





DISTRIBUTED MISSION TRAINING AND ENTERPRISE ARCHITECTURE

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Distributed Mission Training and Enterprise Architecture: Enablers for Secure and Agile Pan-Domain Capability Growth

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DISTRIBUTED MISSION TRAINING AND ENTERPRISE ARCHITECTURE: ENABLERS FOR SECURE AND AGILE PAN-DOMAIN CAPABILITY GROWTH

AIM

1. This service paper presents distinct opportunities for the Canadian Armed Forces (CAF) to improve Force Generation (FG) throughput, raise professional understanding and experiential learning exposure to pan-domain interoperability and further secure these activities from external intelligence collection or characterization by adversaries.¹ The discussion herein and recommendations are directed towards the Vice Chief of the Defence Staff (VCDS), Assistant Deputy Minister (Information Management) and Commander Canadian Joint Operations Command (CJOC) as the responsible L1s, and specifically Director Joint Command and Control Information Systems Force Development (DJC2ISFD) and Canadian Joint Warfare Center (CFWC) as responsible DGs. Simulation and training stakeholders from individual environmental commands will also benefit from the content of this document, specifically regarding the operational function *Generate*.

INTRODUCTION

2. The recently released Pan-Domain Force Employment Concept (PFEC) comprehensively outlines areas where joint planning and capability integration are inadequate for the CAF to meet modern adversarial threats.² It also speaks to the importance of individual members in securing future successes and thus individual and collective training are integral parts of this advancement. The Department of National Defence (DND) and CAF are facing a period of significant reconstitution in both materiel and personnel, unprecedented in recent history, as outlined by the CDS in the summer of 2021.³ Two newer, technology-based communities of practice could assist with this adaptation to the future security environment (FSE). These are Distributed Mission Training (DMT) and the DND/CAF Enterprise Architecture Framework (DNDAF).

CONTEXT

3. It is necessary foremost to briefly define these terms to ensure clarity and accuracy. DMT "introduces high fidelity simulators with visual inputs providing a sense of movement, and the ability to be linked with other simulators, similar and dissimilar aircraft types, as well as the C2 network within a virtual battlespace."⁴ The term Distributed Mission Operations and Federated Simulation(s) have also been used in the past. Canada's principal allies use the term DMT and thus so will this service paper. DMT can also encompass Live, Virtual and Constructed (LVC) forces and these terms are

¹ The topic of this service paper is aligned with question *J.11 Combat Systems Study* from the 2021-2022 JCSP Research Topics List.

² Department of National Defence, Pan-Domain Force Employment Concept, (Ottawa: DND 2021), 7.

³ Chief of Defence Staff Initiating Directive for CAF Reconstitution, 9 July 2021.

⁴ Department of National Defence, Royal Canadian Air Force: Simulation Strategy 2025 (Ottawa: Director Air Simulation and Training, 2015), 4.

regularly used together, however they do not refer to the same concepts. *Live* (i.e. human, living) forces operate in an actual physical battlespace, but are also connected to a synthetic environment and simulation systems (e.g. a HALIFAX class patrol frigate operating in the North Atlantic is also represented in a synthetic environment operating at the same position, course, speed and configuration to virtual forces); Virtual forces refer to humans operating simulators, and thus their tactical actions are taking place in a virtual environment. Finally, Constructed forces refer to computer generated forces that operate and interact according to programmed instructions including randomization when necessary and appropriate. The use of DMT has increased steadily along with simulation in general in DND/CAF, particularly following a number of fleet mid-life upgrades and periods of limited financial resources in the late 2000s. Where DMT has failed to succeed in the CAF is largely in the areas of joint support, governance and changing paradigms and cultures of training efficiency within the various service environments.⁵ Some allies have used policy approaches in the procurement process requiring new capabilities and weapons systems, where simulation is involved, to be acquired as DMT-capable to ensure this interoperability.

4. DMT may also indirectly improve retention. Higher fidelity, experiential and immersive learning can improve member satisfaction and competency-based self-actualization by providing greater confidence in assessment, mutual learning and the outputs of simulation event debriefing. On the other hand, a lack of quality training can lead to feelings of inadequacy and dissatisfaction in military competencies, negatively affecting retention and career or service identity. These experiential gaps lead to increased risk and unpredictability in meeting defence objectives, force generating effective strength, which incrementally reduces the effectiveness of the organization.⁶

