Accelerated Command – decision superiority for the land force in 2035 and beyond

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Abstract

The Australian Army's *Accelerated Warfare* futures statement describes impending operational challenges including rapidly evolving technologies, the spread of conflicts across warfighting domains, the need for training to accommodate demographic change, the requirement to 'scale' for compressed strategic warning times, and the increasing importance of networks for decision superiority.[1,2] Army has endeavoured to address the last challenge through the acquisition of capabilities such as the Elbit Battle Management System, enabled by a tactical communications network to transport data. Future systems will need to do more to meet the challenges of 2035. Aspirationally, human decision-making could be augmented by an artificial-intelligence enabled battle management application that is intuitive to use, catering for Australia's growing number of 'digital natives'. Future communications networks will need to deal with emerging electronic warfare and cyber threats by deceiving adversaries, defending themselves and maintaining alternative links. The supporting elements will need to enable an increase in the Joint Land Force's scale with little strategic warning, be rapidly taught to trainees, responsively adaptable to emerging threats, and ideally be produced by sovereign industry. The feasibility of this aspirational system relies on Army being threat-aware and trusting of autonomous systems. If these prove unachievable, Army and the Joint Land Force will need to be prepared to fight wars with 'decision resilience' rather than 'decision superiority'.

Introduction

The 1977 science fiction novel *Ender's Game* by Orson Scott Card depicts a future world in which the human race dispatches a fleet of warships through space to engage an alien adversary in combat in response to an earlier invasion.[3] This conflict has several salient characteristics which shapes the response of Earth's military forces. Earth faces an insectoid adversary that possesses a hive mind, which enables rapid decision-making and high operational tempo; achieving decision-making superiority in the face of such an enemy

requires several unique challenges to be met. The human personnel recruited for the fight are young citizens, who are brought up with digital technology and are accustomed to playing video games. To realise their potential, young command candidates are trained using a series of gamified immersive simulations that have the same user interface as the command and control system used in combat. This system simplifies command in combat by taking care of logistic, intelligence, surveillance, reconnaissance and communications functions as a background feature; the non-combat aspects of the command and control application are completely opaque to the user. This allows Earth's forces to train and mobilise faster than its adversary, which is necessary due to the short strategic warning time the humans expect will precede a subsequent interstellar invasion of the human homeworld. The combat force was commanded remotely from a base close to home, over long distances dictated by the geography of space, and supported by a communications network with the capacity and resilience to enable near-real time command, control, situational awareness and cooperative engagement across light-years of space. Although this work of fiction was intended to describe a world alien to our own, in 2019 Australia's Army finds itself in an operational environment with some parallels as described in the Australian Army's *Accelerated Warfare* futures statement. The Army's potential workforce is subject to demographic and social change, requiring new training and educational models to be considered. Rapidly evolving technologies such as artificial intelligence and autonomous systems offer potential benefits to the actor or nation-state that can apply them most effectively. Reduced strategic warning time requires that Army is able to 'scale' rapidly for contingencies needing a larger land force. In this context, networks will increasingly be an essential battlefield enabler for achieving and maintaining decision superiority through the provision of fused, synthesized and assured information.[4,5] Part of the possible solution to address this last challenge requires the Army, as the core of the Joint Land Force, to strive to achieve and maintain decision-making superiority through the rapid and accurate collection, processing and dissemination of information to 2035 and beyond.

John Boyd described a cycle through which tactical decisions are made and action is initiated; he purported that the competitor who can cycle through this 'Observe, Orient, Decide and Act' loop with greater tempo would have a distinct advantage.[6, 7] In recent years, Defence has sought to achieve this decision superiority through the use of digital command and control systems, such as the Elbit Battle Management System, comprised of decision-support applications and a supporting communications network.[8] These Battlefield Command

