AUSTRALIAN DEFENCE FORCE

ADF CONCEPT FOR

COMMAND AND CONTROL OF THE FUTURE FORCE

Version 1.0
Reference: DSN O1644248

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FOREWORD

Joint Concepts link strategy to the development and employment of future force capabilities and increase the warfighting effectiveness of the Joint Force. They are the method by which the Australian Defence Force develops ideas that can embrace the opportunities and confront the challenges that we will face in the Future Operating Environment. Joint Concepts inform future iterations of the Integrated Investment Program to design a Joint Force that will fight and win.

This concept is the amalgamation of research activities from scientific and academic communities, the concepts of partner nations and the ideas of critical thinkers from within the Department of Defence. This concept has been tested through the Joint Experimentation Program to confirm that the alternate model of capability and thought it proposes is fit for purpose. The result is a warfighting narrative that identifies the uniquely Australian way in which the Joint Force will achieve operational success.

This Concept is to guide the acquisition of capabilities, employment of the Joint Force and Education and Training of our people. However, Concepts must be subject to continual improvement, as the nature of the operating environment evolves we must reconsider the design of the Future Joint Force. Your feedback is critical to the continued relevance of our capability.

DL Johnston, AO
Vice Admiral, RAN
Vice Chief of the Defence Force

13 May 19


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SECTION 1 - EXECUTIVE SUMMARY

Introduction

1. The doctrine for Command and Control (C2) of the Australian Defence Force (ADF) is a product of Australia's military experience that has served us well on many operations. However, changes to the operating environment give us pause to consider the need to alter Australia's methods for C2 such that we achieve military advantage in the future operating environment.

2. This concept answers the military problem of:

'How does the ADF Command and Control the Future Force to provide a competitive advantage during operations in the Future environment?'

3. **What is C2?** C2 is the process and means for the exercise of authority over, and lawful direction of, assigned forces.[1] It is the means by which military forces are organised towards the strategic goals set by government; the need for C2 is enduring for all military forces. This concept considers that the fundamentals of ADF command are strong but the means by which control is to be conducted is under threat. The term 'C2' has become colloquially associated with the assumption that command is control, rather than command and control. Thus 'C2' when written in this concept refers to current or previous doctrine.

4. The central idea of the future command and control concept is:

'Hierarchical Command - Agile Control'

5. Under this concept, the organisation of ADF operations maintains a hierarchical model aligned with the fundamental principles of command[2]. Commanders then implement mission layers within which control relationships can be adjusted rapidly during an operation. Agility in control allows the control relationships within the force to proactively adapt to the environment to take advantage of opportunities that emerge during operations. This concept balances the fundamental principles of command[3] against the military problem to give the ADF a competitive advantage in the future environment.

1 ADDP 00.1 *Command and Control* Edition 2 AL1

2 ADDP 00.1 Ed2 defines the principles of Command as: Unity of command, span of command, clarity, redundancy, delegation of command, control of significant resources, obligation to subordinates, accountability.

3 Ibid.

Definitions

6. This concept postulates a change to that way in which the ADF conducts Command and Control of the force. It is necessary to review existing doctrinal definitions and change them to enact the new concept.

7. Mission Command. The Mission Command philosophy continues to be critical to the functioning of command and control in the future environment. The ADDP00.1 definition of Mission Command as *"A philosophy for command and a system for conducting operations in which subordinates are given clear direction by a superior of their intentions"* remains valid, but the explanation of Mission Command should be updated to state that *"Under mission command,commanders direct what is to be achieved but leaves controllers free to decide how to achieve assigned tasks."*

8. Command Definition. Under this concept the doctrinal definition of Command changes to *"The authority that a military member lawfully exercises through rank or appointment to determine what is to be achieved by subordinate forces"*

9. Control Definition. Under this concept the doctrinal definition of Control changes to *"The act of coordinating forces towards outcomes determined by Command. Control is undertaken by elements that integrate the actions of forces necessary to achieve Command intent."*

10. Agile Control. Future doctrine will include the following definition of Agile Control; "*An Agile Control system can proactively transition between centralised or decentralised relationship models to optimise force integration for the operating environment and mission."*

11. Collaboration. Collaboration is the method by which control is exercised in this concept and the key to achieving agile control. A hierarchical command structure ensures that unity of effort is achieved and that actions are unified towards that effort. Agile control allows FE

to collaborate horizontally across the organisation to achieve this aim, this is the key to gaining advantage in the future operating environment

12. How will C2 change? Key to the future C2 concept is the separation of control and command functions. The central idea proposes a large change to the definition of control but little change to the definition of command. This concept changes the current idea of control from being the authority exercised by a commander to an idea where control is the authority delegated to someone who is not a commander but must coordinate the action of forces. Under this concept controllers provide direction to integrate forces towards missions determined by commanders. For example, brigade staff officers, air battle managers and principle warfare officers would exercise control on behalf of their respective commanders and such authority could be given to many positions or machine control systems.

13. Under agile control, the joint task force utilises collaboration to improve the speed, efficiency and survivability of the decision making process. Current C2 practices utilise centres of decision making that create a small number of critical nodes which are easy for an adversary to deny or overwhelm – removing all direction to the force. An environment of collaboration allows the force to coordinate action across all participants and thus provides an adversary with no centralised decision making centre to influence.

14. For the ADF to thrive in a future operating environment where adversaries will purposefully attack our ability to direct forces, we must engender a force that evolves the principle of Mission Command[4] upon which ADF C2 is founded. A future ADF that adopts this concept will maximise survivability in this environment, while creating integrated effects at a tempo that surpasses the enemies' ability to observe, orient, decide and act.

4 Ibid.

Scope

15. This concept considers how the ADF might command and control the future force in the period beyond 2035. It is focused on the operational and tactical levels of operations; it considers but is not bound by current strategic guidance. The predicted operating environment for this concept is detailed in 'Future Operating Environment 2035'.[5]

Assumptions & Definitions

16. The inter-relationship between Command, Control, Communications and Computing (C4) has been considered in scoping this concept. Command and control is the philosophical method of directing military forces, while communications and computing support the application of this philosophical method. This concept has not been bounded by current or predicted communications and computing limitations; instead it defines a philosophy for C2 that future C4 capabilities will need to realise.

17. For this concept the term 'flexibility' is the ability to adapt to foreseen circumstances through planned responses. The term 'agility' is the ability to proactively change relationships to pre-empt the environment or to innovate a timely response to unforeseen circumstances. Agility will provide a competitive advantage by encouraging the ADF to gain and maintain the initiative through a proactive rather than responsive control of forces.

Intent

18. This concept is intended to define the organisational and operational structures which the future ADF could employ to gain an operational advantage. This concept will characterise the methods by which future capabilities will be directed during operations. It is intended to be used by those involved in operational planning, force design,

5 Australian Future Operating Environment 2035.

force exploration, experimentation and in the delivery of professional military education and training. It may also be used by partner nations to understand how the ADF will command and control operations that they may join us in and it provides industry with the context within which future capabilities will be employed.

