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# A PRAGMATIC APPROACH TO PROCUREMENT: THE USE OF MODULAR OPEN SYSTEMS

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## JCSP 44

## Exercise *Solo Flight*

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# A PRAGMATIC APPROACH TO PROCUREMENT: THE USE OF MODULAR OPEN SYSTEMS

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# A PRAGMATIC APPROACH TO PROCUREMENT: THE USE OF MODULAR OPEN SYSTEMS

Recent years have witnessed both the Canadian Armed Forces (CAF) and Government receiving considerable negative press and public attention concerning a variety of defence procurement programs. Such attention is certainly not unwarranted, as Canadian defence procurement has often struggled to reconcile traditional challenges associated with competing economic, political, and military demands; all of which are now being further exacerbated by emerging technological and security trends.[1] The importance of getting defence procurement right cannot be understated, as the inability to effectively procure and maintain defence capabilities not only threatens to undermine the legitimacy of relevant government and military institutions, but also risks comprising future military operational capability.

The importance placed upon responsible operational and financial stewardship of defence procurements is readily apparent when one considers that the Department of National Defence (DND) manages over $50B worth of machinery, equipment, and vehicles of all types, representing 74 percent of the Federal government total.[2] This is rendered even more salient now given the new defence policy, *Strong, Secure, Engaged* (SSE), calls for $33.8B in new capital projects and an additional $74.2B in funding for pre-existing capital expenditures over the next 20 years.[3] Provided the enduring nature of many of these major defence capital projects, this major recapitalization of the CAF will

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[1] Charles Davis, "Understanding Defence Procurement," *Canadian Military Journal* 15, no. 2 (Spring 2015): 8; Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 4.

[2] Charles Davis, "Understanding Defence Procurement," *Canadian Military Journal* 15, no. 2 (Spring 2015): 7.

[3] Department of National Defence, *Strong, Secure, Engaged: Canada's Defence Policy,* (Ottawa: Department of National Defence, 2017), 101-102. This investment includes 38 Army, Navy, Air Force and Joint capabilities.

have a direct impact on operational capability for decades to come. Therefore it is imperative that the resulting capabilities effectively address the existing requirement, but also facilitate the continued evolution of the CAF in order to adequately address future challenges.

When considering defence procurement, one must also recognize that these activities are conducted in a unique environment characterized by atypical market forces, uncertainty, niche expertise, and risk.[4] The focus of this paper is that these unique challenges are being further aggravated by evolving trends such as changing security requirements, rapid advances in technology, and new defence related market dynamics. As costs associated with custom defence solutions continue to escalate and militaries become increasingly reliant on networking information technologies (IT), a new paradigm is emerging which is challenging traditional defence procurement models.[5] This approach looks towards leveraging commercial IT trends and market forces in a more "open" manner in order to gain access to near-continuous innovation and facilitate incorporation of new technologies, all while reducing costs. These open models offer the promise of significantly reducing integration risks and life cycle costs, while concurrently

[4] Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 4; Charles Davis, *Competition in Defence Procurement: The Popular Choice, But Not Always the Right One* (Ottawa: Conference of Defence Associations Institute, December 2015), 5.

[5] David L. Kirkpatrick, "Trends in the costs of weapon systems and the consequences," *Defence and Peace Economics* 15, no. 3 (June 2004): 263; Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 220.

increasing operational adaptability through enhanced flexibility within procurement and life-cycle processes.[6]

While the 2014 Defence Procurement Strategy (DPS) sought to address multiple well-established issues related to procurement oversight, timelines, and economic development, it failed to fully recognize many of the emerging issues and potential opportunities listed above.[7] In contrast, procurement reviews and studies by a number of allies have all recently advocated both business and technical aspects of open systems as instruments to address many of these concerns as part of their corresponding procurement strategies.[8] For example, the United States Department of Defence (DoD) modular open system approach (MOSA) has been mandated within all future projects with the explicit aim to design systems "with highly cohesive, loosely coupled, and severable modules that can be competed separately and acquired from independent vendors".[9] The aim of this paper is to demonstrate that MOSA represents a pragmatic business and technical

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[6] Brendan Sims, *Approaches to Open Technology System Specification* (Edinburgh: Defence Science and Technology Organisation), 1; John F.Schank, Scott Savitz, Ken Munson, Brian Perkinson, James McGee and Jerry M. Sollinger, *Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs (*Santa Monica, California: RAND Corporation, 2016), iii; Real-time Innovations, "The UK MOD Generic Vehicle Architecture: A compelling case for Interoperable Open Architecture," last accessed 22 March 2018. https://cdn2.hubspot.net/hubfs/1754418/Collateral_2017/Whitepapers/Generic_Vehicle_Architecture_50010.pdf, 5-6.

[7] Public Works and Government Services Canada*, Defence Procurement Strategy,* 23 September 2016, https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/samd-dps/index-eng.html.

[8] Brendan Sims, *Approaches to Open Technology System Specification* (Edinburgh: Defence Science and Technology Organisation), 1; Ministry of Defence. *System of Systems Approach (SOSA) Open System Strategy*, 18 January 2018, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66098/sosa_open_sys_strategy_nov12.pdf; Joyce L. Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 217. Open systems have recently been advocated within studies and white papers by the United Kingdom, United States, and Australia.

[9] Office of the Deputy Assistant Secretary of Defence, *System Engineering – Initiatives – Modular Open Systems Approach*, last modified 07 October 2017, https://www.acq.osd.mil/se/initiatives/init_mosa.html; Cyrus Azani, "A Multi-Criteria Decision Model for Migrating Legacy System Architectures into Open System and System-of-System Architectures," *Defence Acquisition Research Journal* 16, no. 3 (Nov 2009): 322. MOSA is now mandated as part of all future DoD projects as articulated within Better Buying Power (BBP) 3.0, Department of Defense Instruction 5000.01, and the Defense Acquisition Guidebook.

approach to addressing defence procurement within the context of the evolving security environment; while not a panacea, it could represent a viable and effective instrument as part of a comprehensive Canadian defence procurement strategy.

This argument will be developed in three parts; it will commence with a brief survey of contemporary defence procurement challenges, many of which are not explicated, not adequately addressed as part of current Canadian DPS. Second, key concepts, principles, and benefits of MOSA will be introduced through evaluation of existing allied policy and case studies, demonstrating its ability to address a number of current and emerging procurement issues. Finally, potential implementation of MOSA within the Canadian defence context will be analyzed, illustrating the significant congruency or even synergistic effects with the three objectives outlined within the DPS: delivering the right equipment to the CAF, leveraging purchases to create jobs and economic growth in Canada, and streamlining defence procurement processes.

