often precluded the RNLAF to get fully involved at those levels in coalition operations. Although this counts to a lesser extent for RAAF, it does lead to the same point: employing the F-35 will be a significant different undertaking which requires more involvement at the operation and strategic level. To use the full potential of the F-35, we have to consider the operational and strategic effects it can create. We would never for a moment consider leaving employment of a submarine or SOF in the trustworthy hands of a dominant coalition partner. We would always demand to be fully involved in the planning and execution of these types of assets. The same goes for the F-35, if we have the ambition to rise above the current level of tactical execution. To fulfil this ambition, we need to further expand our Air C2 horizon and assure the ability to get involved in the operational and strategic (Air) C2 level. This does not only require properly trained Air C2 personnel that are able to perform duties at the operational and strategic command levels, but also requires the ability to play an equal role in the targeting process to adequately influence F-35 employment at these levels.

The F-35 ISR capability could potentially be helpful in more deeply involving RNLAF and RAAF at the operational and strategic level. As mentioned, the F-35 will be able to overtly and covertly collect ISR in contested areas. The F-35 is conceptually able to provide BDA for its own and geographically associated missions. The derived ISR results and intelligence are potentially of high value to the operational and strategic level, specifically if these

results concern covert ISR and BDA of strategic targets. Sharing this information could mean two outcomes: breaking open information compartments that currently preclude increased or full Air C2; and involvement in the targeting process at the operational and strategic level. An aspect that needs to be factored in is that the efficiency of F-35 ISR collection and the subsequent value of the ISR results relies largely on knowing where to look and what to look for. In other words, we need good ISR or intelligence to get valuable ISR results. This can involve real-time cross-cuing of sensors at the tactical level but also operational and strategic IRM&CM at the highest (F-35) classification level. Having limited national assets (F-35 and other ISR-capable ones) implies that we have to collaborate with partners to maximise the value of F-35 ISR collection efforts. This also implies that, if we operate with a classic quid pro quo approach, it may be hard to overcome the initial equity threshold required to synergise F-35 ISR collection efforts within a coalition. Thus, if we are ambitious to maximise the efficiency of F-35 ISR collection for operational and strategic purposes, we need to deepen our partnerships within the F-35 community, and likewise other future 5th Generation ISR capable platforms.

From an F-35 perspective, tying challenges at the tactical edge to the dynamic at the operational and strategic level seems far-fetched. And probably not only form an F-35 perspective. That is particular so when the dynamics at the operational and strategic levels are not strictly bound by military considerations but also by the politics at play. In a conflict against a peer adversary, however, specifically in a war of national survival, where the military strategy is dominated by military objectives, this concept may be less far-fetched. In this case, the dynamics at the higher level will be driven more by military logic to which the F-35 at the tactical edge can relate. Understanding those military dynamics has the potential to create a dynamic intent-based framework in which the actors at the tactical edge can operate. It also helps to widen our view of challenges at the tactical edge beyond those tied to decisions to apply kinetic or non-kinetic effects. For instance, a challenge could also involve a particular uncertainty at the operational level that could be taken away by enhancing situational awareness. If an F-35 on a mission understands that uncertainty and can relate that to an ISR result it can deliver, the challenge may be solved without specific tasking; or better still, without interfering with primary F-35 mission objective.

Considering strategic applications of F-35 means facing the fact that we will have limited numbers of F-35s. This is particular the case for RNLAF: the currently plan supports a sustained operational employment of only four F-35s. The question is whether we have sufficient F-35s and pilots to venture into strategic application of F-35. Within an air campaign, such employment differs little from that in a tactical perspective. Both entail creating kinetic or non-kinetic effects at the tactical edge. However, the dedicated commitment of F-35s for strategic purposes may have to compete with a demand for employment in an air operation elsewhere, the point being that the F-35 may become in

higher demand. Nonetheless, the choice for strategic application of F-35 may sometimes be more opportune than tactical application. It could even be the only solution to a national strategic challenge. Not to have F-35s ready and available to cope with that challenge would possibly be both a tough political and public sale and a missed opportunity.

Conclusion

Linking fighter employment to the operational and strategic level is not something RAAF and RNLAF do on a daily basis. Most of our routine effort is tied to excelling at the tactical edge; and that is valuable. However, if we want to keep excelling, we need to ensure that our efforts at the operational and strategic level create the circumstances required to excel at that tactical edge.

Simultaneously, at the operational and strategic level, we want to capitalise on the new abilities that F-35 will bring to our inventory. This mutual interest and dependency not only opens the door for new concepts for Air C2 and ISR, we actually must apply new concepts for these dependency to work in our favour and create that agility we strive for.