SECTION 2 – MILITARY PROBLEM AND CENTRAL IDEA

Military Problem

19. This concept answers the military problem of:

'How does the ADF Command and Control the Future Force to provide a competitive advantage during operations in the Future environment?'

20. Changes in the character of war in the future will be driven by increasing international competition, complex operating environments, and rapid scientific and technological development that will increase the tempo of warfare through the use of autonomous systems. [6]

21. Heightened competition will occur between a diverse range of states and non-state actors seeking to advance their interests. Adversaries will likely engage in competition below the threshold of armed conflict, while retaining the capability to escalate if required. As a result, the lines between peace and war will be increasingly blurred. It is therefore prudent to view competition as a continuum ranging from cooperation to competition below armed conflict, and ultimately armed conflict.[7] Future ADF C2 must be adaptable to operations across this continuum.

22. Future operating environments will be complex and produce quantities of information that far exceed the ability of current C2 organisations to understand. The ADF will employ platforms that gather large amounts of information which will need to be integrated across all domains. To understand the environment, the future C2 structure must leverage AI. Current C2 structures may not be able to leverage all future capabilities due to the centralised structure and emphasis on command decision making.

23. A combination of the complex information environment, adversary action against ADF C2 and over-reliance on commander-led decision-action cycle make the ADF vulnerable to tactical and operational failure. An adversary will deny, obfuscate, imitate and degrade the information commanders require to make the right decision; prevent the decision from being actioned or overwhelm the commander and make them ineffective.

6 Ibid

7 Joint Chiefs of Staff. *Joint Concept for Integrated Campaigning*. 16 March 2018

24. The major technological changes in the future environment are likely to come from the development of automated systems, human-machine collaboration, artificial intelligence, information technologies, quantum computing, sensors, biosciences and advanced weapon systems. These disruptive technologies will be commercially available, which present both opportunities and challenges for C2.

25. As both an enabler and target of modern warfare, data and information will continue to be crucial in the future operating environment. Military forces that can leverage new technologies to assist with gathering, processing and sharing a vast amount of data will possess decision advantage. Given that the future information environment will be contested, the ADF's future force must be robust enough to sustain operations when command communications cannot be relied upon.

26. New technologies will also increase the pace of warfare. The ability to collect, analyse, exploit, and disseminate information will likely accelerate as a result of innovations such as autonomous systems. Technologies such as these have the potential to assist commanders with managing and processing data to make better and faster decisions with the aim to defeat an enemy by operating faster than they are able to recognise or respond. Similarly, the introduction of advanced weapon systems will rapidly decrease decision times.

27. The ADF will be required to lead operations, either independently or as part of a coalition. The ADF will also be deployed as a supporting partner in coalition operations that are led by another nation. Moreover, the ADF will be required to conduct activities as part of a broader WoAG coordinated strategy, perhaps led by another department. Prevailing against these complex challenges will require a C2 concept that continues to integrate the ADF with other government agencies, allies and non-traditional partners without compromising operational security.

28. The future ADF command and control doctrine will face challenges such as:

a. An abundance a data;

b. Shorter decision timelines;

c. Autonomous systems;

d. Enemy deception in the information environment, and;

e. Contested communications methods.

These factors will challenge the ADF's ability to direct forces and require a new command and control concept to maintain advantage in the future operating environment.

Central Idea

29. The central idea proposed to address the military problem is:

'Hierarchical Command – Agile Control'

30. The defining feature of the central idea is that the functions of command and control can be separated. By separating the functions of command and control, the concept balances the need for unity of command and the need to coordinate forces so that the commander can bring integrated, multi-domain effects to bear against the adversary.

31. Purpose of Command. The purpose of command is to determine the actions necessary to achieve the intent of higher authority. Commanders determine *what* is to be accomplished by their subordinate Force Elements (FE) through the application of operational

art. This purpose of command applies at every level; it is relevant to strategic command from government to the Chief of Defence Force and tactical command from Joint Task Force commanders to FE.

32. Command is a fundamentally human function that cannot be conducted by machines; it provides accountability for ethical decision making through a recognised chain of command to a lawful authority for the application of force. Command functions may be assisted by decision support systems, however such systems alone cannot provide the level of creative thinking that a human commander and staff provide that is required to achieve the purpose of command.

33. Purpose of Control. The purpose of control is to coordinate FE in the conduct of tasks necessary to achieve the commander's intent. Control determines *how* the commander's intent is to be achieved and regulating the associated tasks to fulfil that intent. Control is about the science of employing capabilities towards tasks necessary to achieve an outcome. Control applies to FE that through delegation, position or capability can coordinate the actions of other FE. Commanders will still exercise control, however this concept allows for FE to conduct control activities without holding a command authority.

34. Future artificial intelligence systems are expected to have the ability to perform control functions on behalf of, or in collaboration with human operators. The level of autonomy provided to such systems must be relevant to the operational context and risk of undesirable action. Due to the anticipated tempo of future operations, human-machine teams will be necessary to achieve this purpose of control.

35. Evolution of C2. Command is a legal authority bestowed upon an individual to direct military forces and this concept does not propose changes to the fundamentals of command. Where this concept differs from current doctrine is in the implementation of control at the tactical level. This concept envisages that control may not necessarily be undertaken by a commander, but will be conducted on behalf of a

commander. This concept embraces the principle of mission command at all levels and provides the foundation for it to be implemented in a method beyond what is currently practiced.

Evolution of Command

36. The fundamental principles of command have been identified over time and consistently deemed necessary to achieve success in war. A hierarchical command structure has emerged from centuries of conflict as the way in which these principles can be best achieved with the available means of understanding the environment and communicating direction. The conduct of C2 in conflict has evolved from observing the battlefield from a nearby hill and communicating by message delivered on horseback to observing the battlefield from space and communicating via video conference.

37. Previous command structures were influenced by the restrictions of the technology available to implement them. As communications methods improve it is tempting to drastically alter command structures to take advantage of emerging technology either by increasingly centralising decision making or decentralising authority. Other C2 concepts have considered utilising advances in communications technology to achieve agile Command and Control. Such ideas suggest changes of command across the organisation during operations. While this is technologically possible and could solve many aspects of the military problem, doing so would weaken unity and clarity of command. Therefore the ADF should not adopt a concept of agile Command and Control.

38. The authors and stakeholders considered this problem and determined that applying agility to control while maintaining a hierarchy of command allowed for the preservation of the principles of command while solving the military problem. Figure 1 below represents the functions of command, how these functions are implemented within this concept and the new relationship between command and control.