Systems are usually comprised of three elements. A battle management software application, such as the current in-service Elbit capability, replaces or complements voice and paper-based systems with the electronic means to rapidly disseminate graphical and textual command and control, situational awareness and targeting information. The second element is a tactical communications network, which uses radios and other bearers to transmit application data and voice services between users. The third element is the support component, which is made up of training, repair, supply and other functions required to keep the Battlefield Command System running. Currently, competitors are developing their command and control capabilities at a rate that may soon have Australia and its traditional partners at a relative disadvantage.[9] As such, command and control systems that merely communicate the decisions made by humans are unlikely to generate enough tempo to achieve and maintain decision superiority relative to potential future adversaries. Army's future command and control systems for 2035 and beyond may need to exploit rapidly evolving technologies such as artificial intelligence to manage large data streams to assist humans in making better, faster decisions, while making lower order decisions without human intervention.[10]

Army's Battlefield Command System 2035 and Beyond

The future Battlefield Command System for 2035 and beyond will need to augment rather than just support decision-making in order to ensure that Australia's Army has decision superiority in the context of the *Accelerated Warfare* challenges in three ways.

Firstly, decision-making must be augmented by a cognitive battle management software application that can automate as many tasks for tactical commanders as possible, while requiring minimal training to operate. It will need to be capable of recommending or making lower-order decisions for the commander in order to decrease cognitive loads on individuals and accelerate better, faster and safer decision making. This would not require a human-level Artificial General Intelligence to recommend routine tasks which rarely change, such as the replenishment of fuel and ammunition after combat; however, the decision to apply lethal force will probably remain with humans for the foreseeable future due to legal and ethical reasons. An enhanced Battlefield Command System will cater for Australia's changing demographics and increasing numbers of potential recruits who will grow up with digital technology; simplified user operation will allow soldiers to be quickly trained to use the technology.[11]

Secondly, the adversary must not be able to completely deny Army's decision-making by denying or disrupting the use of the tactical communications network. The application requires a semi-autonomous secure and resilient communications network to transport the data around the battlespace between users with minimal human intervention. This network will need to deal with rapidly emerging technological threats by deceiving adversaries and defending itself from electronic or cyber-attack.[12] It will also need to extend over long distances across multiple warfighting domains due to the geography of the region.

Thirdly, the Battlefield Command System will need to be able to support decision superiority for an Army which needs to increase in scale with little strategic warning to deal with large conflicts. As such, the support component will also need to ensure that the future system is able to be rapidly manufactured, quickly adapted to emerging threats and swiftly taught to trainees. Further, the training and manufacturing elements must be trusted, and therefore likely sovereign, due to the amount of responsibility that will be delegated to the system.[13]

In the face of the challenges articulated by Accelerated Warfare, Army's Battlefield Command System for 2035 and beyond must do more than support command; it must augment and accelerate it. The feasibility of this aspirational system however, must be scrutinised in the context of current challenges facing the Australian Army, such as trusting autonomous systems and understanding emerging threats. If these prove insurmountable, it may be that Army and the Joint Land Force will need to be prepared to fight wars with 'decision resilience' rather than 'decision superiority'.

The Application

Future battle management software applications should augment the ability of commanders to gain situational awareness, make decisions and direct the delivery of effects. Current battle management system applications across the globe such as the Elbit product are designed to allow situational awareness, logistics, command, control and targeting information to be presented graphically on an electronic screen. While these systems are advanced when compared to paper and voice-based methods for presenting information and passing commands, they still largely rely on humans to make decisions at all echelons, draft orders, plan and conduct tasks. Human-machine collaboration has the potential to assist humans to

make better, faster decisions through the curation of large amounts of data in shorter periods of time. This will become increasingly important as greater masses of data become available to tactical commanders approaching 2035.[14] Ideally, the future battle management application will be able to augment the commander's ability to make and execute decisions quickly, be as intuitive to use as possible, and allow future recruits to become proficient in its use with minimal training. This would reduce training lead-times and assist Army's ability to expand in scale quickly.