## DRIVERS FOR CHANGE

While it is acknowledged that flaws within Canada's defence procurement process leading to project delays and cost overruns are a "perennial burden on both government and industry", the scope of the current paper is to emphasize the effect of more recently emerging challenges.[10] When considering the procurement of military capabilities, it is important that one looks beyond the initial acquisition of a specific platform or capability, adopting a view that reflects the broader material management framework up to and including capability disposal. This is crucial for two reasons. First is that a significant portion of the life cycle costs will be incurred as a result of the maintenance and operation

[10] Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 1; Ross Fetterly, *Implementing Strong, Secure, Engaged: The Challenges Ahead* (Calgary: Canadian Global Affairs Institute, January 2018), 3.

of a capability and therefore, as mandated by the Treasury Board, must be accounted for as part of any estimate.[11] Second, based on recent trends, the management of any military platform must permit and incorporate elements of system evolution, technology refresh, and obsolescence management as a means to address on evolving operational requirements throughout its lifespan.[12]

The importance of enabling capability evolution becomes particularly salient given that the "CAF typically operate their major platforms for a very long time."[13] This fact is clearly illustrated given the status of many major CAF platforms, such as the Sea King, Aurora, Hornets, and Halifax-class Frigates, which are all still in service after three decades and well beyond their intended lifespans. Such a trend is further exacerbated by the fact that the procurement process itself can add an additional 10 to 15 years between identification of requirements and delivery; meaning that a defined requirement from identification could be expected to remain relevant for as much as half a century if no planned upgrade is incorporated.[14] The decisions behind such long lifespans are certainly rational given that many of these capabilities come with a significant cost; however, the difficulty comes in that such platforms do not operate in a static environment. Often the "only constant is change," with operational requirements evolving in response to diverse

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[11] Charles Davis, "Understanding Defence Procurement," *Canadian Military Journal* 15, no. 2 (Spring 2015): 6-7; Treasury Board of Canada, *Policy on Management of Materiel*. Ottawa: Treasury Board of Canada, 2006, https://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=12062.

[12] Cyrus Azani, "A Multi-Criteria Decision Model for Migrating Legacy System Architectures into Open System and System-of-System Architectures," *Defence Acquisition Research Journal* 16, no. 3 (Nov 2009): 322.

[13] Charles Davis, *Competition in Defence Procurement: The Popular Choice, But Not Always the Right One* (Ottawa: Conference of Defence Associations Institute, December 2015), 14.

[14] Alan S. Williams, *Reinventing Canadian Defence Procurement: A View from the Inside* (Montreal: McGill-Queen's University Press, 2006), *23;* Department of National Defence. *Perspectives on the Capital Equipment Acquisition Process* (Ottawa: Department of National Defence, 2006), B1.

and ever-changing missions, threats, operating environments, and defence policy.[15] For this reason, the rationale to include the capacity to adapt and adjust platform capabilities to maintain relevance in an environment of change is undeniable.

Adaptation becomes even more important when one considers the pace at which technology is evolving. Recent history has witnessed a near exponential increase in computing and networking capabilities, a trend which is fully anticipated to continue as suggested by concepts such as Moore's Law and Butter's Law which argue computing and communications capacity double every 24 and 9 months respectively.[16] Such pressure manifests itself in two ways. The most critical of these is through an operational imperative to adapt; being that "the outcome of military operations is determined largely by the relative performance of the equipment deployed."[17] Therefore, even relatively small innovations in technology can have a significant impact on effectiveness and thus serve as a major enabling factor contributing to success.[18] The second imperative is

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[15] Stephen P. Welby, "Modular Open Systems Architecture in DoD Acquisition," *17th Annual NDIA Systems Engineering Conference* (Springfield, V.A. 29 October 2014) https://www.acq.osd.mil/se/briefs/16943-2014_10_29_NDIA-SEC-Welby-MOSA-vF.pdf; Ross Fetterly, *Implementing Strong, Secure, Engaged: The Challenges Ahead* (Calgary: Canadian Global Affairs Institute, January 2018), 1; John F.Schank, Scott Savitz, Ken Munson, Brian Perkinson, James McGee and Jerry M. Sollinger, *Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs (*Santa Monica, California: RAND Corporation, 2016), iii.

[16] MIT Technology Review, "Moore's Law is Dead. Now What?" Last accessed 2 April 2018, https://www.technologyreview.com/s/601441/moores-law-is-dead-now-what/; Vin Crosbie, "Butter's Law acting on Media," *Digital Deliverance*, last accessed 28 April 2018, http://www.digitaldeliverance.com/2015/01/14/butters-law-acting-on-media/. Moore's law is based on the observation that the number of transistors per square inch on integrated circuits has doubled every year since invention, corresponding to a corresponding increasing in processing capacity. While the realities of finite space on current integrate chips provides a challenge to this trend into the future, emerging technologies such as quantum computing continue to provide significant promise for continues growth in processing capabilities. Butter's law is based on photonics and stipulates that the speed at which information can be communicated through fiber optic circuits has been and will continue to double every nine months.

[17] David L. Kirkpatrick, "Trends in the costs of weapon systems and the consequences," *Defence and Peace Economics* 15, no. 3 (June 2004): 259; Department of National Defence. *The Future Security Environment 2013–2040* (Ottawa: Chief of Force Development, 9 August 2013): 64.

[18]Department of National Defence. Department of National Defence, B-GA-400/FP-001, *Canadian Armed Forces Air Doctrine* (Trenton: Canadian Forces Aerospace Warfare Centre, 2016), 15.

societal, in that most Western liberal societies expect their forces to suffer fewer losses during conflict largely by leveraging technological superiority; thus increasing the emphasis on "technology-driven solutions" as opposed to conventional boots on the ground or employment of obsolete designs.[19] As a result of these pressures and the relative pace of technology relative to the lifespan of most platforms, the reality is that any given system must undergo at least one, or more likely multiple, upgrades during its lifetime. Such an argument is clearly supported by the extensive list of system life extension and upgrade projects listed as part of the current Canadian Defence Acquisition Guide (DAG).[20]

Concerns regarding maintenance of technological superiority are at the heart of recent procurement reviews and programs.[21] A key reason for this is that the acquisition of new platforms as a means of maintaining a technical edge is becoming increasingly cost prohibitive. Analysis across multiple weapon classes has demonstrated that per unit costs have increased significantly faster than the rate of general inflation or contemporary Gross Domestic Products, in many cases at rates exceeding 5-10 percent per year or higher for technologically intensive capabilities.[22] Such trends have served to decrease the purchasing power for defence capital equipment, progressively rendering platform replacement a less viable option. Most nations simultaneously recognize that full

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[19] Tom Jenkins, "Canada First: Leveraging Defence Procurement through Key Industrial Capabilities," Report of the Special Adviser to the Minister of Public Works and Government Services (Ottawa: PWGSC, February 2013): xiv; David L. Kirkpatrick, "Trends in the costs of weapon systems and the consequences," *Defence and Peace Economics* 15, no. 3 (June 2004): 261.

[20] Department of National Defence, *Defence Acquisition Guide 2016,* http://www.forces.gc.ca/en/business-defence-acquisition-guide-2016/index.page.

[21] Frank Kendall. *Better Buying Power 3.0 – White Paper* (Washington: Office of the Under Secretary of Defense, September 2014), 1; Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security* (London: Ministry of Defence, 2012), 8-10.