39. Government provides direction to the ADF on what operations to undertake and answers the strategic question of *Why* a certain operational outcome is desired. Command determines *What* is to be achieved by crafting the strategy, desired outcome and the missions that are required to achieve this outcome. The multi-role nature of ADF capabilities provides us with many possible ways to achieve missions and both the command and control levels determine the best mix of FE to missions and the priority of mission to FE. Command provides intent from strategy to task and guidance for how tasks will be implemented to achieve missions but command does not provide detailed direction on how tasks should be conducted.

40. Controllers[8] then determine *How* the mission is to be achieved by coordinating FE to the tasks necessary to achieve assigned missions. The actions of those with control responsibility are guided by the principle of mission command through understanding the operational environment including the commander's intent, the desired operational outcome and strategy. The nature of relationships between FE is defined through mission layers which are detailed in Figures 2-6.

8 Humans or machines that conduct a control functions.

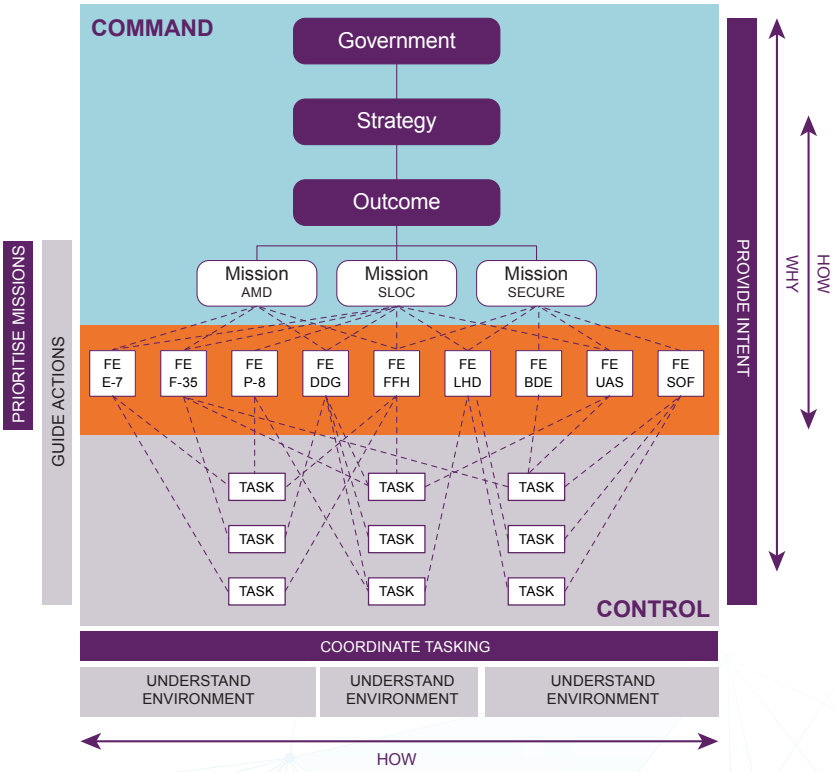


Figure 1 – Relationship between Command and Control

41. Decision-Action Cycle. *'Hierarchical Command - Agile Control'* assists in improving the decision-action cycle by providing a means through which commanders can delegate control responsibility without delegating command. Figure 1 demonstrates that commanders are primarily concerned with the conduct of missions and how they are progressing towards the outcome, the conduct of tasks is the responsibility of controllers.

42. **Intent.** Implicit in this concept is the development of command intent which provides guidance to control nodes that permits flexibility in execution while placing only the most vital of constraints on action.

43. **Breakdown of Command.** Agile control assists in the prevention of breakdown of command. Loss of communications is already understood to be a pre-cursor to a breakdown of command but other events such as information overload can also cause a commander to become ineffective. Agile control reduces the burden on commanders to analyse information and make multiple concurrent decisions by providing a means by which their responsibilities can be delegated.

44. **Non-State Actors.** Certain non-state actors are conducting asymmetric warfare utilising agile control mechanisms. Analysis of their structures, operating environment and outcomes shows that while non-state actors have been able to successfully implement agile control mechanisms, they do so with a high appetite for risk, a lack of accountability and ethics, and thus accept a high potential for unintended consequences.

45. While these forces have achieved tactical successes, their lack of strategic and operational success has been assessed to be caused by failure to implement formal command mechanisms and adhere to the fundamental principles of command. For example, the failure by agile non-state actors, such as the Taliban, to maintain accountability for atrocities in their host communities leads to their eventual rejection as an alternative to legitimate state structures.

46. The hybrid concept of *'Hierarchical Command - Agile Control'* combines the adversaries' tactical strengths of agile control mechanisms with the ADF's strategic and operational strengths of hierarchical command. This will maximise the effectiveness of ADF Command and Control to achieve strategic, operational and tactical success.

Evolution Of Control

47. A control node is a FE that through delegation, position or capability coordinates other FE towards the execution of tasks required to achieve a mission that is defined by command. Control is the science of integrating forces towards the common outcome that is determined by the operational art of command. While command is best depicted as a hierarchy, control is best understood as layers. Figure 1 demonstrated how a number of capabilities may need to be integrated to perform a task, and that there are many options for what capabilities are used. It also showed that a capability may be performing multiple tasks for multiple missions, some simultaneously and some at the expense of other tasks.

48. Collaboration. An environment of collaboration between FE is critical to agile control and solving the military problem. Whereas present command and control doctrine emphasises the coordination of action through centralised control of activity, collaboration emphasises coordination of action through the consensus of participants working towards a common mission.

49. If centralised control cannot be enacted, the efficiency of the force decreases. A collaborative environment allows multiple FE to work together to achieve missions without deference to a centralised controller. This increases the survivability of command and control by increasing the number of elements that must be denied to remove the ability of the force to coordinate action. The capacity of the command and control system is increased through a collaborative environment as control tasks can be distributed across a number of FE rather than limiting them to certain command and control capabilities.

50. FE operating in a collaborative environment may face competing goals and priorities. A purely collaborative environment relies on the agreement of the participants to resolve differences. The hierarchical command component of the central idea provides the missions and priorities that the agile control component utilises as the basis for their actions and to resolve conflicts at the FE level.

51. Control Layers. Each mission required to achieve the desired outcome can be viewed as a layer and each layer demonstrates the potential control relationships for the mission and its tasks. Each layer can then be utilised to understand the nature of control relationships at any time. From this understanding, the FE can implement agile control to rapidly adapt to emerging opportunities within the environment to gain advantage.

52. Each mission layer can then be stacked to understand the relationship between FE performing tasks in multiple missions. This approach to understanding control is necessary to implement control responsibility in an agile manner, it allows FE to understand the difference between allowable or potential control relationships and those that are actually in force at any given moment to more effectively control the force.

53. Control relationships may be adapted to:

a. Allow a FE that has high situational understanding to direct other elements.

b. Purposefully deceive an adversary in their attempt to understand and counter our C2 processes.

c. Overcome loss of communications.

d. Overcome loss of FE.

e. Increase the tempo of operations.

f. Decrease the risk of inadvertent effects.