Army's future battle management system should augment the commander's innate abilities. Due to the complex nature of combined arms combat in a multi-domain environment, tactical commanders today often have large staffs to analyse ever-increasing amounts of data and then use it to conduct most of the detailed planning that supports the manoeuvre concept. An application such as a more advanced version of Rafael's field-tested Fire Weaver system that is able to recommend or make decisions on behalf of the commander, as well as cue actions that support the commander's manoeuvre plan, may alleviate the need for such large headquarters, thereby reducing the personnel requirement and signature of the force.[15]

An application that is intuitive to use may lower the required cognitive load of the user, resulting in shorter and simpler training courses, thereby enabling more tactical commanders to be qualified more rapidly. Currently, officers undergo extensive training over multiple courses covering many aspects of being a commander in the field, including manoeuvre, intelligence, surveillance and reconnaissance and logistics. This knowledge is then developed into skills and maintained over numerous exercises and operations. In the case of rapid national mobilisation, new commanders may not have had the opportunity to undergo this comprehensive suite of training and experiences prior to deployment on operations. A software application which leverages Artificial Intelligence, automation and machine learning to predict, recommend and execute the support planning for rapidly recruited commanders may offset the potential experience and skills gap. For example, while many young Australians may be familiar enough with digital technology to play 'real-time strategy' games such as *Command and Conquer*, in which they issue orders to their units on the game which then execute the tasks they have received through a simple point and click user interface, gamers are rarely asked to consider and plan logistics, communications networks, personnel rotations or other crucial supporting tasks.[16] Aspirationally, a digital software application that allowed someone to command with the swipe of a finger by interpreting relevant parts of the

tactical commander's manoeuvre plan, autonomously cueing intelligence, surveillance, reconnaissance, recovery, repair, communications and medical assets, and presenting a support plan to the commander for approval and execution would allow a fairly inexperienced officer to be trained to conduct operations in excess of what could be expected of them in today's environment.[17,18]

The battle management application should cater for the demographics of Army's future workforce, which is likely to change towards 2035 and beyond. 'Digital natives' will make up an increasing proportion of the people Army will recruit from. They can be defined as individuals who have grown up immersed in digital technology; it is possible they are more easily trained and educated by methods that effectively employ modern digital means.[19] As such, future wars of necessity that require Army to increase the size of its workforce rapidly, may need to rely on communications systems that can be trained simply and quickly via digital methods. The population from which Army may draw its recruits from in the future are becoming accustomed to employing digital means in their personal lives to communicate. The proportion of potential candidates who would rather send a text or social media message over making a phone call or writing a letter is increasing. By 2035, Army should better cater for the learning styles of recruits if the systems they are being trained on are similar to the technology they have been exposed to prior to enlisting. Training large numbers of future tactical commanders in short timeframes may be easier if Army's systems are digitised.

Although younger Australians are more likely to be familiar with technology, it does not necessarily mean they will be intuitively skilled at using the specific types of technology resident in today's Battlefield Command System.[20] Simple systems that provide only the required level of functionality to support decision making superiority may provide Army more capability than an overly complicated system by simplifying and shortening the training required to operate future digital command systems. During the Second World War, the Imperial Japanese Navy trained its pilots to standards that meant they were more highly skilled than any of their competitors.[21] However, this meant that training was long and as such, they were unable to achieve the scale of workforce output required to match the numbers of piloted allied aircraft pitted against them. Shortening the time it takes personnel to become qualified to use the system may not be enough if they cannot become as familiar with the tactical tasks and warfighting functions they will employ the system for.

Conceptually, the tactical employment of such an application may be illustrated as follows. In anticipation of the preparatory and reorganisation phases of the operation, the battle management system interprets the commander's plan, and issues a combination of machine-to-human and machine-to-machine warning orders to a semi-autonomous combat support system. Soldiers are informed they must be ready to fill the estimated reinforcement demands, and a swarm of logistics robots could begin placing caches, forward positioning ammunition and repair assets, as well as posturing to resupply combat forces during the fight.[22] Intelligence, surveillance and reconaissance assets and guard forces are pre-deployed to ensure the commander is not surprised by an enemy counter attack. A joint effects system, such as a more advanced version of Raytheon's Advanced Field Artillery Tactical Data System (AFATDS), generates a draft plan for approval by humans to support the manoeuvre plan with a combination of kinetic and non-kinetic effects, such as long-range fires, air and missile defence, as well as cyber and electronic attack.[23,24] Where stores, equipment or even defensive structures are required, autonomous additive manufacturing facilities in the field could be on standby to produce the anticipated materiel or work on-demand.[25] This support planning may be done rapidly, with human intervention only required to approve lethal force; machine-to-machine orders for non-lethal tasks result in the land force being able to decide, re-orient and act faster than a non-automated adversary.

