National Defence
Défense nationale

Canadian
Forces
College

Collège
des
Forces
Canadiennes

**THE NEED FOR INCREASED SURVIVABILITY OF
THE AUSTRALIAN ARMY COMBAT BRIGADE HEADQUARTERS**

Major Justin D. Tomlinson, ADF

JCSP 50

Service Paper

PCEMI n° 50

Étude militaire

Canada

CANADIAN FORCES COLLEGE - COLLÈGE DES FORCES CANADIENNES

JCSP 50 - PCEMI n° 50
2023 - 2024

Service Paper – Étude militaire

**THE NEED FOR INCREASED SURVIVABILITY OF
THE AUSTRALIAN ARMY COMBAT BRIGADE HEADQUARTERS**

Major Justin D. Tomlinson, ADF

THE NEED FOR INCREASED SURVIVABILITY OF
THE AUSTRALIAN ARMY COMBAT BRIGADE HEADQUARTERS

AIM

1.   The Defence Strategic Review (DSR) states that "the ADF needs to be a more focused force that can respond to the risks we face"[1]. Australian Army Combat Brigade (Cbt Bde) operate in a land domain consisting of increasingly complex technologies and threats. The nature of land combat endures, but the character is changing as adversaries and allies adapt to these new technologies and threats.[2] This is a key reason for the statement in the DSR that "the ADF is not fully fit for purpose".[3] This paper is focused on the changes needed in the command-and-control (C2) function within the Cbt Bde. Proposed changes will seek to develop a HQ system which is more streamlined, more mobile, and more survivable at the expense of the more static HQ structures that trade survivability for larger staffs and extra resources. The endorsement of Head Land Capability (HLC) is sought, and an urgent rethink of the design and requirements of the Australian Army Cbt Bde deployable headquarters (HQ) is proposed.

INTRODUCTION

2.   The DSR provided the three Cbt Bde new focused roles and a requirement to be capable of amphibious operations.[4] These Cbt Bde form a large portion of the Army's conventional combat power as 'units of action'[5]. Critical to enabling this combat power and associated effects is the C2 provided by the Cbt Bde HQ.[6] This HQ is an essential tool in integrating land domain effects of the Cbt Bde with actions in other domains.[7] To operate at maximum efficiency the Cbt Bde HQ must deploy physically into the land environment, close to the Forward Edge of Battle Area (FEBA) to achieve line of sight (LOS) communications and to facilitate face to face interactions with subordinate commanders.[8] Having senior combat commanders closer to the FEBA enables clearer provision of commander's intent and application of 'Power to the Edge' principles.[9] This paper will detail vulnerabilities of the current Cbt Bde HQ, describe some of the

---

[1] Australian Government, *National Defence - Defence Strategic Review*, (2023) https://www.defence.gov.au/about/reviews-inquiries/defence-strategic-review.

[2] Paul R. Norwood, Benjamin M. Jensen and Justin Barnes, "Capturing the Character of Future War," *The US Army War College Quarterly: Parameters* 46, no. 2 (2016)

[3] Australian Government, *National Defence - Defence Strategic Review*

[4] Australian Government, *Major Changes to Army Announced*, (28 Sep 2023), https://www.defence.gov.au/news-events/news/2023-09-28/major-changes-army-announced.

[5] Chris Field, *Command and Control,* 20 May 21, accessed 07 Jun 21, www.cove.com.au

[6] From the HQ, the Bde Comd can command their subordinate battle group (BG) and the staff can exercise control over Cbt Bde actions. However, the Cbt Bde HQ also serves as the system through which the Cbt Bde receives direction from Division HQ and deconflicts with neighboring call sign.

[7] Including cyber and EMS actions (CEMA) (cyber), satellite communications (space), air-ground deconfliction (air), amphibious planning (maritime) and joint fires and effects coordination cell (JFECC) (multi-domain).

[8] This is different to the requirements of the Divisional HQ, which is more likely to be sited outside of the immediate Joint Area of Operations (JAO) in a location out of range of tactical effects such as long-range fires.