54. Figure 2 depicts how an Air and Missile Defence (AMD) mission layer may implement agile control. It depicts all of the control relationships that are possible between the FE that are assigned to this mission and a possible default control state for the layer, it is highly centralised to the JMOC[9] so that one control node can efficiently allocate tasks.

9 Joint Mobile Operations Centre proposed for project AIR6500.

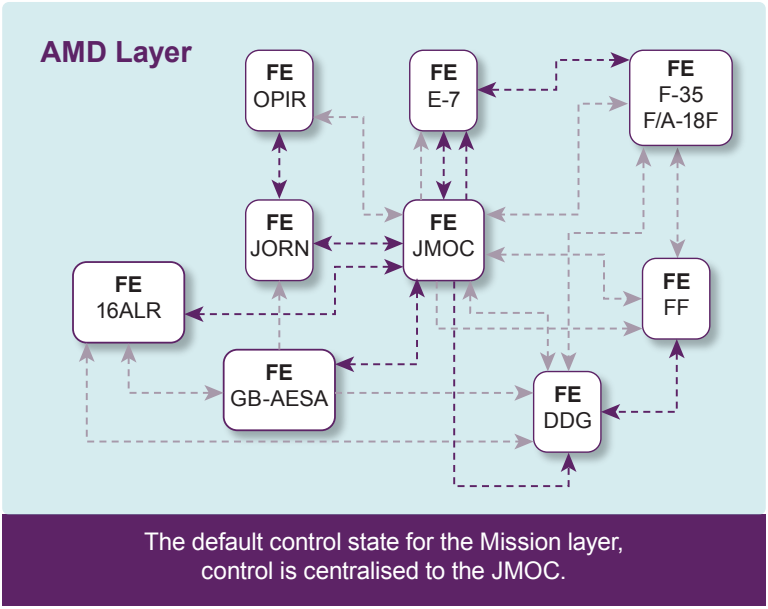


Figure 2 – Agile Control within a Mission Layer

55. Figure 3 considers a high tempo missile defence environment where relationships are adjusted to provide speed of action despite the loss of a FE. It represents how the FE within the layer may optimise their control structure towards a threat to the surface action group.

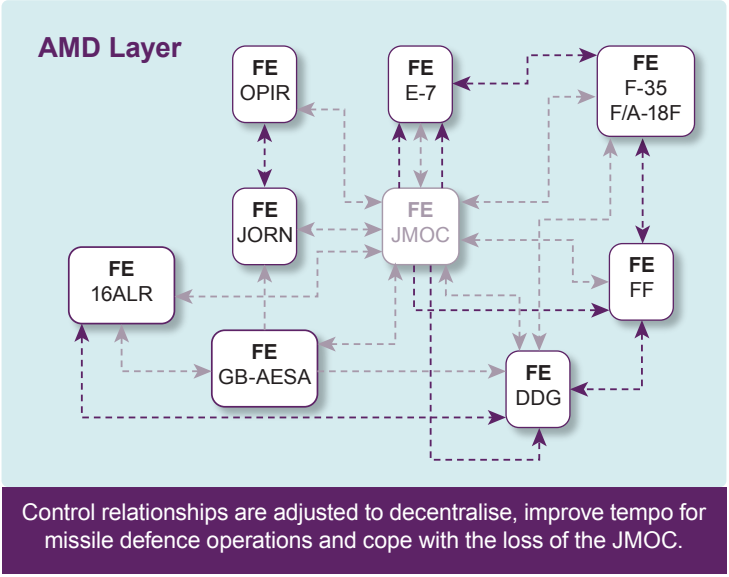


Figure 3 – Loss of platform

56. Figure 4 demonstrates control agility in an environment where the AMD layer anticipates a threat to the Surface Action Group (SAG) and optimises control relationships to the DDG to most effectively integrate forces towards the defence. In this instance, the DDG has the greatest situational understanding and ability to coordinate a response. It becomes the 'scene of action controller' providing the majority of control within the layer until the situation changes or control is transitioned to a platform with greater understanding and ability to control.

57. Scene Of Action Controller. The scene of action controller idea assumes that the first unit to respond to a situation will have the greatest understanding of the situation during initial phases of response and is best placed to coordinate initial actions. A FE may not be the best platform to perform the control function but due to its greater

situational understanding it should be allowed to direct action until such time as a more capable FE gains sufficient situational understanding to take control.

58. The collaborative process within a control layer enables Distributed Situational Awareness (DSA)[10] between involved agents, both human and machine. DSA provides FE with the awareness necessary to understand when they need to step forward into a scene of action controller role. Alternatively, DSA can allow FE to mutually adjust the nature of their control relationships in response to a change in the state of another peer. Either of these approaches result in the control layer acting with swarm intelligence.

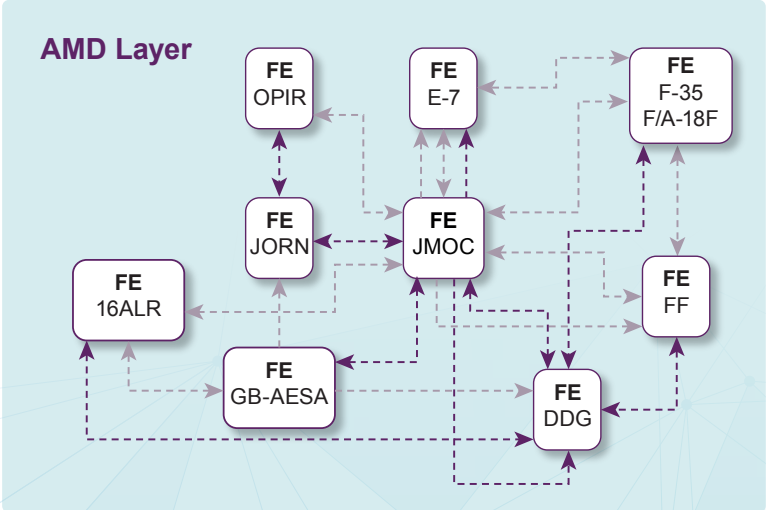


Figure 4 – Control agility to optimise against a threat

10 Stanton et al. State-of-science: situation awareness in individuals, teams and systems. 2017.

59. Command intent provides the direction that creates control layers and the intent necessary for FE within the layers to collaborate and determine the best mixture of control relationships for the task and operating environment. These relationships may be formed through planning and 'if this, then that' arrangements for some contingencies. However, such planning cannot create a truly proactive system; it is only through a collaborative system, guided by a common aim that a control layer can achieve the agility necessary for operational advantage.

60. Figure 5 considers the control layer for a mission to secure an area. It depicts planned control arrangements, in this scenario some of the air and maritime assets are also assigned to the AMD mission.