[22] David L. Kirkpatrick, "Trends in the costs of weapon systems and the consequences," *Defence and Peace Economics* 15, no. 3 (June 2004): 263, 270; Ross Fetterly, "Shaping Future Procurement Strategies through Canadian Defence Procurement Reform," in *National Approaches to Shipbuilding and Ship Procurement*, edited by Douglas L. Bland, 47-69 (Kingston: Queen's University, 2010), 55.

withdrawal from many weapon or platform classes is not palatable as this would render them unable to effectively undertake the full range of military options, something manifestly at odds with Canada's current defence policy.[23] For this reason, the contemporary defence environment has begun witnessing fewer new-start programs in favour of service life extension and modernization programs; a shift recent defence procurement reviews fully expect to continue for the foreseeable future.[24]

Traditionally, this natural response to extend the service life of a given platform, thus slowing the replacement cycle also comes with its own set of costs, both fiscal and operational. Fiscally, such extensions typically result in increased maintenance demands and higher costs associated with the limited availability of obsolete parts.[25] Operationally, this manifests itself through reduced platform availability combined with decreased capability in comparison to more modern adversary capabilities.[26] Such concerns could potentially be mitigated through appropriate obsolescence management or capability upgrades, however, this was not always a simple solution. In many cases, traditional service extensions involving upgrades often meant significant non-recurring work or engineering solutions, physical reconfiguration, or in some cases pre-existing physical or

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[23] Department of National Defence, *Strong, Secure, Engaged: Canada's Defence Policy,* (Ottawa: Department of National Defence, 2017), 13; David L. Kirkpatrick, "Trends in the costs of weapon systems and the consequences," *Defence and Peace Economics* 15, no. 3 (June 2004): 270.

[24] Tom Jenkins, "Canada First: Leveraging Defence Procurement through Key Industrial Capabilities," Report of the Special Adviser to the Minister of Public Works and Government Services (Ottawa: PWGSC, February 2013): x; Stephen P. Welby, "Modular Open Systems Architecture in DoD Acquisition," *17th Annual NDIA Systems Engineering Conference* (Springfield, V.A. 29 October 2014) https://www.acq.osd.mil/se/briefs/16943-2014_10_29_NDIA-SEC-Welby-MOSA-vF.pdf.

[25] David L. Kirkpatrick, "Trends in the costs of weapon systems and the consequences," *Defence and Peace Economics* 15, no. 3 (June 2004): 270.

[26] Edward Keating and Mathew Dixon, "Investigating Optimal Replacement of Aging Air Force Systems," *Defence and Peace Economics* 15, no. 5 (2004), 427, 429; David L. Kirkpatrick, "Trends in the costs of weapon systems and the consequences," *Defence and Peace Economics* 15, no. 3 (June 2004): 270.

system architecture simply limited the potential modernization options.[27] A proposed solution to this has been the systematic decomposition of higher level systems into their constituent sub-systems or modules.[28] From a technical standpoint, modular design decouples platforms from their resident capabilities, facilitating spiral development and incorporation of future technology without significant re-design or engineering.[29] The net outcome being the ability to maintain capability, while simultaneously decreasing life-cycle costs.[30]

Equally as important as the means by which these capabilities are integrated, are the sources of these innovations and emerging technologies. No longer are governments and militaries the "dominant source of technological innovation that they once were," instead the private sector and academia are anticipated to continue dominating the forefront of most technological-advanced domains.[31] Moreover, it has been argued that this expanding "rate-of-change gap in technology" between the traditional defence industry and commercial offerings is the direct result of inefficiencies resulting from the

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[27] Charles Davis, "Understanding Defence Procurement," *Canadian Military Journal* 15, no. 2 (Spring 2015): 9; John F.Schank, Scott Savitz, Ken Munson, Brian Perkinson, James McGee and Jerry M. Sollinger, *Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs (*Santa Monica, California: RAND Corporation, 2016), xi.

[28] Arthur Ollett and John Coleman, "Break the stove-piped stranglehold on capability with an open system approach," *Journal of Battlefield Technology* 18, no. 3 (December 2015): 18.

[29] VICTORY Standards Support Office, "Vehicular Integration for C4ISR/EW Interoperability," last accessed 7 April 2018, https://www.victory-standards.org/; Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 220; Real-time Innovations, "Interoperable Open Architecture: MOD and DoD – architecting for interoperability," last accessed 22 March 2018. https://info.rti.com/hubfs/whitepapers/Interoperable_Open_Architecture.pdf, 2.

[30] Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 220; Frank Kendall. *Better Buying Power 3.0 – White Paper* (Washington: Office of the Under Secretary of Defense, September 2014), 2.

[31] Bernd Horn and Peter Gizewski, *Towards the Brave New World: Canada's Army in the 21st Century* (Kingston, Ontario: Directorate of Land Strategic Concepts, 2003), 104; Department of National Defence. *The Future Security Environment 2013–2040* (Ottawa: Chief of Force Development, 9 August 2013): 65; Frank Kendall. *Better Buying Power 3.0 – White Paper* (Washington: Office of the Under Secretary of Defense, September 2014), 2.

traditional government-driven defence innovation processes, in comparison to the rapid technology cycles in the competitive commercial sector.[32] These inefficiencies are often the result of overly detailed and constraining specifications and requirements, which serve to stifle the natural course of industry research and innovation. This is made worse by the often delayed and ad hoc nature of defence industry engagement, resulting in the creation of unrealistic, costly, and misaligned requirements and expectations.[33] As the sole customer for many of these industries, it is ultimately the government who then assumes most of the risk and cost for defence research and development, while the firms themselves also suffer in that they maintain little autonomy in choosing their own technological trajectory.[34] If the CAF is to effectively leverage the commercial sector and other non-conventional sources of innovation as a means to combat obsolescence while maximizing the benefits of technological change, it will require a shift away from traditional methods. This will have to include more "agile and flexible military procurement strategies" capable of leveraging commercial markets, while requiring shorter "capability planning cycles with modular sub-systems."[35]

When comparing the traditional defence market framework against more free market structures, another key differentiating factor and often point of contention is the apparent lack of competition. The "features of the weapons acquisition process lead to a

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[32] Real-time Innovations, "Interoperable Open Architecture: MOD and DoD – architecting for interoperability," last accessed 22 March 2018. https://info.rti.com/hubfs/whitepapers/Interoperable_Open_Architecture.pdf, 8.

[33] Dave Perry, *Putting the 'Armed' Back into the Canadian Armed Forces: Improving Defence Procurement in Canada* (Ottawa: Conference of Defence Associations Institute, January), 11; Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 227.

[34] Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 218 Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 3-4

[35] Department of National Defence. *The Future Security Environment 2013–2040* (Ottawa: Chief of Force Development, 9 August 2013): 66-67.

non-conventional market system," characterized by the presence of too few buyers and sellers to foster true competition.[36] This is further exacerbated by a combination of long-term in-service support contracting frameworks which emphasize single points of authority, and existing intellectual property and proprietary standards approaches; all of which combine to create "vendor-lock".[37] This situation has created significant tension within segments of Canadian industry, having the unintended consequence of inhibiting competition and freezing out many potential competitors to most aspects of the supply chain for the lifespan of the capability.[38] This lack of competition is likely one reason why the expenses associated with many military systems have far outpaced similar civilian counterparts.[39] Thus it has been argued that military use of commercial sources may provide the corresponding free market benefits of competition, reduced cost, and transfer of product development risk to potential sellers.[40]

Emerging trends are significantly challenging western defence procurement. Rapidly escalating costs are proving cost-prohibitive in terms of platform replacement, while platform life-extensions come with their own fiscal, operational, and obsolescence costs. Coincident with these trends, the operational and societal imperatives to adapt and

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[36] Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 1, 4.