At the operational level, we must ensure that we are fully involved in planning and execution to maintain adequate influence on F-35 employment. As the F-35 will be able to create operational and strategic effects, we clearly rise above F-18 and F-16 tactical level employment. Subsequently, we must establish and maintain influence at the operational level. Furthermore, we should think how to create sufficient depth in the command relationship from the operational level, enhance trust and empower units at the tactical edge to support a higher operational tempo. Also, the operational level will probably have to rely more on F-35 derived ISR results to support MOPs and MOEs as non-stealth ISR assets will not be able to operate in the contested air space. Likewise, we may have to start thinking how enable assets at the tactical edge to not only observe but also understand the dynamics at the operational level and apply this understanding at the tactical edge, supporting operational agility through dynamic actions at that tactical edge. The mutual dependency is quite clear, now we have to find ways to turn that dependency into synergy.

At the strategic level, we must increase our awareness about how we can and should employ F-35 to reach strategic effects. We should understand the true strategic value of this new tool in our strategic tool-box, and benefit from it in the international strategic arena. As much as it can support the operational level with ISR results, F-35 could support strategic agility by combining speed and reach with covert ISR. To make this happen, we must determine how our existing strategic framework will support F-35 employment, or maybe even re-think that framework. At the same time, we must also keep in mind that F-35 will not only serve as a strategic asset, it still is and will remain a primary tactical assets in many scenarios.

This chapter offered an operational and strategic perspective to Air C2, ISR and F-35 employment to invigorate discussion. At a glance, this chapter does not solve issues but only challenges them by widening the discussion about Air C2 and ISR related to F-35 employment. However, looking back at Chapter 4, there are common themes that could channel the discussion back into a manageable proportion. To guide us, we should use themes like: the importance of sharing information and collaboration (see Alberts and Hayes' model); the depth of command relationships, empowerment, trust and accountability (see Kometer's thesis). Specific technical solutions to enhance Air C2 – ISR integration and distribute control at the tactical level and lower operational level are not necessarily suitable for the higher operational and strategic level. However, their underlying principles may work well; principles like interoperability, sharing and managing information and real-time collaboration. For instance, although establishing a combat cloud may often relate to sharing information and collaboration at the tactical edge, the principles of such a cloud are just as valuable at the operational and strategic level to enhance agility. But it is not just technology and underlying principles that will enable more agility at the operational and strategic level. Here again, Deptula's words should be valued: that the technology enablers are tied to a transition from industrial-age, platform-centric methods of force employment to an interconnected, information-driven model of C2. That transformation involves working on all the DOTMLPF-P factors. Furthermore, that interconnected, information-driven model of C2 needs to be implemented at all levels. Not just at the tactical level but also, or maybe: first and foremost, at the operational and strategic level. We want to avoid that a lack of operational and strategic agility puts the brake on agility at the tactical edge. We need to put that mutual interest and interdependency between excelling at the tactical edge and capitalising on F-35 employment at the operational and strategic level to work for us. This requires new concepts of Air C2 and ISR in our future 5th Generation Air Forces.

6. Conclusions

In our attempt to find ways to enhance agility, we have ventured from the technical and tactical level via the operational level to the strategic level. We have talked about Air C2 – ISR integration at the tactical level and the Air C2, ISR and F-35 system improvements to enhance this integration. We explored the application of distributed control based on strategy and context, and the required depth of the command relationships between the operational and tactical level to enable empowerment and accountability down to the tactical edge. The relationship between command at the operational level and ISR has been discussed, and how the concept of a combat cloud could support operational agility. We talked about what strategic potential F-35 employment could have. Along the way, a few common themes among these aspects of 5th Generation Air C2 and ISR emerged: the importance of collaboration, ICT, trust and the need for new operator skill-sets. Now how could all of this come together in our efforts to achieve a higher degree of Air Power agility?

To take a bottom-up approach, I consider the last theme first: the operator and his or her skill-sets. A good way of doing this from a generic and holistic perspective can be found in Kainikara's working paper on professional mastery.[90] He suggests that, in the complex contemporary battlespace, 'airman must have a clear understanding of all aspects of air operations and adequate professional mastery at the required level in order to ensure the application of Air Power is optimised (…)'. Our exploration through the different levels of air operations in this paper illustrate the point that professional mastery is also required across all levels of air operations. For professional mastery asks for tactical proficiency, operational understanding and strategic awareness. A suitable way to link the elements of professional mastery to the clear understanding of all aspect of air operations can be derived from Kainikara's model that depicts the unity of the key functions of Air Power[91]. This model defines know, shape, respond and align as the key functions to obtain control of the air. Within this paper (and perhaps even beyond it), the functions 'know' and 'respond'

90 Sanu Kainikara, *Professional Mastery and Air Power Education*', Working Paper 33, Air Power Development Centre, Canberra, October 2011.