[9] David S. Alberts and Richard E. Hayes, *Power to the Edge: Command, Control in the Information Age* (Washington, DC: CCRP Publication Series, 2004).

relevant modern threats and propose renewed requirements of the HQ system which support a HQ which is more survivable in the modern operating environment as described by the DSR.[10]

VULNERABILITIES OF THE CURRENT COMBAT BRIGADE HQ

3.   **Protection.** Cbt Bde HQ staff currently work in tents which afford no overhead protection (OHP) from indirect fire (IDF). HQ operations occurring in a high intensity conflict that involves a real and sustained IDF threat need to occur within vehicles with some level of OHP such as a Bushmaster Protected Mobility Vehicle (PMV) or an A vehicle such as a M113-AS4 Infantry Fighting Vehicle (IFV). During an IDF attack, with current capabilities, many personnel would not have a vehicle with OHP available to them, and those personnel would need to wait out the IDF in a shell scrape, where they would be more vulnerable. Staff hiding in shell scrapes are also not contributing to Bde C2. In the event of a ground based kinetic attack on the HQ node, the HQ would be limited to fighting out of PMV or pre-dug fighting pits with small arms. Realistically, this level of protection would only protect the HQ from a disorganized dismounted kinetic action.

4.   **Mobility.** HQ MAIN is significantly lacking mobility.[11] It has at least 10 heavy vehicles and once established, it has a large amount of tentage and an extensive Field Power Distribution System (FPDS). Cbt Bde HQ Forward (FWD) is, by design, more mobile.[12] However, communication and information system (CIS) equipment which is required to be loaded in and out of a 6x6 G-Wagon, tentage, and FPDS does limit mobility and dictates a notice to move of approximately 90 minutes. In a high-intensity peer-on-peer conflict with modern intelligence, surveillance, and reconnaissance (ISR) and long-range fire capabilities, both MAIN and FWD would be highly vulnerable to destruction due to an inability to avoid enemy targeting once identified.

5.   **EMS signature.** Modern C2 systems, introduced to support 21st century C2 networks as described by 'Power to the Edge' and 'Network Centric Warfare'[13] have come with a high cost in increased EMS signature, without enough effort and resourcing to manage and control signatures throughout the battlefield.[14] This is important noting the possibility of SATCOM jamming and the wide range of electronic warfare (EW) effects that a near peer enemy can direct at a HQ. The use of PACE (Primary, Alternate, Contingency, and Emergency) in Cbt Bde HQ is also clunky and not well defined. It occurs with limited understanding of the second and third order effects in

---

[10] Examples from Russia and China will be used. The War in Ukraine and the lessons of modern conflict and Russian tactics are an excellent demonstration of modern threats. Additionally, the competition between China and the United States in the Indo Pacific is the key strategic concern listed in the DSR.

[11] DGTRADOC, "Standard Operating Procedures for the Combat Brigade, Part 2 – the Headquarters of the Combat Brigade," *Forces Command, Australian Army* (2020).

[12] Cbt Bde HQ currently comply with the SOP above. This SOP dictates a need for a HQ MAIN and HQ FWD. HQ MAIN is very large, with working space for a large HQ staff. It is not survivable in a modern fight as it takes a day to move. HQ FWD is more aligned with the HQ required on the modern battlefield, but it is not an integrated capability, and its movement time is also too high. The Bde Comd traditionally can shift between MAIN, FWD and TAC. This paper suggests that the responsibilities of MAIN should shift back to barracks or in some limited cases move to FWD.

[13] Irena Ali and Celina Pascoe, "Taking Power to the Edge with Network Centric Warfare and the New Command and Control: An Australian Perspective," *Australian Defence Force Journal*, no. 176 (2008), 34-46.

[14] Steven R. Smith. "Hide and Seek: 21st Century Battle of Signatures," (2018).

the EMS, and the step through of the PACE only occurs out of necessity, rather than by design or SOP.

6.   **Noise.** The requirement to generate power to support the maintenance of multiple wideband communication circuits, to power deployable information systems, and to power lights for the maintenance of 24-hour operations in the HQ tentage is impossible to avoid in the HQ's current form. However, the noise signature of the generator creates a significant increase in the likelihood of detection of the HQ, exacerbated by thermal signature. These power requirements can be reduced by removing tentage and associated lighting from the Cbt Bde HQ to reduce overall power requirements and by implementing more modern power technologies with lower signatures.