[37] Dave Perry, *Putting the 'Armed' Back into the Canadian Armed Forces: Improving Defence Procurement in Canada* (Ottawa: Conference of Defence Associations Institute, January), 13; Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 3 stone; Charles Davis, "Understanding Defence Procurement," *Canadian Military Journal* 15, no. 2 (Spring 2015): 9; Department of Defence. *Defence Acquisition Guidebook 2017,* Last updated 26 February 2017, https://www.dau.mil/tools/dag, 25.

[38] Industry Canada, *Beyond the Horizon: Canada's Interests and Future in AEROSPACE: Aerospace Review Volume 1* (Ottawa; Industry Canada, November 2012), 1; Tom Jenkins, "Canada First: Leveraging Defence Procurement through Key Industrial Capabilities," Report of the Special Adviser to the Minister of Public Works and Government Services (Ottawa: PWGSC, February 2013): xii.

[39] Mark Arena *et al. Why has the Cost of Navy Ships Risen? A Macroscopic Examination of the Trends in U.S. Naval Ship Costs Over the Past Several Decades* (Santa Monica, CA: RAND, 2006), 1.

[40] Clayton K.S. Chun, *Aerospace Power in the Twenty-First Century: A Basic Primer* (Colorado Springs, CO, Maxwell AFB, AL: United States Air Force Academy in cooperation with Air University Press, 2001), 316; Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 223.

maintain a modern force have persisted, creating a situation whereby militaries must adapt their approach to materiel and capability management. For these reasons the traditional approaches leveraging large defence contractors in isolation are losing relevance, particularly given that the preponderance of technological innovation is now occurring outside these institutions. While the Canadian procurement system has largely failed to keep pace with this rapidly evolving problem space, many of these issues are not unique to Canada. Several close allies have been more proactive in addressing these challenges, and in doing so generating early lessons that can be leveraged by Canada in adapting its own approach.

## A MODULAR OPEN SYSTEMS APPROACH

Given the inherent technical and business nexus to many of these issues, no viable solution could be developed by defence officials in isolation. Rather, collaborative approaches were deliberately undertaken by the Australian DoD, US DoD, and UK Ministry of Defence (MoD), sponsoring studies in partnership with both industry and academia; much of this work advocating for the benefits of more open technical and business practices.[41] As a direct result, the last decade has witnessed the emergence of a number of significant MOSA initiatives relating to military architecture and procurement, all with the common theme of leveraging the potential technical and cost benefits associated with more open approaches.

[41] Arthur Ollett and John Coleman, "Break the stove-piped stranglehold on capability with an open system approach," *Journal of Battlefield Technology* 18, no. 3 (December 2015): 17; Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 217.

With respect to system design, System Engineering (SE) ultimately establishes the "technical framework for delivering material capabilities to the warfighter."[42] Within the current context, the term *system* will primarily be used to refer to a military platform. A fundamental approach within SE is to initially define the architecture of any given system, being its constituent components, connections, and rules or processes that enable operation. In adopting this approach, systems can then be decomposed into a number of modular subsystems and corresponding external and internal interfaces.[43] *Open systems* rely on SE processes that stress modularity and the corresponding functional analysis and identification of key interfaces between self-contained modules or sub-systems.[44] These key interfaces then become candidates for defence mandated open standards, which ultimately serve as the cornerstone for any open architecture. Open standards are "well-defined, consensus-based and non-proprietary standards of sufficient maturity to be widely accepted and used by competing vendors and system developers."[45] Such standards should be open to change through collaboration while removing barriers to implementation by third parties, their ultimate aim being to reduce the "risks associated with integration and interoperability with new systems and components."[46]

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[42] Department of Defence. *Defence Acquisition Guidebook 2017,* Last updated 26 February 2017, https://www.dau.mil/tools/dag, 1.

[43] Joyce L. Tokar, "A Comparison of Avionics Open System Architectures." *ALET* 26, no. 2 (December 2016): 22; Arthur Ollett and John Coleman, "Break the stove-piped stranglehold on capability with an open system approach," *Journal of Battlefield Technology* 18, no. 3 (December 2015): 18.

[44] John F.Schank, Scott Savitz, Ken Munson, Brian Perkinson, James McGee and Jerry M. Sollinger, *Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs (*Santa Monica, California: RAND Corporation, 2016), xi; Ministry of Defence. *Defence Standard 23-009 Part 0 Issue 4.* 03 October 2016. https://www.dstan.mod.uk/StanMIS/Indexes/DefenceStandardDownload/4925?seriesId=20, 2-5.

[45] Brendan Sims, *Approaches to Open Technology System Specification* (Edinburgh: Defence Science and Technology Organisation), 3.

[46] Ministry of Defence. *Defence Standard 23-009 Part 0 Issue 4.* 03 October 2016. https://www.dstan.mod.uk/StanMIS/Indexes/DefenceStandardDownload/4925?seriesId=20, 2-5; Ministry of Defence. *System of Systems Approach (SOSA) Open System Strategy*, 18 January 2018, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66098/sosa_open_sys_strate

Consistent with these SE concepts, the US DoD defines an open system as "a technical architecture that adopts open standards supporting a modular, loosely coupled and highly cohesive system structure that includes publishing of key interfaces within the system and full design disclosure."[47] From a technical perspective, open architectures:

> …enable easier integration of properly engineered modules across a wide range of systems, effective reconfiguration and reintegration into joint warfighting and system of systems constructs, successful exchange of information and services with other modules on local and remote systems, and more affordable and quicker adaptation to evolving needs and technologies.[48]

By reducing integration risk and alleviating the requirement for platform specific non-recurring engineering requirements it significantly reduces the upgrade development cycle; thus facilitating more efficient modification and upgrade of existing capabilities in response to changing requirements.[49] In doing so, this not only allows for more efficient technology refresh and obsolescence management through more effective assimilation of emerging technology, but it has the potential of dramatically increasing access to new innovative commercial off-the-shelf (COTS) technology from third-party vendors that now have access to published open standards.[50] Additionally, by essentially divorcing

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gy_nov12.pdf; Brendan Sims, *Approaches to Open Technology System Specification* (Edinburgh: Defence Science and Technology Organisation), 3.

[47] Nickolas Guertin and Thomas Hurt, "DoD Open Systems Architecture Contract Guidebook for Program Managers: A Tool for Effective Competition," *Defence AT&L,* September-October 2013: 32.

[48] Cyrus Azani, "A Multi-Criteria Decision Model for Migrating Legacy System Architectures into Open System and System-of-System Architectures," *Defence Acquisition Research Journal* 16, no. 3 (Nov 2009): 324.

[49] Brendan Sims, *Approaches to Open Technology System Specification* (Edinburgh: Defence Science and Technology Organisation), 2; Joyce L. Tokar, "A Comparison of Avionics Open System Architectures." *ALET* 26, no. 2 (December 2016): Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security* (London: Ministry of Defence, 2012), 22; Joyce Tokar, "An Examination of Open System Architectures for Avionics Systems – An Update," Paper presented at *Air Force FACE Technical Interchange Meeting,* Dayton, OH, March 2017, 6.