5. Enterprise Architecture (EA) is defined as a "collection of strategic information that defines a business, the information and technologies necessary to operate the business, and the transitional processes necessary for implementing new technologies..."⁷ It is a tool with a number of 'views' and sub-views representing the interfaces between strategy, capabilities, operations, systems, along with technical, information and security elements. DND/CAF have been mapping-out these views within DNDAF in *as-is*, and *target* or *to-be* structures since departmental direction was issued in 2008. It is important to reiterate that EA is only a business tool and the quality of the product is directly linked to the accuracy of information mapped. Figures 1 and 2 below provide examples of two of the operational sub-views: the Operational Viewpoint (OV-1) High-Level Operational Concept Graphic, and Common View (CV-1) (in this case the Block IV upgraded CP140M Aurora). Mapping EA views is in itself is a particularly specialized and complex process for which the DND/CAF provide training and comprehensive description and understanding of all views is outside the scope of this service paper. What is important to

⁵ T. M. Verbenkov, "The Future of Joint Training and the Need for a Champion of Simulation in the Canadian Armed Forces" (Joint Command and Staff Program Service Paper, 2021), 5.

⁶ Amanda Huddleston, "Canadian Armed Forces Retention: A Wicked Problem?", (Master's thesis, University of Manitoba, 2021), 1; Office of the Auditor General, *Report 5 Canadian Armed Forces Recruitment and Retention* (Ottawa, 2016), art. 5.15.

⁷ Department of National Defence, *Department of National Defence and the Canadian Forces Architecture Framework (DNDAF) Volume 1: Overview and Definitions*, Ottawa: DND Canada, 2013, 2.

capture is the overwhelming value derived from a comprehensive and accurate EA database and the benefits to interoperability, change management, acquisition support, management of systems complexity and standardized vocabulary, among others.⁸



Figure 1 – Example of an OV-1 High-Level Concept Graphic of a Canada-NATO Intelligence Sharing Network⁹



Figure 2 – Example of a CV-1 of the Upgraded CP140M Aurora (Block IV)

⁸ Ibid.

⁹ Ibid., 20.

6. With these two concepts briefly introduced above, it is easier to understand the positive outcomes enabled by taking advantage of EA in the management and upgrading of existing DMT structures and the design of future DMT capability in the simulation elements of future CAF platforms and organizations. There is incredible potential for growth in conducting various types of collective training, decision making and command and control training and interoperability (joint and combined) training within synthetic systems, using synthetic environments or linking them with real environments, and also building the fidelity of the EA mapping that represent the views and means through which these systems and processes must connect. This service paper will now present the benefits this combination can provide in supporting the CAF readiness for the future security environment.

DISCUSSION AND ANALYSIS

7. The Pan Domain Force Employment Concept (PFEC) specifically outlines a variety of areas where defence and security interests must adapt to the operating environment of the future. Specifically, the emergence of cyber, space and information domains will challenge conventional military planning and capabilities. Maintaining situational awareness, control and assigning threat origin attribution will increase in difficulty as concealment and deception in these domains remains easier for our adversaries, who are held to lesser thresholds of ethics and transparency.¹⁰ Consequently, the principles of *security, agility* and *precision* are regular themes in the PFEC and critical to the operational function of command, and subsequently generate to ensure these foundational principles are learned attributes during education and training.

8. Security is exceptionally important to conceal our FG activities. Live training exercises are increasingly under observation and intelligence collection from our adversaries through the used of space-based surveillance, over the horizon remote-sensing and the consequences of operating in or near commercial airspace which is becoming increasingly congested. Transponders and other radio frequency-based systems used in relative peacetime provide our adversaries with real-time information on our movements globally. For example, the *@mil_radar* TwitterTM profile provides regular updates on NATO maritime surveillance flights in the North Atlantic operating area. During major exercises, adversaries typically manoeuvre surface and air units within effective sensing ranges to collect information on allied tactics, techniques and procedures. DMT safeguards this information by limiting exposure and observation to those internal to the network.

9. *Agility* and *precision* are directly linked to the use of EA to enhance the quality, accuracy and fidelity of DMT training. Training within the closest facsimile to the actual weapon system, for tactical and systems operators, provides better training at the cognitive level in terms of memory, quick reactions, troubleshooting and mutual support to other crew members. In order to achieve the greatest degree of institutional growth and benefit from our training activities outside of live training EA must be applied to all synthetic training, whether stand-alone or connected via DMT. These information

¹⁰ Department of National Defence, *Pan-Domain Force...*, 7.

exchange requirements and connectivity frameworks must be well understood by all participants supporting the technical integration and therefore EA is best suited to provide this capability as an industry accepted format and community of practice. Furthermore, when changes to design are required, configurations are better understood by participants due to the clear, unambiguous nature of the *views* and corresponding diagrams. Table 1 below outlines the comparative differences in conducting training through the use of DMT and the live training equivalents.