MODERN THREATS TO THE COMBAT BRIGADE HQ

7.   **Satellite based ISR.**[15] Access to space-based technologies and associated ISR capabilities has increased significantly throughout the 21st century. The proliferation of StarLink capabilities is one commercial example of that, with real time implications in modern combat.[16] China has "embarked on a sustained national effort to develop a broad spectrum of space capabilities across the civil, national security, and commercial sectors."[17] On 30 Apr 21, China launched the Yaogan 34 spacecraft on a medium-class Long March 4C rocket. The Yaogan 34 is an optical sensing satellite that "will be used for the survey of land resources, urban planning, the confirmation of land rights, road network design, crop yield estimation and disaster prevention and reduction."[18] China's Aerospace Science and Technology Corp (CASC) stated that the satellite will provide support "for the implementation of major national strategies and the modernization of national defense."[19] A cautious review of this launch, and others similar, yields an assumption that China can field an array of space based ISR assets that could be used in aid of the identification high value targets (HVT) in the event of a peer-on-peer conflict.

8.   **UAS ISR.** In the Russia-Ukraine conflict, UAVs have been "used by both sides of the conflict, not only for guiding artillery strikes, but also for monitoring compliance with the ceasefire or for electronic reconnaissance and intelligence"[20] Cbt Bde HQ are vulnerable to detection by these assets. One example of this is the HERMES 900 UAV, a fixed wing (FW) UAS with daylight video, Infrared (IR) ISR and EW capabilities. It has a 10-hour flight time and a 200km range.[21] Assets like this have the potential to be used to conduct ISR missions to detect HVT. When conducting ISR on HQ nodes they will seek to identify satellite communications

---

[15] Potential adversary investment in space-based collection assets is difficult to confirm through non-classified material, but consideration of open-source materials can allow relevant deductions to be made.

[16] Kaushik Ray and William Selvamurthy, "Starlink's Role in Ukraine," *Journal of Defence Studies* 17, no. 1 (2023), 25-44.

[17] Brian Weeden and Victoria Samson, *Global Counterspace Capabilities: An Open Source Assessment* Secure World Foundation Washington, DC, 2018).

[18] Stephen Clark, *China launches military observation satellite,* 04 May 2021, accessed 07 Jun 21, https://spaceflightnow.com/2021/05/04/china-launches-military-observation -satellite/

[19] Ibid

[20] Hubert Królikowski, "The use of Unmanned Aerial Vehicles in Contemporary Armed Conflicts – Selected Issues," *Politeja* 19, no. 79 (2022), 17-34.

[21] TRADOC G-2, "Worldwide Equipment Guide: Volume 2: Air and Air Defense Systems," *TRADOC G-2 ACE-Threats Integration Ft. Leavenworth, KS* (Dec, 2016b).

(SATCOM) capabilities, antenna farms, tents, large vehicles, generators, and other easily identifiable equipment to develop an understanding of where Cbt Bde HQ nodes are located, and what level of HQ has been identified, so targeting options can be developed.

9.   **Ground based EW.** The Leer-2 is one example of EW equipment that could be used to target the Cbt Bde HQ. It has a jamming range of 20-1000 MHz.[22] The Light Electronic Support System (EULE) is another example. It can identify and locate low probability of intercept (LPI) and low probability of detection (LPD) and frequency hopping waveforms across 20-1300MHz.[23] Based on this brief snapshot of tabulated data, if the current order of battle of the Cbt Bde HQ was facing an adversary with this type of EW capability, that threat would be able to detect HQ node transmissions across all bands (with the exception of lower band HF). In direction finding (DF) mode, the Leer-2 could support a combined enemy ISR effort to identify friendly HQ nodes and their current significant EMS signatures from large distances, prior to the generation and actioning of targeting actions designed to destroy the HQ.