[50] James Ash and Willie McFadden II, "Open Systems: Designing and Developing our Operational Interoperability," *Defence AR Journal* 17, no. 1 (2010): 113; Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 220; Ministry of Defence. *System of Systems Approach (SOSA) Open System*

specific sensors or capabilities from the platform itself, modular elements can be recombined or added towards new cohesive purpose providing enhanced flexibly and adaptability within existing systems or platforms.[51]

In addition to the technical aspects, open system approaches also inherently increase competition while concurrently "leveraging the collaborative innovation potential of numerous participants across the enterprise, permitting shared risk, maximized asset reuse, and reduced total ownership costs."[52] Through the effective removal of barriers to third parties, open systems largely mitigate many of the issues associated with vendor lock-in and thus re-introduce traditional competitive market forces and downward pressure on otherwise inflated costs.[53] This not only provides the potential to significantly reduce life-cycle costs associated through the lowered cost of the modular components themselves by virtue of increased competition, but common interfaces and modularity also decrease design, engineering and installation costs typically associated with these projects.[54] Moreover, if common interfaces are designed across multiple

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*Strategy*, 18 January 2018, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66098/sosa_open_sys_strategy_nov12.pdf

[51] Arthur Ollett and John Coleman, "Break the stove-piped stranglehold on capability with an open system approach," *Journal of Battlefield Technology* 18, no. 3 (December 2015): 17-18.; Cyrus Azani, "A Multi-Criteria Decision Model for Migrating Legacy System Architectures into Open System and System-of-System Architectures," *Defence Acquisition Research Journal* 16, no. 3 (Nov 2009): 325; Joyce L. Tokar, "A Comparison of Avionics Open System Architectures." *ALET* 26, no. 2 (December 2016): 6.

[52] United States Navy. *United States Fact File – Open Systems Architecture*. Last modified 18 December 2013. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=450&ct=2.

[53] Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security* (London: Ministry of Defence, 2012), 22. Arthur Ollett and John Coleman, "Break the stove-piped stranglehold on capability with an open system approach," *Journal of Battlefield Technology* 18, no. 3 (December 2015): 17-18.

[54] John F.Schank, Scott Savitz, Ken Munson, Brian Perkinson, James McGee and Jerry M. Sollinger, *Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs (*Santa Monica, California: RAND Corporation, 2016), 74.

related platforms, re-use of common components and solutions can be more quickly and efficiently implemented across multiple fleets.[55]

Given the advantages presented by open systems, multiple nations have recently implemented MOSA programs and policies to varying extents. The current state of MOSA in the US began with the establishment of the Open Systems Joint Task Force in the late 1990's by the Office of the Secretary of Defence.[56] At present, MOSA is captured under a number of closely related policies, beginning with Better Buying Power 3.0 which provides specific guidance reference innovation, technical excellence and promotion of competition while highlighting the importance of open systems approaches.[57] This direction is further reinforced within a number of DoD Directives and Instructions pertaining to the Defence Acquisition system, which outline and mandate the employment of MOSA as a part of all projects and programs as a means to "optimize total system performance and minimize total ownership costs."[58] It is important to note that the "openness" of a system is not binary, but rather various aspects may be open or closed to varying degrees as outlined in the DoD Open Systems Architecture Contract

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[55] Department of Defence. *Defence Acquisition Guidebook 2017,* Last updated 26 February 2017, https://www.dau.mil/tools/dag, 24; Brendan Sims, *Approaches to Open Technology System Specification* (Edinburgh: Defence Science and Technology Organisation), 3.

[56] James Ash and Willie McFadden II, "Open Systems: Designing and Developing our Operational Interoperability," *Defence AR Journal* 17, no. 1 (2010): 113; John F.Schank, Scott Savitz, Ken Munson, Brian Perkinson, James McGee and Jerry M. Sollinger, *Designing Adaptable Ships: Modularity and Flexibility in Future Ship Designs (*Santa Monica, California: RAND Corporation, 2016), 9.

[57] Frank Kendall. *Better Buying Power 3.0 – White Paper* (Washington: Office of the Under Secretary of Defense, September 2014), 2; Department of Defence. *Open System Architecture – Contract Guidebook for Program Managers,* v.1.1 (Washington D.C.: Department of Defence, June 2013), ix-x. BBP 3.0 is developed and implemented by the Undersecretary of Defense (Acquisition, Technology and Logistics).

[58] Office of the Deputy Assistant Secretary of Defence, *System Engineering – Initiatives – Modular Open Systems Approach*, last modified 07 October 2017, https://www.acq.osd.mil/se/initiatives/init_mosa.html. DoD Directive 5000.01 – The Defense Acquisition System, and DoD Instruction 5000.02 – Operation of the Defense Acquisition System, mandate the employment of MOSA as a part of all future US acquisition programs.

Guidebook, which provides additional guidance on contracting, data rights, and system design processes for open systems.[59]

The DoD is now actively pursuing MOSA in the life-cycle activities of its "Major Defense Acquisition Programs" and "Major Automated Information Systems", while the US Army, Navy and Air Force have also begun implementation of their own MOSA strategies and roadmaps.[60] The US is not alone in pursuing such initiatives, a recent UK White Paper also emphasized "modular approaches, based around packages of incremental development, that lend themselves to efficient and effective technology insertion, making use of open standards and architectures..."[61] The UK has further articulated such objectives within its System of Systems Open System Strategy and has begun implementation of MOSA as part of the both the New Generation Submarine Command System and the General Vehicle Architecture for Land Vehicles.[62]

Both the US and UK programs utilize closely linked technical and business approaches based on a number of central principles in order to facilitate their respective MOSA strategies. These tenets aim to combine a "vibrant business strategy" with an

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[59] *Ibid.* Further direction regarding the application of MOSA approaches and contracting direction are outlined as part of the DoD Open Systems Architecture Contract Guidebook for Program Managers.

[60] Cyrus Azani, "A Multi-Criteria Decision Model for Migrating Legacy System Architectures into Open System and System-of-System Architectures," *Defence Acquisition Research Journal* 16, no. 3 (Nov 2009): 322; Office of the Deputy Assistant Secretary of Defence, *System Engineering – Initiatives – Modular Open Systems Approach*, last modified 07 October 2017, https://www.acq.osd.mil/se/initiatives/init_mosa.html

[61] Ministry of Defence, *National Security through Technology: Technology, Equipment, and Support for UK Defence and Security* (London: Ministry of Defence, 2012), 22; Ministry of Defence. *Defence Standard 23-009 Part 0 Issue 4.* 03 October 2016. https://www.dstan.mod.uk/StanMIS/Indexes/DefenceStandardDownload/4925?seriesId=20, 2-5.

[62] Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security* (London: Ministry of Defence, 2012), 22; Ministry of Defence. *System of Systems Approach (SOSA) Open System Strategy*, 18 January 2018, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66098/sosa_open_sys_strategy_nov12.pdf.

"end-to-end, integrated perspective of the technical activities and processes across the system life-cycle."[63] These include:

> …modular designs based on standards, with loose coupling and high cohesion; enterprise investment strategies, based on collaboration and trust; transformation of the life cycle sustainment strategies for software intensive systems through proven technology insertion; dramatically lower development risk through transparency of system designs, continuous design disclosure, and Government, academia, and industry peer reviews; and the strategic use of data rights to ensure a level competitive playing field and access to alternative solutions and sources, across the life cycle.[64]

The achievement of these principles and the real test for all MOSA initiatives is whether multiple suppliers or third parties can offer similar or improved capabilities and have these modules easily integrated within the larger system. In accomplishing this task, MOSA serves as an enabler towards increasing innovation, reducing life-cycle costs, and enabling more agile technology insertion and obsolescence management through enterprise collaboration, industry competition, and streamlined integration resulting from effectively coupled business and technical strategies.[65]

While many of these initiatives remain relatively nascent, multiple projects including VICTORY (US Army), Future Airborne Capability Environment - FACE (US Navy), Generic Vehicle Architecture - GVA (UK), Open System Approach - OSA (US Air Force) among many others, are already beginning to yield early signs of progress.[66]

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[63] Department of Defence. *Open System Architecture – Contract Guidebook for Program Managers,* v.1.1 (Washington D.C.: Department of Defence, June 2013), 1; Department of Defence. *Open System Architecture – Contract Guidebook for Program Managers,* v.1.1 (Washington D.C.: Department of Defence, June 2013), iii.