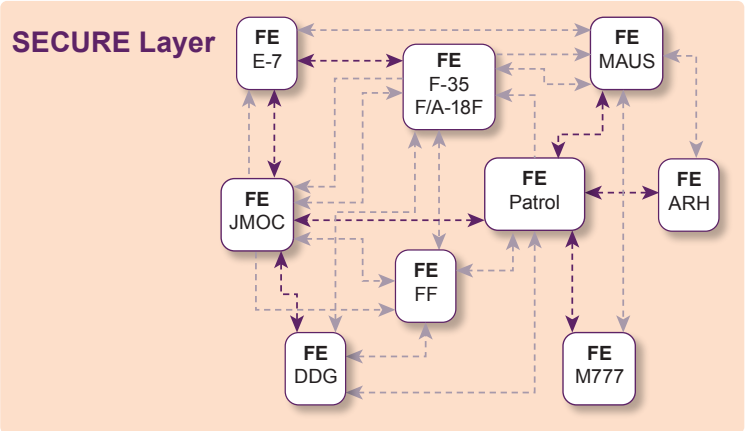


Figure 5 – Control for a secure mission

61. Figure 6 depicts how control arrangements may adapt to take advantage of additional assets being assigned to the mission – this agility allows the patrol to effectively employ all the available assets without overloading themselves or the commander with information or responsibilities.

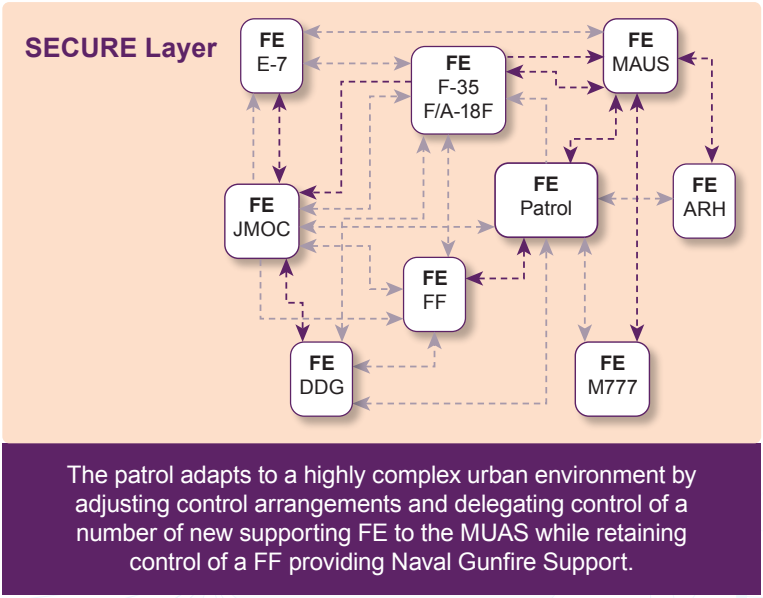
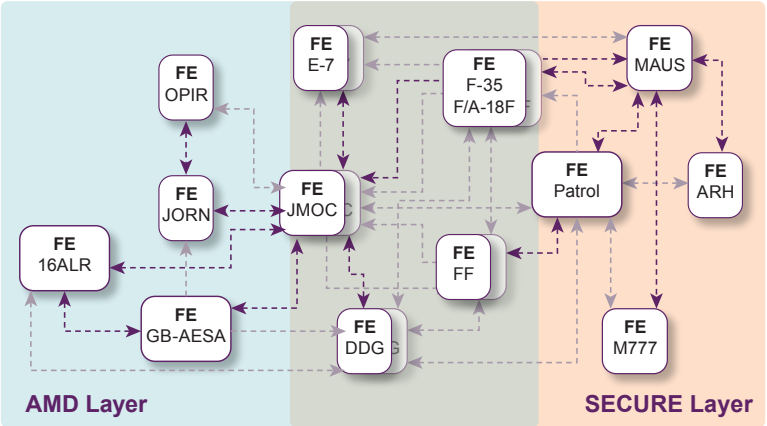


Figure 6 – Agile control to avoid overloading Patrol commander

62. Figure 7 depicts how the AMD and SECURE mission layers can be stacked to view cross-mission dependencies and opportunities. Some of the air and maritime assets are drawn upon for both missions, as they understand the situation across both layers they can adapt capability use across both layers through mission command principles.



The **AMD** and **SECURE** mission layers seen together highlight the multi-role nature of some platforms. Platforms may have multiple roles and a separate control relationship for each role. This conflicting relationship is managed through the unit of Command that a hierarchal Command structure provides through Mission Command principles.

Figure 7 – Agile Control with stacked Control Layers

63. A layered approach to conceptualising control promotes agility rather than mere flexibility by providing FE a framework within which they can collaborate towards missions. By determining the control relationships between FE and across multiple missions, the force can be directed in such a way that unity of effort and command is maintained. This also provides tactical elements maximum flexibility in how they collaborate to create effects towards common outcomes.

64. Any operation will contain vastly more layers and greater complexity than those depicted here as examples. This complexity is inherent in the current force but is presently resolved by a complex C2 structure requiring a large number of staff who seek to anticipate discrete sets of possibilities for the planning of an operation. The

current structure is not agile, nor does it encourage initiative in FE to adjust the control structure to gain an operational advantage. Section 3 will discuss how the ADF will be able to understand the potential control relationships of the future force and how actual relationships can be created with the agility required by this concept.

65. Agile control can create operational advantage by encouraging use of a system that adapts to the operational environment without the need for centralised direction. Elements within an agile control structure collaborate to adjust tempo, optimise resource allocation, respond to enemy action, and compensate for combat losses.

66. Non-human control. The separation of Control from Command allows the ADF to set different policies for future technologies such as Artificial Intelligence (AI) in either command or control. This concept conceives of an environment where humans command non-human control nodes. A potential example of this is control of activities in the Electro Magnetic (EM) spectrum as humans may not be able to keep up with the pace of enemy EM operations conducted at machine speed.

67. In such a circumstance, human commanders would determine what EM control systems were required to achieve and provide guidance on how the machine was to perform that function through priorities or allowed/disallowed actions. Human commanders would also determine the nature of human-machine teaming utilising categories of teaming such as:

a. **Full Human Control**. A human controls every aspect of the machine's function.

b. **Human In The Loop.** The machine performs some functions autonomously yet it requires a human to perform functions that complete the task cycle.

c. **Human On The Loop.** The machine performs all functions autonomously but a human may intervene to stop or modify the outcome before the task is complete.

d. **Human Starts The Loop.** A human sets operational parameters and initiates the machines operation; the machine requires no further human interaction to complete its task.

Evolution Of Mission Command

68. Mission Command continues to be the philosophy that guides Command and Control relationships within the ADF. The ADF will continue to embrace Mission Command because it utilises Australian culture to generate an advantage by:

a. Creating diversity of ideas and approaches;

b. Utilising complexity theory to cope with dynamic environments;

c. Reducing the shock of surprise, and;

d. Embracing ambiguity.