Corresponding PFEC Elements ¹¹	Distributed Mission Training	Enterprise Architecture
Improved Security• (1) An Integrated OperationalApproach to act holistically againstthe full array of threats andchallenges;• (11) Modern and CompleteCapability to prevail againstadversaries and operate alongsideour allies and partners as a force ofchoice; and• (14) Comprehensive Resilienceto protect and preserve our capacityfor action.	 Connectivity is provided via a Level II network between training devices, live platforms and C2 elements; Network enclaves provide the additional security required for CANUS, FVEY or NATO training; Capable of supporting client-based enterprise applications (e.g. PEGASUS (FVEY) Chat; and Synthetic environments and synthetic battlespace entities are able to be shared between allies. 	 Provides the framework to identify essential elements of friendly information across multiple domains, capabilities and respondent systems to real or hypothetical threats; Accessible, accepted database and comparable to US and UK, safeguarded from adversaries; Vulnerabilities easier to represent, quantify, isolate and resolve within systems-design; and Vulnerabilities exposed in DMT can inform real-world systems design.
 Improved Agility and Precision (3) Pan-Domain Integration to act with synergy across the entirety of the operational environment; (5) Collaboration with Allies and Partners to detect, understand, and overcome challenges with our collective strength; and (10) Evolved Planning and C2 to enable integration in all its forms and thrive in our environment; 	 Improved training fidelity against both conceptual and practical threats and vulnerabilities across all six domains¹²; Aligns training methods with our closest allies with which we will deploy and operate alongside; C2 Lessons Learned can be applied in both directions (Live to Virtual and vice-versa). 	 Ability to quantify information and systems pathways to predict or 'wargame' threat responses, variables and outcomes; Not limited to CAF, able to map capabilities, systems, etc. to external Whole-of-Gov't approaches with other government departments; and Likely contains sufficient viewpoints to map traditional and evolved C2 concepts.

Table 1 – Selected PFEC	Elements supported	l by DMT and EA
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¹¹ The PFEC identifies 14 elements that address the imperatives of the strategic and operational environment as well as other specific characteristics of the problem. They serve as the conceptual foundation for how the CAF must fight. The elements are interrelated; collectively they provide guidance for all members of the CAF and a unifying vision to work toward. See page 4 of the PFEC for additional information. Element number is in parenthesis.

¹² For example, during a live exercise the simultaneous use of GPS-jamming, radar and communications jamming, and persistent ISR network cyber-attacks would likely be considered too risky for an airborne asset in losing situational awareness. However, the asset participating virtually could face these compounded threats to the point of mission denial, without risks to life, and yet still provide training benefits to live participants who have a peer participant with lost capability, situational awareness, increased vulnerability, etc. and must respond accordingly with ROE, mitigation, mission adaptation, etc.

Supporting the GENERATE function

10. This section will present a more detailed analysis of how DMT supports the operational function of Generate¹³. Generate is also chosen to acknowledge the priority and necessity placed on modernizing all training systems¹⁴, but most critically those which support members from enrollment to reaching the Operational Functional Point (OFP)¹⁵. The principles and benefits of EA presented earlier reinforce this section and must be considered, however they will be less explicitly described for brevity.

11. DMT, as introduced earlier, supports force generation by providing high-fidelity training representative of real-life scenarios particular to primary training audience. This can be live or virtual and involves a network connection between the various participants to share communications, tactical, surveillance and sensor data. This network connection serves to emulate another form of link or interaction between two or more participants and is representative in both design and function to real-world scenarios (i.e. it is not implausible or unrealistic when used). For example, a network connection could serve as a radio frequency (RF), line-of-sight Link 16 connection, sharing a tactical common operating picture between two participant units. At the same time, it could serve as the data connection between a real-world and synthetic environment where both live and *virtual* participants receive the same data (e.g. an airborne maritime helicopter is represented as a radar return and datalink track, annotated accordingly in the live environment for situational awareness). These simulated entities, when performing to the requirements of DMT policy, perform and interact in the same manner as live forces. The benefit of DMT is ability to control a number of variables to deliver the training desired or prescribed and will greatly help the CAF achieve the improved training required to support the PFEC. This is not to say DMT provides training in a *perfect scenario*, but rather certain negative externalities can be reduced such as: cancellations due to weather; blue forces withdrawing from training; operating risks beyond a threshold acceptable for training; impact of exercise tactics on real-world wildlife.¹⁶

12. Live exercises are still required to provide exposure to deployment, sustainment, and personnel issues which cannot be replicated virtually, however DMT provides a far greater suite of training options along the spectrum of conflict to build strong, competent

¹³ The six operational functions are Command, Sense, Act, Shield, Sustain and Generate, and are typically presented in that order based on functional primacy.