[64] Department of Defence. *Open System Architecture – Contract Guidebook for Program Managers,* v.1.1 (Washington D.C.: Department of Defence, June 2013), iii.

[65] Department of Defence. *Defence Acquisition Guidebook 2017,* Last updated 26 February 2017, https://www.dau.mil/tools/dag, 24-25; Department of Defence. *Open System Architecture – Contract Guidebook for Program Managers,* v.1.1 (Washington D.C.: Department of Defence, June 2013), ix.

[66]Brendan Sims, *Approaches to Open Technology System Specification* (Edinburgh: Defence Science and Technology Organisation), 5; Joyce Tokar, "An Examination of Open System Architectures for Avionics Systems – An Update," Paper presented at *Air Force FACE Technical Interchange Meeting,* Dayton, OH, March 2017, pg 3 - Some of the US avionics weapons systems currently using OSA include:

GVA for example, exists within the contexts of the UK Land Open Systems Architecture program which is aimed at "at efficiently integrating equipment and services within a brigade… through the use of defined open system architectures and mandated standards, developed in conjunction with industry."[67] The direction for GVA exists within Defence Standard 23-009 which mandates the use of GVA for all future UK land platform procurements. It largely espouses many of the same broad principles and benefits as more generic MOSA policy, while providing more focused guidance on land platform design and integration; mandating design principles for both the System Data Dictionary (primary software interface) and key hardware interfaces to ensure full interoperability with third-party developed hardware and software solutions.[68] The success of this standard has been demonstrated at multiple venues, most recently among industry partners including Qinetiq, Selex-Galilei, and Thales who demonstrated their ability to quickly integrate new sensor and controller modules based on mandated GVA standards.[69] Interestingly, the UK GVA has subsequently become the basis for the NATO GVA established within STANAG 4754 in 2016, expanding the benefits of this program across multiple member states.[70]

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the Common Mission Control Center which manages command and control of disparate platforms; Global Hawk and MQ-9 Reaper unmanned vehicles; AH-64 E Apache and HH-60W Black Hawk Rescue Helicopters; U-2 Dragon Lady, F-22, AV8B Harrier Jets, as well as in the development of the new Long Range Strike-Bomber – B-21.

[67] Ministry of Defence. *Defence Standard 23-009 Part 0 Issue 4.* 03 October 2016. https://www.dstan.mod.uk/StanMIS/Indexes/DefenceStandardDownload/4925?seriesId=20, 2-4.

[68] Real-time Innovations, "The UK MOD Generic Vehicle Architecture: A compelling case for Interoperable Open Architecture," last accessed 22 March 2018. https://cdn2.hubspot.net/hubfs/1754418/Collateral_2017/Whitepapers/Generic_Vehicle_Architecture_50010.pdf, 3.

[69] *Ibid*, 3.

[70] NATO Standardization Office, *NATO Generic Vehicle Architecture (NGVA) for Land Systems,* edition 1 (Brussels, Belgium: NATO Standardization Office, 15 November 2016); Arthur Ollett and John Coleman, "Break the stove-piped stranglehold on capability with an open system approach," *Journal of Battlefield Technology* 18, no. 3 (December 2015): 19.

The US Air Force OMS effort has involved extensive collaboration between government, industry, and academia and utilizes commercially developed Service Oriented Architecture concepts and consensus-based standards to define the "basic behavior of clients and services as well as the Avionics Service Bus protocols for entering and exiting the system."[71] This, in turn, provides a flexible and viable path to future system upgrades and expansion, while removing all barriers to entry for alternative platform or service providers. A number of recent demonstrations including Have Raider, Project Hunter, Blue Guardian, Project Iguana, Project Missouri, and the U-2 OMS flight tests have all served to further validate the OMS concept, and proven that new capabilities and COTS solutions can be rapidly integrated through leveraging open system design.[72] For example, in a series of U-2 flight tests, multiple electronic warfare and multispectral imaging payloads designed by BAE Systems, Lockheed Martin, Raytheon, and UTC Aerospace Systems were rapidly integrated and swapped into an open system environment designed by Lockheed based on USAF OMS specifications. Trial data suggested that overall design and integration timelines were cut by up to two-thirds.[73]

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[71] Joyce L. Tokar, "A Comparison of Avionics Open System Architectures." *ALET* 26, no. 2 (December 2016): 23,26.

[72] Lockheed Martin. "Enterprise Open System Architecture (E-OSA)." Last accessed 7 April 2018. https://www.lockheedmartin.com/us/products/OSA.html; Pocock, Chris. "U-2 Pioneers Open-mission Systems for US Air Force." *AIN*, 6 September 2015. https://www.ainonline.com/aviation-news/defense/2015-09-06/u-2-pioneers-open-mission-systems-us-air-force; Barrett, Donald A. Luke A Borntrager and David M. Green. "Blue guardian: an open architechure for rapid ISR demonstration." Proceedings of *SPIE* 12 May 2016; Jennings, Gareth. "USAF and Lockheed Martin demo Have Raider manned/unmanned teaming." *Jane's International Defence Review*, 11 April 2017. http://www.janes.com/article/69444/usaf-and-lockheed-martin-demo-have-raider-manned-unmanned-teaming; Joyce L. Tokar, "A Comparison of Avionics Open System Architectures." *ALET* 26, no. 2 (December 2016): 25.

[73] Pocock, Chris. "U-2 Pioneers Open-mission Systems for US Air Force." *AIN*, 6 September 2015. https://www.ainonline.com/aviation-news/defense/2015-09-06/u-2-pioneers-open-mission-systems-us-air-force.

Through the development of MOSA policy and corresponding programs such as GVA and OMS, the DoD and MoD have proactively addressed many of the procurement challenges associated with recent operational and technological trends. While it is still too early to say decisively whether the promises of fully stream-lined integration, enhanced competition, and significantly reduced life-cycle costs will come to fruition; early empirical indications largely support the underlying concepts of open technical and business models and would suggest that such approaches shows definite promise. It must also be emphasized that MOSA is not an end result, but an "approach to system design that can enable additional characteristics" that must be tailored appropriately as part of a comprehensive procurement strategy.[74]

## MOSA AND THE CANADIAN DEFENCE PROCUREMENT STRATEGY

Canada's procurement strategy is often predicated on far more than just military requirements and cost. In this regard, Canada's DPS is certainly no different. While the use of modular approaches as a key enabler of evolutionary or spiral procurement have been well documented elsewhere, the emphasis here will be to gather an initial impression for whether, and to what extent, MOSA is congruent with existing Canadian defence procurement strategy.[75] To this end it will be demonstrated that MOSA aligns with all three objectives outlined within the DPS: delivering the right equipment to the CAF, leveraging purchases to create jobs and economic growth in Canada, and streamlining

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[74] Department of Defence. *Defence Acquisition Guidebook 2017,* Last updated 26 February 2017, https://www.dau.mil/tools/dag, 24.