Command and Control Integration

69. This concept has been optimised for operations that are led by the ADF; however consideration has been given to how it would be implemented in scenarios where the ADF is not the lead. This concept combines hierarchy and agility, with its concomitant requirement for collaboration, retains a dual culture of decision making that enables working with other militaries (that tend to be more hierarchical) and civilian agencies (that tend to be more collaborative).

70. **Partner Led.** It is possible that the ADF will enter into coalition operations as a junior partner to a lead nation that implements a different concept for C2. In this circumstance the ADF commander will need to consider that ADF FE may not be able to fully implement agile control. National Command responsibilities will need to consider the difference between coalition control relationships. A ‘National Intent’

could be utilised to provide ADF FE with guidance on the types of collaboration they should and should not undertake with international partners to ensure all national restrictions are adhered to.

71. ADF Led. The ADF may lead operations where another nation joins as a junior coalition partner but is unable to adopt the ADF C2 concept. In this situation it may be necessary to incorporate coalition partner commanders into the control layer of the ADF. This will allow ADF FE to collaborate directly with coalition FE that have sufficient authority to integrate into an agile ADF operation. Should coalition partners hold command authority at higher levels, it will prevent units from collaborating in the way that the ADF requires to achieve operational outcomes.

Vulnerabilities

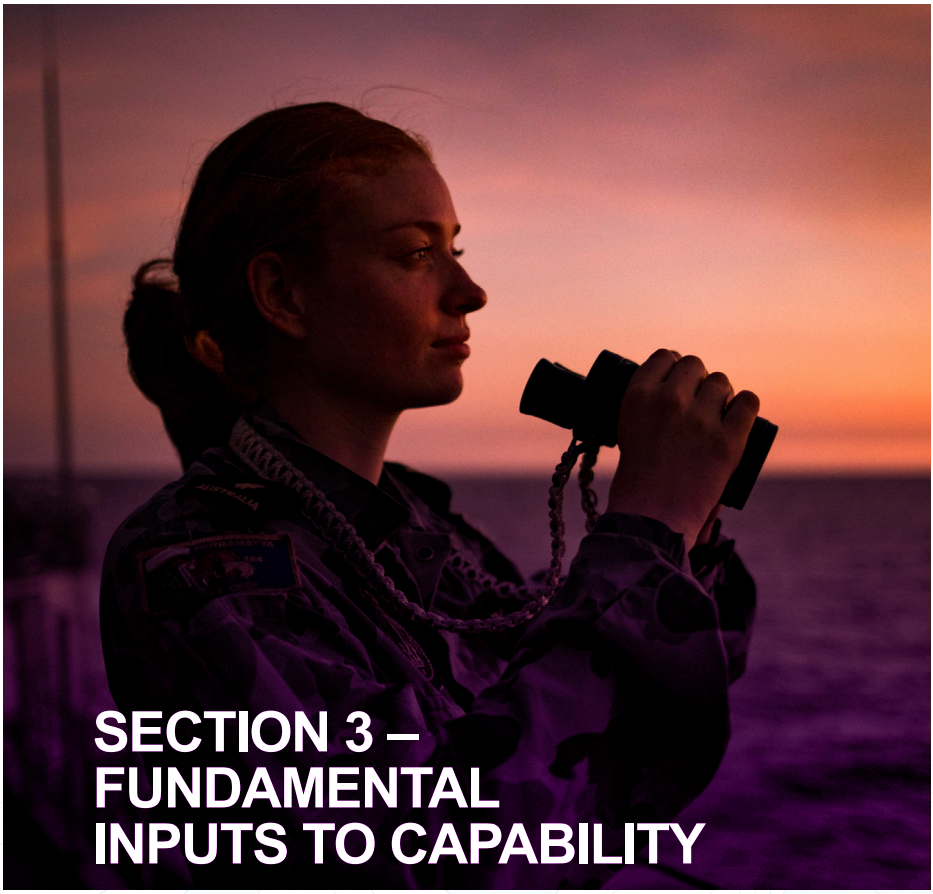
72. Current C2 doctrine ensures that all military action is dedicated to single goal through centralised direction of forces and while the mission command principle allows FE to exercise some freedom in achieving their tasks this concept expands this freedom and removes some direct command controls over forces. A vulnerability of this concept is that FE do not take necessary actions, or may take undesired actions due to mis-understanding commanders intent or lacking the confidence to take initiative. Training in an environment where control FE initiative is necessary for mission success in contested C2 conditions will be necessary to mitigate this vulnerability.

73. The necessity of collaboration within this concept raises the risk of disagreement amongst FE to the point where integration does not occur. As the centralised arbitrator should not be providing strong direction in the conduct of tasks, the concept is vulnerable to internal conflict. Clear commanders' intent, prioritisation and a culture of joint collaboration will need to be developed to ensure that this vulnerability is mitigated.

74. The application of this concept will require an increased level of trust between command and control. Without a high level of trust, commanders may not give the freedom of action necessary to thrive in a contested C2 environment. Similarly, agility may not be achieved within control layers if participants do not trust the abilities of others. The subject of trust also applies to AI systems; the force may not fully exploit their capabilities if their implementation does not engender trust in their performance. Trust is currently built around training, education, experience and proven performance – mitigating this vulnerability will require a training environment where humans and machines can engender trust in one another.

Summary

75. *'Hierarchical Command - Agile Control'* alters the ADF's method for directing forces towards a more efficient, survivable control model but still maintains a command model that adheres to the enduring principles of command. This central idea provides not only a concept upon which to base doctrine, but a method of employment that will influence the design of C4 systems. To implement this concept the ADF will need to make changes across all fundamental inputs to capability.



SECTION 3 – FUNDAMENTAL INPUTS TO CAPABILITY

76. This section provides an indication of the fundamental inputs to capability that will be required to realise the future C2 concept. These inputs were generated throughout the concept development workshops to provide an indication to capability planners the characteristics that future command and control will require.

Personnel

77. This concept empowers junior leaders to make decisions and provides junior ranks the opportunity to consistently develop operational art throughout a career. This standardised concept of command and control can provide the basis of joint training.

78. *Hierarchical Command – Agile Control* will require significant trust between the highest command level and the lowest control level to effectively co-ordinate operations. By 2035 tactical/operational levels are likely to involve AI and may be highly automated. This will require relationship building to develop confidence in decision making, and trust in the execution of decisions by force element at all levels.

79. Commanders and Controllers may be required to respond to a partner (or machine) with a C2 concept that differs from the ADF. Personnel will require an operational understanding of other C2 cultures, including but not limited to WoAG, allies and non-governmental organisations.

80. The ADF will require personnel to train algorithms used by machines in decision support and control functions. This personnel requirement will be enduring as the ADF will need to continually train algorithms with new datasets and maintain the quality of existing data.