¹⁴ Office of the Auditor General, 2016, *Report 5, Canadian Armed Forces Recruitment and Retention*, Ottawa, Article 101; and additionally: 'Once recruited, the Canadian Armed Forces needs to follow through with modern, world-class training that will put new recruits on a solid foundation to succeed. This will require adapting training to meet the highly technical requirements of modern militaries...', see Department of National Defence, *Strong, Secure, Engaged: Canada's Defence Policy* (Ottawa: DND Canada, 2017), 21. ¹⁵ Canadian Armed Forces, *Acting Chief of the Defence Staff Focus Areas*; [Letter to members of the CAF]. March 24, 2021, 4.

¹⁶ An example of this consideration is the use of low-frequency active sonar in a littoral area which has a considerably negative impact on marine mammal (whales, dolphins, porpoises) orientation and buoyancy control leading to beaching and/or death due to asphyxiation.

operators with instinctive behaviours and improved awareness.¹⁷ The ability for exercise controllers to manipulate the scenario, environment and red force reactions in a completely secure setting allows participants to experience the full spectrum of conflict, loss of situational awareness, congested communications, loss of command and control elements, etc., without physical risks to life in peacetime.

13. As mentioned earlier and in the preceding paragraph, it is critical that training equipment reflects reality as it pertains to the training audience. At the tactical level, this requires simulators for aircraft, armoured tanks, surface combatant operator stations, etc. to be as realistic as possible. On the other hand, operational-level and strategic-level training audiences require accuracy in the *functional layout* of their Air Operations Center or Joint Task Force HQ. What is critical in the latter is accuracy in the superior and subordinate connections and networks. For example, an exercise using DMT and oriented towards the command staff of a maritime task force will have communications, datalink and surveillance data connections to live, virtual and possibly constructed forces. These links must absolutely reflect realistic conditions in terms of voice traffic density and RF horizon, jamming and spoofing by enemies, encryption problems and the realities of information exchange requirements between the classified and unclassified systems of various allied countries. EA supports this through accurate, coherent and updated database information accessible to clients using or designing training systems.

14. Developing an accurate EA characterization complements this by ensure the FG activities take place within synthetic environments, communications and network environments and scenarios that reflect real-world information exchange capacities. It serves no purpose to the war-fighter to have surveillance sensor data shared amongst exercise participants if network gateways or encryption limitations would not permit this to occur in the real world. Thus DMT and EA work best when they are mutually respective of each other's truth data, and used to identify, capture and exploit opportunities and resolve deficiencies.

15. It is lastly worth noting the use of DMT will support the efficiency of FG by reducing the burden associated with deployments to live exercises, which stress the logistical functions of many fleets-in-transition for the RCAF and RCN without providing adequate training value (e.g., due to participant withdrawal or unserviceability). While it is necessary to stress-test the ability to deploy and operate, the increasing Force Employment (FE) demands on these same fleets ensures these requirements are frequently applied in both domestic and expeditionary situations.

¹⁷ T. M. Verbenkov, "*The Future of Joint Training*, 3; and Jack P. Landolt, and John R. Evans. "R&D Initiatives in Modelling and Simulation for Capability Modernization of the Canadian Air Force". *Canadian Military Journal*, Spring, 2001, 39.

CONCLUSION

16. DMT and EA are both proven communities of practice, however their initial capital investments required has often been an impediment to successful promotion and implementation compared to tried and true live training. As a result, the CAF has seen more and more problems manifest in environment-based training *silos* and synthetic training devices acquired without interoperability in mind. While the CAF should never consider abandoning physical, live and deployed training exercises, the unintended consequences of operational security, assured participation, weather cancellations and systems failures provide a rationale to invest in DMT as an alternative and controlled approach to generate and develop ready forces, new capabilities pivot training towards the future security environment.

RECOMMENDATIONS

17. Director General Capability and Structure Integration, in concert with Director General Information Management Engineering and Integration, reiterate to all L1s the critical importance of resuming and maintaining regular updates to the DNDAF databases. This is necessary to ensure new capabilities are successfully integrated and capability deficiencies are mitigated or resolved through appropriate design considerations for operational flexibility, obsolescence management, and emergent technology from the defence industry.

18. The two preceding organizations reiterate to component commanders the criticality of providing continuous operational feedback of both successes and failures in joint, combined exercises and operations as a result of systems integration, connectivity, or information exchange requirements and processes, including virtual training events.

19. The Canadian Joint Warfare Center Synthetic Environment Coordination Office (SECO) provide permanent liaison officer to DJC2ISFD to ensure continued sharing of information between the two organizations and identify real-world capabilities that could be advantageously exercised using DMT.

20. The CJWC and CJOC are strongly encouraged to continue engagement with DMT centers of excellence across allied organizations (i.e. NATO, FVEY, etc.) with the goal of expanding the capabilities able to be exercised but also the fidelity and collaboration possible in enhancing the synthetic environment and quality of sensor data.

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