10.   **Decreased targeting and decision time frames.** Modern, sophisticated C2 systems which involve a sensor to shooter network create very fast reaction from identification (sense) to targeting (act). An analysis of friendly force capabilities in open-source media helps us gain an understanding of the type of technology Cbt Bde HQ can face on the modern battlefield. Looking at a friendly force example, the US Military has been experimenting with target detection through Low Earth Orbit Satellites, with detection data provided to C2 systems which process the data using autonomous systems and allocate an effect to destroy the target in minutes.[24] Network topologies for these sensor-shooter networks develop relative to the modernization of the sensors such as the aforementioned ISREW technologies and shooter such as the long range fires mentioned below.[25] These emerging capabilities and techniques present a strong threat to Cbt Bde HQ. Modern threat actors can use these technologies as a method to decrease time from detection to targeting.

11.   **Increasing accuracy and effectiveness of long-range fires.** Once identified, the Cbt Bde HQ will be vulnerable to targeting actions designed to destroy, degrade, or disrupt Cbt Bde C2. One of the most significant assets future adversaries will have, is the ability to target an identified HQ from great distance using long range fires. This has been seen in devastating effect in Ukraine. On the morning of 11 Jul 2014 two Ukrainian mechanized combat brigades were rendered ineffective by damage inflicted by Russian Tornado Rockets. The rockets had been fired from 15km away, across the Russia/Ukraine border, and are believed to have been vectored by a single Russian UAS. This was after Russian UAS ISR observation had identified their Ukrainian Armed Forces target, making this a modern, real-time example of the use of long-range fires to execute a target identified by UAS ISR. [26]

[22] TRADOC G-2, "Worldwide Equipment Guide: Volume 1: Ground Systems," *TRADOC G-2 ACE-Threats Integration Ft. Leavenworth, KS* (Dec, 2016a). page 13, page 21
[23] Ibid, page 27
[24] Sydney Freedberg, *Target Gone in 20 Seconds: Army Sensor-Shooter Test,* 10 Sep 20, accessed 09 Jun 21 https://breakingdefense.com/2020/09/target-gone-in-20-seconds-army-sensor-shooter-test/
[25] Patrick Chisan Hew, "New Paths from Sensor to Shooter: How Digitization can Change the Formability and Topology of Information Flows in Systems that Acquire and Prosecute Targets," *Rockingham, October* (2017).
[26] Thomas Bradbeer, *Lethal and Non-Lethal Fires: Historical Case Studies of Converging Cross-Domain Fires in Large-Scale Combat Operations,* Military Review: Fort Leavenworth, Vol. 98, Iss. 5, Sep/Oct 2018

COMBAT BRIGADE HQ SURVIVABILITY ENHANCEMENT

12.   AHQ should commence rapid design and integration of a more survivable Cbt Bde HQ now, to ensure the C2 of the Land Force's 'unit of action'[27] is ready for conflict.[28] Noting the shortcomings in the current HQ capability, a considered systems engineering process with a focus on what the requirements of the HQ are, will enable a HQ that is integrated by design, rather than an informal gathering of parallel capabilities, which it is currently. Two of these requirements are considered essential for effective C2 in the modern land environment.

    a.   **Mobile, lethal, and protected.** A Cbt Bde HQ involved in peer on peer, high-intensity conflict should be mounted in a fighting vehicle. This fighting vehicle should be commensurate with the mounted fighting platform of each of the Cbt Bde. This vehicle will protect the occupant and Cbt Bde capabilities from IDF and small arms. The fighting vehicles within the HQ require weapons to be a fighting force which can defend itself from ground-based attack from a peer enemy. The next generation Land 400 vehicles (IFV and ASLAV replacement) C2 variants are good platforms for this need, but they will require considered CIS installation.[29] Importantly, there should be no CIS equipment that will need to be dismounted from one of the fighting vehicles to operate. All CIS equipment needs to be mounted in racks in the back of the fighting vehicle, the vehicle's racking should be designed purposefully to incorporate future LC4 projects. SATCOM capabilities need to be mounted to the roof of the fighting vehicle, tracking their satellite on the move. If this level of protection and mobility can not be provided to the HQ, and given the threats described, the HQ should be well clear of the FEBA, using 'beyond line of sight' (BLOS) C2 methods. This comes with C2 effectiveness issues, such as lack of proximity of the Bde Comd to his/her subordinates and over-reliance on BLOS bearers without LOS redundancy.