81. Under *Hierarchical Command – Agile Control* AI may control some actions. AI will require similar considerations to personnel in the future force as AI will need development and exercising alongside other human and machine force elements to optimise human-machine teaming.

Organisation

82. The ADF will need to develop the baseline purpose and characteristics of a JTF. Australian JTFs have been historically geographic in nature and encompass the functions necessary to conduct operations. The future ADF will operate in domains that are not

characterised by geography. It is therefore prudent to consider a mix of domain, objective or geographic bound JTFs.

83. The ADF presently employs a number of joint and service specific headquarters that perform operational and tactical level functions. These facilities are unable to perform each others functions in a contingency. The ADF needs to establish headquarters with the ability to simultaneously command all domains. This will decrease bespoke headquarter capabilities and provide the capacity for redundancy.

84. The ADF will require an organisation with the authority and resources to lead a joint, multi-domain training and education program for the ADF. This organisation will be crucial in preparing personnel to command and control multi-domain operations.

Collective Training

85. The ADF will require Joint collective training in *Hierarchical Command – Agile Control*. The aim of this training should be to develop personnel and refine procedures under this concept. To achieve this aim the whole of ADF C2 structure from CDF to FE must be exercised.

86. The ADF will require exercises to specifically test agile control. Training should occur at multiple failure levels within the C4 system in a representative information warfare environment. The ADF's multinational exercise partners will use alternate C2 models. To avoid reputational issues, our intentional loss of C4 during exercises to test agility to the point of failure will need to be a clear exercise objective.

87. Conducting realistic C2 training of *Hierarchical Command – Agile Control* may occur at the expense of tactical level employment training. Exercises should be sequenced so that all training requirements can be met across a cycle of ADF activities.

Major Systems

88. The future C2 concept provides a central idea from which a C4 system can be developed. Future C4 systems will need to provide commanders the information relevant to their role of defining strategy, outcomes and missions. The C4 system will also need to enable collaboration between FE conducting control of tasks.

89. This concept removes the propensity for platforms to be required to exchange all information within the joint force. By considering control as a layered structure, integrators are required to determine scenario based control relationships between agile control FE. This can be utilised by capability designers to determine platform C4 that is relevant to the decisions that they may be required to make in this agile control concept.

90. 'Edge AI' refers to the use of AI to analyse data at the point of collection. As the volume of data collected by platforms increases and the relative availability of bandwidth decreases, Edge AI will allow the ADF to decrease the amount of data that needs to be communicated without decreasing the amount of information available to achieve situational understanding.

91. Although this concept will allow the ADF to continue operations in a heavily degraded communications environment, there will be a threshold level of communications required for the joint force to remain effective. Studies will be required to determine this level and ensure that sufficient hardening of networks occurs so that this threshold can be maintained. The ADF will also need to be practiced in prioritising networks so that the force is not unduly degraded by communications system attacks.

92. Analysis of C2 relationships will highlight areas of C4 weakness that must be addressed to deliver commanders and controllers information critical to their roles. This analysis can be used to focus the hardening of C4 systems and determine how much agility the force needs in C4 to support agile control.

93. This concept sets the model to determine where operational information should be prioritised to leverage organisational speed in decision making. Near-term AI systems will be optimised to specific subjects or environments. Mission layers described in figures 2 and 3 are well placed to determine subject specific AI environments. Decision support systems should be placed in these layers so that AI can be fed the data necessary to create an optimum learning environment and organisationally exploit decision support outputs.

94. A future C4 system must enable collaboration within and across control layers. This system must enable control FE to operate without reference to a central system. Control relations within and across control layers will be complex and difficult to understand without the assistance of an autonomous system to track and suggest control relationship changes during an operation.

95. This concept promotes the acquisition of affordable C4 systems as it drives the ADF to tailor information exchange to the role of each level of command and layer of control. This contrasts to potential practices that require C2 at all levels to be provided with all possible information.

Facilities and Training Areas

96. The ADF requires the ability to exercise in a contested C4 environment without impacting the conduct of current operations. The ADF requires a C4 ‘range’ where the C4 system can be exercised in a representative environment. The C4 range requires the ability to stimulate *Hierarchical Command - Agile Control* to assess and refine implementation.

97. The ADF will not have the capacity to exercise all potential variations of C2 structures that may occur under this concept. To develop C2 structures and tactics it is necessary to test multiple courses of action against multiple scenarios through a C2 war gaming capability. Implementing AI in this area will provide significant advantage by increasing the number of scenarios, alternate courses

of action and control measures that may be considered in a short time period.

Command and Management

98. *Hierarchical command – agile control* fundamentally changes the practice of control and creates additional burdens in understanding the nature of relationships between FE. Current terminology, such as OPCON and TACON, may not adequately describe the nature of control relationships in a collaborative environment. Doctrinal terminology will need to be reviewed to ensure that the ADF has a relevant lexicon that aligns with the central idea of this concept. Any review must consider the need to maintain the ability to integrate with the C2 doctrine of potential partners.

99. **Culture.** Over the past two decades, the ADF has displayed a preference for centralised command and control. While this has not been due to a shift in doctrine, it has been borne of the types of operations conducted over this period, the low intensity of the conflict compared to the future environment and the low appetite for risk. Thus, the ADF is well prepared for centralised command and control. The implementation of this change in command and control concept must be cognisant of the cultural tendency that the ADF has towards centralisation must be altered through organisation, training and collective training.

Conclusion

100. The central idea of *Hierarchical Command – Agile Control* answers the military problem of *How does the ADF Command and Control the Future Force to provide a competitive advantage during operations in the Future environment.* It defines a concept in which the fundamental principles of command are maintained while implementing the agility necessary for the future ADF to thrive in the future operating environment. This concept embraces the principle of mission command and outlines the fundamental inputs to capability that must be enacted to achieve future operational success.

Annex A – Research Summary

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Annex B - Artificial Intelligence Glossary

The definitions of artificial intelligence and related autonomy terms are complex and change as technologies evolve. Defence does not currently have standardised definitions for the below terms and community thought varies widely. For the purpose the *Command and Control of the Future Force Concept* it is necessary to define these terms, these terms are contextual to Australian command and control and while they frame the subject in reference to it they may not be relevant to other contexts.

Artificial Intelligence (AI) refers to an emerging and disruptive suite of technologies that exhibit intelligent behaviour. AI includes algorithms, machine learning and deep learning.[11]

> **Algorithms** are clear processes or sets of rules to be followed in calculations, data processing or other problem-solving operations.
>
> **Machine Learning** uses statistical techniques to give computer systems the ability to learn from data without being explicitly programmed. Machine learning is generally task specific.
>
> **Deep Learning** is a form of machine learning that examines data by processing it in multiple layers to learn the features of the data. It is inspired by the information processing of biological nervous systems and such systems are generally not specific to one task.