91 'Air Power and the national interest', presentation by Dr S. Kainikara at the Inaugural Sir James Rowland Air Power Seminar, Canberra, 13 October 2016.

can be tied to tactical proficiency, 'shape' can be tied to operational understanding, and 'align'[92] can be tied to strategic awareness.

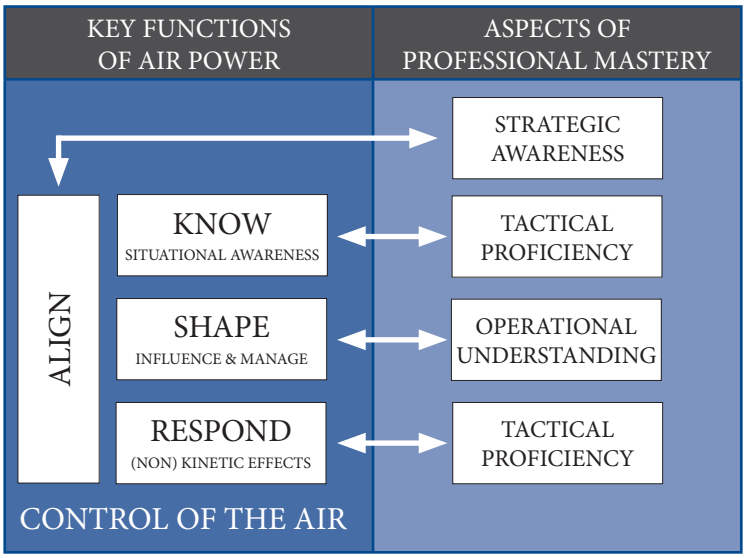


Figure 20: Key functions of air power and aspects of professional mastery

Within our (RAAF and RNLAF) professional mastery, it seems there is an imbalance between tactical proficiency on one side and our operational understanding and strategic awareness (see Figure 20) on the other side. As concluded in Chapter 5, most of our routine effort is tied to excelling at the tactical edge. In other words, we keep our tactical proficiency at a high level. However, creating and maintaining understanding of the operational level is less of a routine effort and in case of the RNLAF, occurs at a bare minimum. And of the three aspects, strategic awareness seems at the bottom of the barrel. This imbalance should be taken seriously by both RAAF and RNLAF if we want to consider applying new concepts of Air C2 and ISR related to F-35 employment as we strive for increased agility.

If we take professional mastery as a point of departure in our efforts to unite the elements of this paper, we should also include the theme 'trust'; it is repeatedly mentioned by Kainikara as an element of professional mastery.[93] Trust is something that comes naturally to our

92 The function Align it not bound by air operations. It is also applicable in a broader perspective as alignment of air operations at the joint, interagency and political level.

93 Sanu Kainikara, *Professional Mastery and Air Power Education*', Working Paper 33, Air Power Development Centre, Canberra, October 2011, pp. 3, 5 & 9.

military culture and organisation and is an essential element for success. As described in Chapters 4 and 5, empowering units at the tactical edge requires that trust to be enhanced, perhaps even beyond the current levels. If we operate specifically within a coalition, we may have to determine ways to enhance trust at the operational and strategic level to be able to effectively apply concepts like distribution of control and empowering coalition units at the tactical edge. In Chapter 5, it was contended that these new concepts will likely meet resistance as it means taking decisions out of the hand of commanders that now very comfortable with the level of centralised command and control that they currently exercise. We should nonetheless aim at enhancing trust as an element of professional mastery.

If we were to approach professional mastery as the first step, or foundation, to build a coherent view of the elements of this paper, we would next take a holistic view of our specific findings in the areas of Air C2, ISR, collaboration and ICT. From the start, this paper has articulated the importance of the coherence among these aspects. This coherence can be found in the C2-approach model of Alberts and Hayes, in Kometer's work on distribution of control and, in Deptula's combat cloud. Chapter 3 took a rather detailed approach towards that coherence when looking at enhancing Air C2 – ISR integration at the technical and tactical level. Chapters 4 and 5 were significantly less detailed from a technical perspective detailed than Chapter 3, but the coherence among Air C2, ISR, collaboration and ICT maintained an important aspect towards applying new concepts, either implicit or explicit.

So, where does F-35 employment fit in? While the relationship with F-35 employment has been central to this paper, now may be a good moment to look beyond a system-centric F-35 approach. This paper concludes that the F-35 is as much a part of these new concepts as that successful F-35 employment requires them. In other words, the F-35 will both enable and require these new concepts. A consequence of dependency is that the F-35 is also bound by the coherence among Air C2, ISR, collaboration and ICT. This is even more reason to approach F-35 operational concepts and future improvement from a non-F-35-centric, holistic, air operations perspective. It is also important to acknowledge that the F-35 is not the nirvana towards reaching operational agility.