    b.   **Modular.** CIS and other capabilities should be designed and mounted in a modular fashion. When the fighting vehicle reaches a halt in urban terrain, the modern HQ needs the option to rapidly redeploy CIS equipment into buildings to maintain C2 and continue the fight. CIS equipment should be as simple as possible[30], and software defined (SDN) so that racking can be maintained for a long period of time, while also upgraded through software updates and improvements. SDN provide for "easier design, simpler testing strategy, and faster deployment of new protocols and technologies, as well as other systems and paradigms."[31] CIS equipment will be cooled by vehicle based air-conditioning solutions, with modular units able to be removed and co-located with building-based deployments. Modularity will also assist with the varied amphibious

---

[27] Chris Field, *Command and Control,* 20 May 21, accessed 07 Jun 21, www.cove.com.au

[28] The actual C4ISR technical systems are outside of the scope of this brief. Importantly, those future systems, which are vital for effective C2 in the modern battlefield, must nest within the recommendations of this paper.

[29] John Matsumura et al., "Assessing Tracked and Wheeled Vehicles for Australian Mounted Close Combat Operations," (2017).

[30] Simple does not mean not capable. 'Elegant' is also way of describing the type of CIS equipment required.

[31] Gabriel Martins Leal et al., "Empowering Command and Control through a Combination of Information-Centric Networking and Software Defined Networking," *IEEE Communications Magazine* 57, no. 8 (2019), 55. doi:10.1109/MCOM.2019.1800288.

roles each Cbt Bde has been assigned. Without modularity, expensive CIS capabilities will not be able to be used across the spectrum of conflict suggested in the DSR. Modularity is considered essential because of the implication in the DSR that the Australian Army will need to be adaptable and scalable to amphibious operations.[32]

13.   The following are important requirements for the modern Cbt Bde HQ that should be explored by future project managers especially across the Combat Vehicles and Land C4 Directorates:

a.   **Sophisticated signature management.** The Cbt Bde HQ signature management should be at least partially managed by autonomous systems. Sophisticated technology can analyze the spectrum and look for opportunities and gaps within that spectrum, noting the bearers and systems available to it, to transmit data across the tactical and strategic networks to the required user.[33] This type of signature management should be aimed at maximizing C2 network effectiveness while decreasing susceptibility to EW targeting.

b.   **Power.** The nature of the C2 networks required at the Cbt Bde HQ means power will always be an important consideration and requirement. LCD should consider the balance of austerity and maximal effectiveness with the requisite power requirements. Biofuels, solar, hydrogen cells and advanced battery storage solutions are areas that can be explored to reduce reliance on fossil fuels due to their noise, but also due to climate change.

c.   **Camouflage.** IFV C2 variants, and any CIS asset such as satellite bearers should come with customized camouflage options which complement the vehicle's natural colours and the use of natural camouflage and concealment. They should be designed specifically to counter sophisticated satellite based ISR assets, as well as UAS, other aerial and ground based ISR assets. It is recommended that LCD ensure this requirement is part of future CIS projects from early in the capability acquisition process.

14.   **A modern Cbt Bde HQ concept:** A conceptualised understanding of the application of these considerations has been used to design the Cbt Bde HQ in Annex A as an example of a Cbt Bde HQ capability designed to be operable in a modern battlefield against modern threats.

CONCLUSION

15.   Threat force capabilities have grown in scale and lethality in recent years, and technologies in support of space, air, and ground based ISREW, alongside long-range fires, are a particular threat to the Cbt Bde HQ. The Cbt Bde HQ, as it is designed currently is significantly lacking mobility, holds minimal organic protection, and an unsophisticated and poorly exercised signature. This HQ would not be survivable in a high-intensity conflict with a peer threat. It is recommended that AHQ LCD invest in modernizing the Cbt Bde HQ by implementing changes to next generation capabilities to generate a Cbt Bde HQ which is mobile, scalable, protected,