Artificial General Intelligence (AGI) refers to the intelligence of a machine that could successfully perform any 'general intelligent action'

11 Draft Strategic Policy Statement, Strategic Policy, Department of Defence 2018

that a human can. Much of academia reserves the AGI title to machines capable of experiencing consciousness. Whilst AGI is being widely globally researched it does not yet exist.

Automated Systems are, in response to inputs from one or more sensors, programmed to logically follow a predefined set of 'if-x-then-y' deterministic rules in order to provide an outcome. Knowing the set of operating rules means that the systems outputs are constant and predictable.[12]

Autonomous Systems are able to operate independently, without input or guidance from another entity, to achieve set objectives.[13] These systems are capable of understanding higher level intent and utilise a probabilistic system to decide a course of action from a range of alternatives. Whilst the overall activity of an autonomous system will be predictable, individual actions may not be.[14]

Decision Support Tools are systems developed to support analysts and decision makers in making better decisions, faster. A decision support tool utilising Artificial Intelligence can extract insights from multiple sources and analyse each piece of information at a deep level and with great speed to produce a range of potential options.

Human-Machine Teaming is where humans are integrated into complex technological systems and, rather than use them as tools, co-work with machines and Artificial Intelligence systems.

Quantum Computing is computing using quantum-mechanical phenomena. Large-scale quantum computers could theoretically be able to solve certain problems faster than classical computers and solve novel problems that are currently impossible. The development

12 JDP 0-01.1 UK DoD 2018

13 US DoD 2016, Modelling and Simulation Glossary

14 JDP 0-01.1 UK DoD 2018

of actual quantum computers is still in its infancy, but both practical and theoretical research continues to be funded by many national government and military organisations.

Annex C – Alternative Ideas

C-1. While the ADF must maintain the ability to conduct operations independently of other partners, it has always fought as a part of a coalition. In addition to operations within formed coalitions, the ADF is now conducting operations alongside actors with similar interests but without formalised relationships. This concept postulates an idea for how the future ADF will command and control its own forces during conflict and this annex considers how the ADF will conduct operations with coalition partners, or with actors whom have similar interests but are not a part of a coalition which the ADF is a member.

C-2. Within an operational environment, the ADF may need to manage a number of different types of relationships with other actors that may be characterised:

a. **Coalition.** An informal agreement between two or more nations to undertake military action.[15]

b. **Cooperation.** An arrangement where parties operating in the theatre are under no agreement to undertake military actions together but through mutual interest will not only coordinate their actions but negotiate the manner of these actions.

c. **Coordination.** An arrangement where parties operating in the theatre communicate their intended actions to one another and will self-synchronise their activities but will not negotiate the manner of their actions.

d. **Non-interference.** Parties operating in the theatre advise their actions to one another and take actions

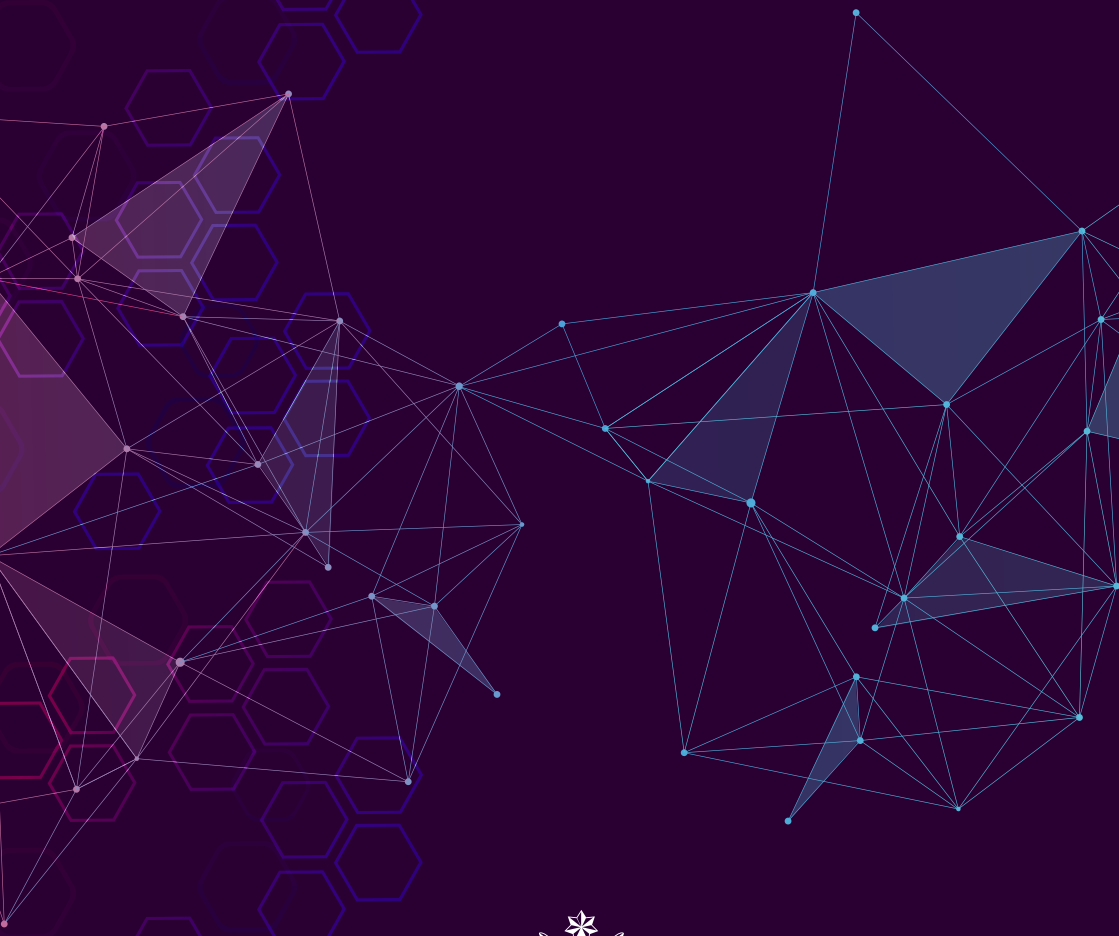
15 ADDP 3.0 – Campaigns and operations Ed 2.

to ensure that their actions do not conflict with each other.

C-3. This future C2 concept assumes that unity of command is necessary for the unity of effort required to succeed operationally. An alternative C2 concept might be to achieve unity of effort across actors with a theatre through collective interests and cooperation. This would allow for Command and Control to be agile without a loss of unity of effort that may jeopardise operational success.

C-4. In cooperation, coordination and non-interference relationships, unity of effort though common interest may be the only principle by which the actions of actors in the theatre are aligned. This relies on the sharing of information between actors with which we may not have formal agreements. This information sharing is required so that actors can self-synchronise their actions.

C-5. The proposed definition for command does not factor in the task of relationship building that commanders undertake in order to build trust across actors within a theatre. In a multi-actor construct, this task is critical to ensuring that information regarding operational actions can be shared and coordination of action occurs if possible.



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