An easy to use battle management system that could augment or replace the headquarters staff required to conduct support functions that enable a commander's manoeuvre plan would allow the same number of recruited digital natives to fill an Army which needs to rapidly increase in scale. There are however, many issues regarding the likelihood of such an aspirational system being developed even out as far as 2035. Army would need to adequately address the software integration, technological feasibility and ethical acceptability issues which would affect how employable any Artificial Intelligence-enabled system would be.[26] Further, the application data would be useless if it is not supported by a resilient, assured network to transmit this information between users on the battlefield.

The Network

Army's networks are key to synchronising combat power across multiple warfighting domains; they are the bearers over which the battle management system will transport application data between sensors, users and weapons systems.[27] In a future where the use of

the electromagnetic spectrum will be contested by cyber and electronic warfare, these networks must be capable of surviving by acting and reacting faster than the enemy can attack them. Advanced networks could potentially achieve this by autonomously deceiving the enemy as to the location, purpose and intent of friendly forces; by automatically defending themselves when attacked; and by re-establishing connectivity with minimal human intervention.[28] Further, the system should ensure that users within Australia's region and operating environment can access Army's data; it will need to operate over long distances in littoral and urban environments across multiple warfighting domains including land, air, maritime, cyber and space.

The science fiction film *Independence Day* depicts an alien invader that, though in possession of technologically advanced weaponry and vehicles, relies heavily on a communications network that lacks adequate redundancy as it is mounted in a single mothership.[29] Further, the hub of the network is easily detectable due to its signature and does not have adequate defensive mechanisms. Any army looking to realise the potential that a networked force offers should also aim to design a system that can survive enemy attacks, lest it present itself as an Achilles heel. Australia's potential competitors are improving their ability to disrupt, degrade and deny friendly networks by continuing to raise, modernise and train electronic warfare forces through large-scale exercises to improve future readiness for modern conflicts.[30,31] The effectiveness of the electronic warfare capabilities of Australia's potential adversaries has already been proven recently in combat; in 2035 it could be expected that friendly networks will need to be survivable in the face of more advanced attacks.

One method of maintaining communications is to avoid the degradation or disruption of friendly networks by deceiving the adversary. The advanced state of modern electronic warfare means that hiding electromagnetic signatures of friendly forces is practically impossible, short of not employing any electronic devices or communications. Since avoiding detection during combat operations is becoming more difficult, deception may more usefully be achieved through the generation of false or misleading electromagnetic emissions – a modern version of Imitative Communications Deception, where friendly forces imitate the communications of the enemy to deceive them. Automated network management systems could be used to deceive the adversary of the characteristics, location and amount of data being transmitted, thereby shielding the commander's intent and main effort. Generative Adversarial Networks could potentially be employed to generate signals that appear as

something else, such as a lower-value target, an adversary emitter or multiple platforms. While the employment of decoys in warfare is not new, a combination of advanced versions of Penten's Wireless Artificial Intelligence Decoy (WAID) system and the Defence Science and Technology Group's Self-organising Communications and Autonomous Delivery Service (SCADS) project have the potential to achieve deception without placing additional soldiers in harm's way.[32,33] Even if an autonomous network management system could deceive an adversary as to the disposition, scale and type of friendly network capabilities within an area of operations, the effect may only be temporary; thought must also be given as to how to defend the network once it is found.