---

[32] Australian Government, *National Defence - Defence Strategic Review*
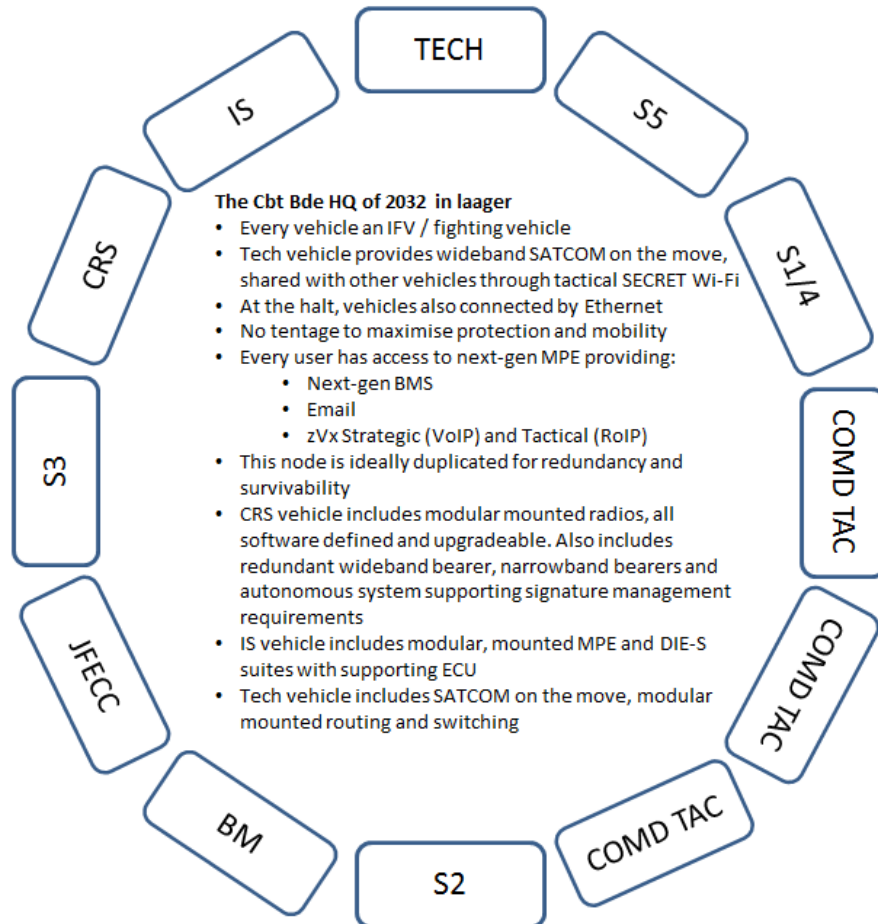[33] Matthew J. Florenzen, Kurt M. Shulkitas and Kyle P. Bair, "Unmasking the Spectrum with Artificial Intelligence," *Joint Force Quarterly* 95, no. 4 (2019), 116.

lethal, camouflaged, modular and which has a sophisticated signature management capability to increase its survivability in conflict.

Annex:
A.   The modern conceptual Cbt Bde HQ in laager

The modern conceptual Cbt Bde HQ in laager[34] - an example capability

The Cbt Bde HQ of 2032 in laager
- Every vehicle an IFV / fighting vehicle
- Tech vehicle provides wideband SATCOM on the move, shared with other vehicles through tactical SECRET Wi-Fi
- At the halt, vehicles also connected by Ethernet
- No tentage to maximise protection and mobility
- Every user has access to next-gen MPE providing:
    - Next-gen BMS
    - Email
    - zVx Strategic (VoIP) and Tactical (RoIP)
- This node is ideally duplicated for redundancy and survivability
- CRS vehicle includes modular mounted radios, all software defined and upgradeable. Also includes redundant wideband bearer, narrowband bearers and autonomous system supporting signature management requirements
- IS vehicle includes modular, mounted MPE and DIE-S suites with supporting ECU
- Tech vehicle includes SATCOM on the move, modular mounted routing and switching

Notes:

1. CRS – the Combat Radion Systems detachment responsible for narrowband radio networks and encryption.

2. IS – Information Systems detachment responsible for the SECRET local area network and access to cloud services.

3. TECH – the telecommunications technician detachment responsible for the wide band bearers and power.

4. S1, S2, S3, S4, BM (Brigade Major), JFECC – fighting vehicles assigned to the members of the Cbt Bde HQ who are executing the control portion of the command function over the Cbt Bde.