[75] Rene G. Rendon, "Using a Modular Open System Approach in Defence Acquisitions: Implications for the Contracting Process," *2007 IEEE International Conference on System of Systems Engineering* (San Antonio, TX. 2007), 1; C.R.J Desgagne, "Evolutionary Acquisition – A Complementary Approach to Capability Based Planning for the Delivering of Aerospace Power" (Masters of Defence Studies Research Project, Canadian Forces College, 2009).

defence procurement processes.[76] Interestingly, as outlined in a recent UK whitepaper, its government recently undertook open system approaches in support of objectives that nearly mirror those articulated within Canada's DPS.[77]

Delivering the right equipment is ultimately "about ensuring that the CAF…is equipped with the equipment needed to successfully do what the government asks of them."[78] Many of the linkages between MOSA and the timely and efficient delivery of emerging capabilities have already been extensively discussed above. One point worth emphasizing is the considerable alignment between MOSA and Capability-Based Planning (CBP); CBP being the methodology the CAF uses to guide Force Development decisions concerning future capabilities.[79] CBP seeks to analyze, assess, and integrate future capability requirements in a manner that disassociates itself from the traditional platform-centric view towards a more capability-based approach.[80] This is entirely consistent with MOSA principles which similarly focus on capabilities vice platforms. Moreover, MOSA also supports more performance-based procurement approaches, such as those advocated since the 1992 Defence Policy statement, but which have long been challenged by the high integration risks associated with non-standardized off-the-shelf components; issues that could be mitigated through MOSA.[81]

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[76] Public Works and Government Services Canada, *Defence Procurement Strategy,* 23 September 2016, https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/samd-dps/index-eng.html.

[77] Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security* (London: Ministry of Defence, 2012), 13.

[78] Craig Stone, *Implementing the Defence Procurement Strategy: Is It Working?* (Calgary: Canadian Global Affairs Institute, July 2016): 1.

[79] Department of National Defence, *Capability-Based Planning Handbook* (Ottawa: Chief Force Development, June 2014 (Version 8)): 5.

[80] R.M. Hartfiel, "Planning without guidance: Canadian Defence policy and planning, 1993-2004," *Canadian Public Administration* 53 (2010): 337; Department of National Defence, *Capability-Based Planning Handbook* (Ottawa: Chief Force Development, June 2014 (Version 8)): 10.

[81] Dave Perry, *Putting the 'Armed' Back into the Canadian Armed Forces: Improving Defence Procurement in Canada* (Ottawa: Conference of Defence Associations Institute, January), 17.

An additional aspect of capability delivery emphasized within the DPS includes "ensuring early and continuous industry and client engagement."[82] The rationale being that Canadian defence industry has habitually not been involved within the procurement process until after requirements have been determined, the issue here being that this is clearly at odds with the fact that often industry has the best "knowledge of what is technologically feasible."[83] This has served as a significant dissatisfier for Canadian industry; however, through earlier engagement, industry could allow DND to gain a better understanding of technological trends, while industry could concurrently leverage such opportunities to focus their own research and development efforts.[84] Such an approach would be entirely supported by existing MOSA concepts, which call for extensive government, academia, and industry engagement as a means to develop consensus-based open standards and jointly developed technology development roadmaps.[85] In fact, extensive collaboration has already been witnessed as a part of multiple MOSA programs including OMS, FACE, GVA, and VICTORY.

The second objective of the DPS is aimed at leveraging defence procurement towards Canadian economic growth. One of the primary tools to accomplish this is through value propositions, which requires companies to indicate where and how projects

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[82] Public Works and Government Services Canada, *Defence Procurement Strategy,* 23 September 2016, https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/samd-dps/index-eng.html.

[83] Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 6.

[84] Industry Canada, *Beyond the Horizon: Canada's Interests and Future in AEROSPACE: Aerospace Review Volume 1* (Ottawa; Industry Canada, November 2012), 2.

[85] Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 224, 227; Ministry of Defence. *System of Systems Approach (SOSA) Open System Strategy*, 18 January 2018, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66098/sosa_open_sys_strategy_nov12.pdf.

will invest in Canada.[86] Under MOSA, all tier-2 or 3 system integrators or sub-contractors have access to the open-standards dictated by the relevant defence department officials.[87] When combined with early industry engagement, this serves two purposes. It would ensure all relevant Canadian industry stakeholders were aware and able to comply with any consensus-based standards. Second, from the prime-contractor point of view, it would reduce integration risk and ensure that Canadian sub-contractors were positioned and readily identifiable early within any given project.[88] In doing so, this would directly facilitate and streamline Canadian industry participation during initial capital project acquisition, while also opening the market to any follow-on life-cycle extension or modernization projects. This is particularly relevant for many small and medium-sized enterprises across Canada who have been largely excluded from ongoing competition based on traditional original-equipment manufacturer and in-service support models.[89]

Another aspect of promoting economic growth in Canada is tied to the identification and promotion of key industrial capabilities.[90] Of particular interest here, as emphasized in the Jenkins report, is the importance of the innovation criterion. This report reinforced:

> The increasing emphasis on technology-driven solutions for threats of the future… [further] reinforced by the need for future planning of mission requirements, and for defence platforms to take on a modular approach to technologically advanced sub-systems, recognizing that innovation

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[86] Public Works and Government Services Canada, *Defence Procurement Strategy,* 23 September 2016, https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/samd-dps/index-eng.html; stone implementing pg 4

[87] Real-time Innovations, "The UK MOD Generic Vehicle Architecture: A compelling case for Interoperable Open Architecture," last accessed 22 March 2018. https://cdn2.hubspot.net/hubfs/1754418/Collateral_2017/Whitepapers/Generic_Vehicle_Architecture_50010.pdf, 5.

[88] Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 225.

[89] Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 4; davies pg 14.

[90] Public Works and Government Services Canada, *Defence Procurement Strategy,* 23 September 2016, https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/samd-dps/index-eng.html.

> evolved at different rates. A modular approach not only helps contain cost, but also ensures a long useful lifetime for a platform.[91]

Traditionally, industry has been over-constrained with respect to innovation in having to strictly adhere to requirements articulated by defence clients.[92] Under open technological and business approaches, these firms can largely take ownership of their own research, development and investment strategies, in so far as they can still comply with established open standards.[93] While admittedly this may not fully reflect natural commercial approaches due to some of the nuances of the defence environment, it would more closely reflect the DPS aim of promoting innovation and productivity in Canadian firms, particularly with respect to technological high-value activities.[94]

The final DPS objective involves the "adoption of a new regime to ensure streamlined and coordinated decision-making for defence…procurements."[95] While a significant part of this involves the establishment of the Defence Procurement Secretariat, there are means by which open system approaches could alleviate current capacity issues in defence procurement. While it must be acknowledged that MOSA may increase some upfront work in order to achieve consensus on technical interfaces, define technical standards, and address the inherent complexities associated with data rights and intellectual property; to adopt a view that strictly looks at procurement as initial platform

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[91] Tom Jenkins, "Canada First: Leveraging Defence Procurement through Key Industrial Capabilities," Report of the Special Adviser to the Minister of Public Works and Government Services (Ottawa: PWGSC, February 2013): xiv.