Once under attack, a network may still be able to maintain connectivity if it can adequately and rapidly defend itself. The use of cognitive Electronic Warfare for electronic attack and defence have been explored by the United States' Defense Advanced Research Projects Agency's (DARPA's) *Behavioral Learning for Adaptive Electronic Warfare* (BLADE) and the United States Army's Rapid Capabilities Office's Cognitive Electronic Warfare competition (of which an Australian team came second place).[34,35] These projects examined the use of Artificial Intelligence to execute Electronic Warfare through software-defined radios and analytical tools at machine speed; the next logical step is to extend that function into the physical domains. An autonomous networked swarm could then actively defend itself through pre-emptively positioning emitter and range extension nodes to mitigate anticipated communications degradation. It could also cue kinetic offensive action against enemy jammers and intercept stations either from another capability system such as precision long-range fires, or from one of the multi-role platforms within the swarm itself. This will increase not only the difficulty, but also the potential danger for adversaries when targeting Army's future networks. However, if a portion of the network is degraded, there needs to be multiple paths along which the data can be transferred between users to maintain connectivity by methods that are largely opaque to the commander.[36]

After a future communications network has been attacked, it should ideally re-establish services with little human intervention. Network redundancy has previously been built into networks through the use of alternative transmitters, such as radio retransmission detachments, satellite and cables, and the use of meshed networks. These have generally been controlled by humans and may therefore not be responsive enough against Army's adversaries in 2035. An 'intelligent and autonomous' network enabled by an agent such as the

Defence Science and Technology Group's *OPAL* self-healing communications network concept may only require minimal human input to rectify network issues by controlling the deployment of uninhabited communications nodes to re-establish connectivity.[37] This potentially accelerates the rate at which the network is rectified and allows humans to either be removed from harm's way, or employed on tasks that only humans can do.

The geography of Australia's region demands that any network designed to carry Army's data must do so at long ranges, in complex urban terrain and across the warfighting domains.[38] Unlike traditional meshing and range extension methods that involved manned retransmission vehicles or stations, an automated network management system augmented with an uninhabited autonomous swarm of transmitters and receivers provides the ability to cover a large area and provide high-density redundancy without the need to significantly increase the personnel or vehicle numbers within a contingent. A 'virtual swarm', or a group of agents within the cyber domain that act in concert with physical nodes in the air, land and maritime domains, may have the ability to provide connectivity in urban environments by using existing infrastructure, such as mobile phone towers, public Wi-Fi hotspots and other transmitters.

An aspirational network that supports the Joint Land Force's communications requirements in 2035 that is able to autonomously deceive the adversary, as well as defend and heal itself would have many benefits. The uninhabited nature of some of the nodes within the network may reduce the risk to human lives, while outpacing the enemy' ability to attack it. However, without a support system that can cope with compressed strategic warning in which to increase the scale of equipment provisioning rapidly, adapt to emerging developments in technological threats and train users, it is unlikely that this aspirational network will be able to enable decision resilience, let alone decision superiority.

The Support System

The system that supports the future Battlefield Command System should also be postured to meet the challenges of *Accelerated Warfare*. Two of the fundamental inputs to capability that are critical to this are training and industry. Without the ability to securely and swiftly manufacture and adapt the technology, as well qualify operators in its use, Army's networks

may not be able to rapidly enable decision superiority at larger scales in the context of reduced strategic warning times.[39]

Army may need to rapidly and significantly expand in size in order to fight a war of necessity in the future; to support this, part of the force would need to be trained to operate the battle management application as well as the supporting communications network. The framework to train those people on Army's technology also needs to be rapidly scalable if it is to enable rapid mass mobilisation with little warning. This requirement would likely overwhelm existing communications training establishments due to the reliance on lengthy, complex qualification courses and centralised training models that require trainees to attend residential courses away from their parent units. Current training establishment facilities are based on the directed training requirement for maintaining the current force, and therefore only have classrooms, training equipment, instructors and accommodation for the corresponding number of trainees. The future Battlefield Command System should be acquired in such a way that the non-military specific technology and theory components could be delivered by partnering with industry and academia in a decentralised way. By delivering the maximum amount of training in units' home-locations, using non-military personnel, facilities and accommodation would no longer be a limiting factor. Partnerships with Technical and Further Education (TAFE) establishments, universities and industry would allow more of the nation's resources to be applied to increasing Army's scale rapidly, while allowing uniformed instructors to focus on the military aspects of training soldiers to employ the technology on operations. The value of being able to qualify numerous trainees in a short timespan will be diminished however, if equipment resupply relies upon vulnerable sea and air lines of communication that may be targeted by an adversary during a time of conflict.[40]