5. COMD TAC – a smaller, more combat orientated C2 platform comprising of three fighting vehicles in C2 configuration with associated next generation C4ISR systems. Supports the Bde Comd conducting battlefield circulation in execution of the command function.

---

[34] Laager is a term for a circle of armoured vehicle in a defensive posture. The actual arrangement of these vehicles would be dependent on the tactical situation and terrain, enabled by the local SECRET Wi-Fi and ethernet cabling.

BIBLIOGRAPHY

Alberts, David S. and Richard E. Hayes. *Power to the Edge: Command, Control in the Information Age*. Washington, DC: CCRP Publication Series, 2004.

Ali, Irena and Celina Pascoe. "Taking Power to the Edge with Network Centric Warfare and the New Command and Control: An Australian Perspective." *Australian Defence Force Journal* no. 176 (2008): 34-46.

Australian Government. *National Defence - Defence Strategic Review*. Department of Defence 2023. https://www.defence.gov.au/about/reviews-inquiries/defence-strategic-review.

Australian Government Department of Defence. *Major Changes to Army Announced*. Department of Defence 2023. https://www.defence.gov.au/news-events/news/2023-09-28/major-changes-army-announced.

Clark, Stephen *China launches military observation satellite,* 04 May 2021, accessed 07 Jun 21, https://spaceflightnow.com/2021/05/04/china-launches-military-observation -satellite/

DGTRADOC. "Standard Operating Procedures for the Combat Brigade, Part 2 – the Headquarters of the Combat Brigade." *Forces Command, Australian Army* (2020).

Field, Chris, *Command and Control,* 20 May 21, accessed 07 Jun 21, www.cove.com.au

Florenzen, Matthew J., Kurt M. Shulkitas, and Kyle P. Bair. "Unmasking the Spectrum with Artificial Intelligence." *Joint Force Quarterly* 95, no. 4 (2019): 116.

Hew, Patrick Chisan. "New Paths from Sensor to Shooter: How Digitization can Change the Formability and Topology of Information Flows in Systems that Acquire and Prosecute Targets." *Rockingham, October* (2017).

Królikowski, Hubert. "The use of Unmanned Aerial Vehicles in Contemporary Armed Conflicts – Selected Issues." *Politeja* 19, no. 79 (2022): 17-34.

Leal, Gabriel Martins, Iulisloi Zacarias, Jorgito Matiuzzi Stocchero, and Edison Pignaton de Freitas. "Empowering Command and Control through a Combination of Information-Centric Networking and Software Defined Networking." *IEEE Communications Magazine* 57, no. 8 (2019): 55. doi:10.1109/MCOM.2019.1800288.

Matsumura, John, John Gordon IV, Randall Steeb, Scott Boston, Caitlin Lee, Phillip Padilla, John Parmentola, and RAND Corporation. "Assessing Tracked and Wheeled Vehicles for Australian Mounted Close Combat Operations." (2017).

Norwood, Paul R., Benjamin M. Jensen, and Justin Barnes. "Capturing the Character of Future War." *The US Army War College Quarterly: Parameters* 46, no. 2 (2016): 9.

Ray, Kaushik and William Selvamurthy. "Starlink's Role in Ukraine." *Journal of Defence Studies* 17, no. 1 (2023): 25-44.

Smith, Steven R. "Hide and Seek: 21st Century Battle of Signatures." (2018).

TRADOC G-2. "Worldwide Equipment Guide: Volume 1: Ground Systems." *TRADOC G-2 ACE-Threats Integration Ft. Leavenworth, KS* (Dec, 2016a).

TRADOC G-2. "Worldwide Equipment Guide: Volume 2: Air and Air Defense Systems." *TRADOC G-2 ACE-Threats Integration Ft. Leavenworth, KS* (Dec, 2016b).

Weeden, Brian and Victoria Samson. *Global Counterspace Capabilities: An Open Source Assessment* Secure World
    Foundation Washington, DC, 2018.