[92] Dave Perry, *Putting the 'Armed' Back into the Canadian Armed Forces: Improving Defence Procurement in Canada* (Ottawa: Conference of Defence Associations Institute, January), 11.

[93] Eugene Golhz, "A Business Model for Defense Acquisition under the Modular Open Systems Approach," *Defense Acquisition Review Journal* 14, no. 1 (February 2007): 222-223.

[94] Public Works and Government Services Canada, *Defence Procurement Strategy,* 23 September 2016, https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/samd-dps/index-eng.html; Craig Stone, *Implementing the Defence Procurement Strategy: Is It Working?* (Calgary: Canadian Global Affairs Institute, July 2016): 4.

[95] Public Works and Government Services Canada, *Defence Procurement Strategy,* 23 September 2016, https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/samd-dps/index-eng.html.

design and acquisition would be myopic. This would ignore many of the benefits to be accumulated throughout the life-cycle of many programs due to the savings realized in avoiding the significant non-recurring engineering work as part of traditional life cycle extension or modernization programs.[96] Human resources capacity and available expertise has been recognized as one of the "top risks to the delivery of capital equipment programs."[97] As evidenced by the current DAG, the majority of the current projects and initiatives include life extension, sustainment, and modernization projects, rather than new acquisitions; thus it can be inferred that by directly streamlining the design and engineering solutions required for future ongoing life cycle programs, capacity can be freed to address other new capital projects and optimize defence procurement as a whole. Such benefits can be even further exploited if common open standards are generated across fleets, facilitating maximum reuse of technical and system engineering solutions.

The employment of open system approaches is not without potential issues. Aside from the complexities and requisite expertise required to navigate some of the contractual and data rights aspects of open systems; some skeptics have also suggested lack of compatibility of defence procurement with open systems due to cyber-security risks, the sensitivity or classification of some defence related systems and technology, performance compromises due to adherence to open standards, and the potential to develop an over-reliance on the commercial sector for support to critical defence capabilities.[98] First of

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[96] Charles Davis, "Understanding Defence Procurement," *Canadian Military Journal* 15, no. 2 (Spring 2015): 9.

[97] Ross Fetterly, *Implementing Strong, Secure, Engaged: The Challenges Ahead* (Calgary: Canadian Global Affairs Institute, January 2018), 9; Dave Perry, *Putting the 'Armed' Back into the Canadian Armed Forces: Improving Defence Procurement in Canada* (Ottawa: Conference of Defence Associations Institute, January), 9.

[98] Ministry of Defence, *National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security* (London: Ministry of Defence, 2012), 14; Donald Firesmith, "Open System Architectures: When and Where to be Closed," System Engineering Institute (blog), 19 October 2015.

all, it must be stressed that open architecture does not imply that firms must compromise their intellectual property. Quite the opposite, while key interfaces are regulated and data rights are considered upfront, the vast majority of modules that operate within the system serve to effectively compartmentalize proprietary data and intellectual property.[99] Most importantly, however, open systems should not be viewed as binary. Any given system will almost certainly contain varying degrees of "openness" designed around a given engineering and implementation strategy, with these strategies being predicated upon "threat analyses, functional criticality analyses, technological opportunities and evolved capability assessments."[100] In many cases, for reasons such as security, classification or performance some system interfaces may be selected to remain closed, however, such decisions should explain the rationale behind the use of proprietary or closed interfaces and be based on deliberate decision-making criteria.[101]

**CONCLUSION**

There is no doubt that failings within Canada's defence procurement processes have long been viewed as a "perennial burden on both government and industry," serving at times to undermine both the operational effectiveness of the CAF as well as the legitimacy of the corresponding government institutions.[102] Recent trends are further

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https://insights.sei.cmu.edu/sei_blog/2015/10/open-system-architecture-when-and-where-to-be-closed.html; Sydney J. Freedberg, "Open Architecture: The Devils ARE In The Details," *Breaking Defence*, 11 November 2015. Last accessed 15 April 2018. https://breakingdefense.com/2015/11/open-architecture-the-devils-are-in-the-details/.

[99] Sydney J. Freedberg, "Open Architecture: The Devils ARE In The Details," *Breaking Defence*, 11 November 2015. Last accessed 15 April 2018. https://breakingdefense.com/2015/11/open-architecture-the-devils-are-in-the-details/.

[100] Department of Defence. *Defence Acquisition Guidebook 2017,* Last updated 26 February 2017, https://www.dau.mil/tools/dag; Ministry of Defence. *Defence Standard 23-009 Part 0 Issue 4.* 03 October 2016. https://www.dstan.mod.uk/StanMIS/Indexes/DefenceStandardDownload/4925?seriesId=20, 2-5.

[101] Department of Defence. *Defence Acquisition Guidebook 2017,* Last updated 26 February 2017, https://www.dau.mil/tools/dag.

[102] Craig J. Stone, "Improving the Acquisition Process in Canada," *University of Calgary: School of Public Policy Research Papers* 8, no. 16 (April 2015): 1.

exacerbating many of these issues, as procurement processes struggle to keep pace with the rapidly increasing reliance upon new technology, escalating costs, new market dynamics, and a continually evolving set of operational requirements. While the recently released Canadian DPS seeks to alleviate many of the long-standing core issues with defence procurement, it largely fails to adequately address many of these emerging challenges.

Ultimately, any new processes established to address these issues "must be designed with a clear understanding of the true weaknesses of the existing model, and be based upon a coherent concept that does not see procurement as a discrete activity, but one integrated into the conduct of military operations…and the effective life-cycle management of defence systems and capabilities."[103] MOSA seeks to accomplish exactly this, having already been implemented by multiple other defence departments with the aim of addressing similar challenges. Through the effective integration of open technical and business principles, open systems facilitate a more efficient assimilation and reconfiguration of technology, effectively streamlining life-cycle design and engineering solutions, and allowing a more effective and rapid response to evolving demands; while concurrently leveraging commercial innovation and an increasingly competitive environment in order to address escalating costs.

SSE explicitly calls for "reform of Canada's procurement model and adoption of life-cycle costing" to ensure that DND is able to procure, maintain and operate new equipment through its lifespan; a point rendered even more salient given the planned

[103] Charles Davis, "Understanding Defence Procurement," *Canadian Military Journal* 15, no. 2 (Spring 2015): 14.

near-term recapitalization of the CAF.[104] An open strategy considers these life-cycle support requirements upfront while permitting system evolution and technology development in a feasible manner, developed in collaboration with key stakeholders including academia and industry. While many suggest that the adoption of open approaches constitutes a 'paradigm shift', an open approach is in fact already largely consistent with many of the goals and objectives of Canadas DPS. The principles underlying MOSA are ideally suited to assist Canada in facing many of its emerging procurement challenges, and early empirical data is supporting this potential. For nations including Canada, open approaches such as MOSA should not be viewed as a panacea or something to be applied in all situations, but instead as a pragmatic approach providing a number of viable technical and business instruments to better enable decision-making and support capability development as part of a comprehensive procurement strategy.

[104] Department of National Defence, *Strong, Secure, Engaged: Canada's Defence Policy,* (Ottawa: Department of National Defence, 2017), 45.

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