As Army's networks will continue to be critical to the Joint Land Force by linking sensors, users and weapons across multiple warfighting domains, they should be considered as a sovereign industrial capability priority. Australia should therefore have access to, or control over the skills, technology and infrastructure that underpins the capability.[41] The Australian Government has stated its intent to maximise the use of Australian Defence Industry as a means to manage strategic risk and add to Australia's strategic weight.[42,43] The ability to manufacture and adapt technology and products within Australia means that the Army may be able to rapidly adapt its Battlefield Command System to an emerging threats, such as an unanticipated development in electronic warfare capabilities which could be employed by

potential adevrsaries. Additionally, the ability to manufacture replacement parts or more equipment without relying on long overseas supply chains provides a level of assurance that communications stores will be available regardless of sea control or air superiority. Army's Robotics and Autonomous Systems strategy highlights that the Commonwealth is responsible for the behaviour of the systems it employs, especially where autonomy and Artificial Intelligence are involved.[44] This is equally applicable to a Battlefield Command System that makes or recommends decisions on behalf of human commanders. This responsibility could be met in part through a sovereign assured supply chain. The fictional 2015 novel *Ghost Fleet* described a situation in which an adversary had undermined the United States Military's technological advantage through corrupting their supply chain and manufacturing integrity. It allowed an enemy to introduce cyber vulnerabilities into aircraft and ships which rendered them detectable and malfunctioning. The remedy was to retro-fit major platforms with sovereign electronic components.[45] Australia should seek to avoid a similar predicament, but self-reliance has other indirect benefits as well. For example, the national shipbuilding endeavour sows the seeds for development in Australian technical education, training, industrial investment and employment.[46]

Decision Superiority or Decision Resilience?

The feasibility of this aspirational system and its potential to enable Army to achieve decision superiority over its adversaries past the next fifteen years must be scrutinised in the context of current challenges facing the Australian Army. If Defence, the Government and the Australian public do not have faith that autonomous systems can be trusted to make or recommend decisions in combat, it may be that Army will not be permitted to acquire and employ these capabilities despite the possibility that potential adversaries may do so. While militaries strive to understand the potential threats future adversaries may be able to bring to bear, if Army has not correctly anticipated and prepared for malicious attacks against its communications networks, sensors, commanders and weapons systems may not be able to seamlessly pass information between each other. In the face of an enemy that has better connectivity and is able to make decisions more quickly, commanders at all levels may need to fall back on trusted methods of command and control, such as mission command, lower-technology options for communications such as High Frequency (HF) communications, and well-rehearsed tactics, techniques and procedures. It may be that Army and the Joint Land

Force will need to be prepared to fight wars with 'decision resilience' rather than 'decision superiority'.

Conclusion

In the context of the *Accelerated Warfare* operating environment, Army's Battlefield Command System for 2035 and beyond will need to be more than a collection of decision support tools and graphical displays in order to achieve and maintain decision superiority. A cognitive battle management system software application must automate, recommend and execute as many tasks for the commander as possible, and require minimal training and human intervention. Doing so will address Australia's changing demographics in preparation for rapid scaling and mobilisation. The battle management application requires a semi-autonomous secure and resilient communications network to transport the data around the battlespace. It must deal with rapidly emerging technological threats through autonomously deceiving the adversary, as well as defending and repairing itself. It must also ensure it reaches the required users across long distances, in urban and complex terrain, across multiple domains with little human intervention. The whole system must be capable of being scaled, adapted and trained quickly. To meet the challenges of Accelerated Warfare, Army's Battlefield Command System for 2035 and beyond must be more than a digital management system; it must accelerate command.

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