Although the F-35 will bring us an until now unprecedented situational awareness and a highly capable kinetic and non-kinetic effects bearer all in one, it is still just one of the many systems in a large, complex, interactive and adaptive system-of-systems we employ to conduct air operations. Nonetheless, under two conditions: (1) that the F-35 is well-integrated into, and supported by, modern (5th Generation) concepts for air operations; and (2) that the articulated F-35 system-centric challenges have been met, F-35 employment will indeed enable us to make significant steps towards a higher degree of operational agility.

The next and final step towards reaching operational agility can be found in empowerment and accountability. If we accomplish profession mastery within our organisations, apply new 5th Generation concepts for Air C2 and ISR while safeguarding the coherence with collaboration and ICT, we will be able to deepen the command relationships between the strategic, operational and tactical level. Subsequently, we will be able to enhance the ability to empower units at the tactical edge and facilitate the accountability that comes with that empowerment. This will have a positive impact on the operational tempo on all levels, as we will be better at seizing emerging opportunities at the tactical edge that are aligned with our strategic and operational objectives. If we then enable the strategic and operational level to have near real-time awareness of the very complex and highly dynamic environment, including our achievements at the tactical edge, we can in fact enhance our agility.

Put all of these steps into a model, we end up with framework for 5th Generation Air C2 and ISR that ties the different aspects of this paper together (see Figure 21).

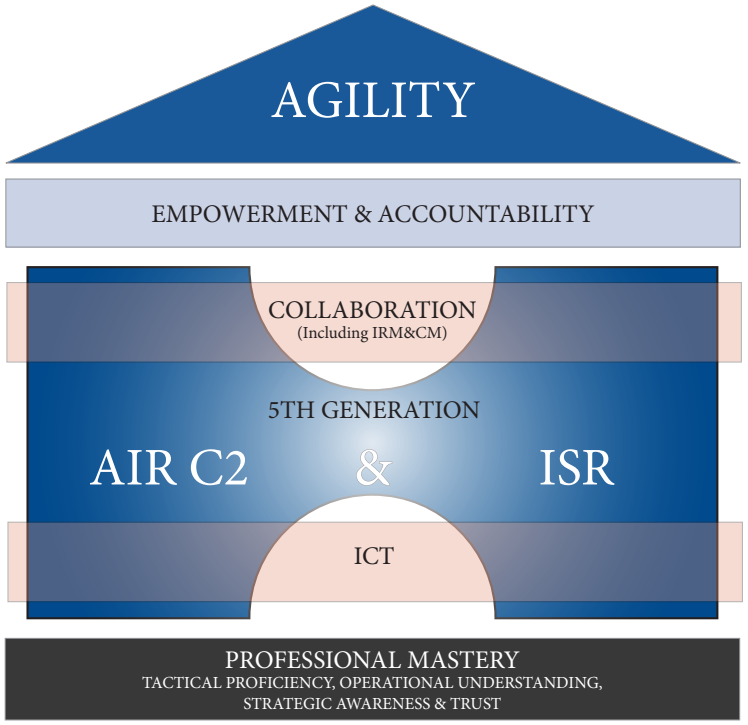


Figure 21: Framework for 5th Generation Air C2 and ISR.

This framework is meant to contribute to the aims of the paper. First, it can illustrate the importance of coherence among Air C2, ISR, collaboration and ICT when formulating

requirements for system improvements, tied to enhancing Air C2 – ISR integration at the tactical level. Second, it can also be used as a framework to further discuss the new concepts for Air C2 and ISR related to F-35 employment. The framework also supports a broader view of these concepts, including the required professional mastery, collaboration and ICT. Hence, it could also be used as a point of departure for further analysis and concept development to support the transformation towards that 5th Generation Air Force both RAAF and RNLAF are committed towards. It is important that both RAAF and RNLAF understand that they do not stand alone (or merely the two together) in this transformation; it must be seen from a wider coalition perspective. Moreover, neither RAAF nor RNLAF have the numbers nor power to force our coalition partners to follow the new concepts of Air C2 and ISR that emerge from the path of transition. Nonetheless, it is for RAAF and RNLAF both a great opportunity and a requirement to be fully engaged in the international discussion and concept development related to 5th Generation Air C2 and ISR. It will drive the way we employ the F-35 and benefit from its capability. It will give us a chance to gain and maintain information superiority and decision superiority in a conflict against a peer adversary; a conflict that we cannot afford to be unprepared for.

International Fellowship Paper

AIR POWER DEVELOPMENT CENTRE
AUSTRALIA