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A MARITIME UNCREWED SYSTEMS STRATEGY

Lieutenant-Commander Anonymous

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CATCHING THE UNCREWED WAVE: TOWARD A MARITIME UNCREWED SYSTEMS STRATEGY

The turn of the twenty-first century saw a drive from militaries for increased human and machine collaboration, intending to let uncrewed systems take on the "dull, dirty, dangerous and dear tasks" from humans.[1] In 2020 NATO assessed the potential impact of uncrewed systems to be revolutionary over the next 20 years.[2] Uncrewed systems have become increasingly essential to military operations across domains, including naval warfare.[3] Within a maritime context, uncrewed systems complement crewed platforms in the air, on the surface, and underwater by increasing awareness, persistent surveillance, range, and endurance, while decreasing cost, decision-making time, and risk to personnel.[4] The challenging demands imposed by the maritime environment and integration in space-constrained crewed ships necessitate recognizing maritime uncrewed systems (MUS) as a subset of uncrewed systems with special requirements and capabilities.[5]

Canada and its allies, notably Australia, the United States (US), and the United Kingdom (UK), have recognized the opportunities presented by MUS.[6] These opportunities come associated with complex challenges for adopting MUS, which Canada and its allies are working to overcome. MUS technology development is advancing rapidly, including for potential adversaries, and "the future maritime threat

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[1] The term "uncrewed" is used throughout this paper for consistency. Canada adopted the gender-neutral term "uncrewed" in 2021 to replace the word "unmanned" which remains in use by the US and NATO. "Uncrewed" is synonymous with the term "robotics and autonomous systems (RAS)" used by Australia, and is inclusive of "remotely piloted" and "autonomous" systems; Bernard Marr, "The 4 Ds Of Robotization: Dull, Dirty, Dangerous And Dear," Forbes, October 16, 2017, https://www.forbes.com/sites/bernardmarr/2017/10/16/the-4-ds-of-robotization-dull-dirty-dangerous-and-dear/; Canada. Department of National Defence, "From Unmanned to Uncrewed: Moving Away from Gender-Based Terminology," May 10, 2021, https://www.canada.ca/en/department-national-defence/maple-leaf/defence/2021/05/unmanned-to-uncrewed-moving-away-from-gender-based-terminology.html.

[2] D.F. Reding and J. Eaton, "Science and Technology Trends 2020-2040: Exploring the S and T Edge" (NATO S and T Organization, October 1, 2020), 16, https://www.sto.nato.int/publications/Management%20Reports/2020_TTR_Public_release_final.pdf.

[3] Uncrewed system vary in level of autonomy from remotely piloted by a human in the loop to nearly-independent autonomous, depending on the onboard processing and sensor set; Peter Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems: Building an Evidence Base" (RAND Corporation, September 14, 2021), 25, https://www.rand.org/pubs/research_reports/RRA929-1.html; Reding and Eaton, "Science and Technology Trends 2020-2040," 61.

[4] USA. United States Navy, "Unmanned Campaign Framework" (Department of Defense, March 16, 2021), 10, https://www.navy.mil/Portals/1/Strategic/20210315%20Unmanned%20Campaign_Final_LowRes.pdf?ver=LtCZ-BPlWki6vCBTdgtDMA%3d%3d; Reding and Eaton, "Science and Technology Trends 2020-2040," 59.

[5] Australia. Department of Defence, "RAS-AI Strategy 2040" (Australia: Royal Australian Navy, October 2020), 4, https://www.navy.gov.au/media-room/publications/ras-ai-strategy-2040; Reding and Eaton, "Science and Technology Trends 2020-2040," 62.

[6] Although the United Kingdom has also aggressively pursued and operated MUS since 2006, little is published about their approach, experiences and lessons learned; therefore, this paper will focus on Australia and the US.

environment will involve widespread proliferation of [MUS]"; therefore, Canada needs a plan to gain then maintain a competitive edge.[7] Traditional technology introduction processes have not successfully adopted MUS technology at a pace commensurate with the rapidly evolving technology. Acknowledging these complex challenges, the Royal Australian Navy (RAN) and US Navy (USN) each overhauled their approaches to MUS adoption by publishing MUS strategies in October 2020 and March 2021, respectively.[8] Their strategies are similar; they shifted to a holistic approach and focused on establishing a solid technological and organizational foundation while promoting innovation. Both navies have vast experience introducing and operating MUS. The Royal Canadian Navy (RCN), whose MUS initiatives remain in their infancy, would benefit from following their approach and applying their lessons learned.[9]

This paper proposes that a systematic, holistic approach could enable the RCN to overcome the challenges of adopting MUS while exploiting opportunities to gain and maintain an advantage. As adopted by the RAN and USN, a strategy is needed to drive and coordinate the multiple concurrent lines of effort required to adopt MUS effectively. Canada should learn from the experience of its allies in overcoming the challenges of adopting MUS.[10] In doing so, it should first focus on establishing a solid foundation for MUS. This foundation comprises the technological enablers for interoperability and integration and the organizational change required for the transformational technology of MUS. Since the RCN's MUS capability introduction remains in development, this paper focuses on the fundamentals of adopting MUS with higher levels of human dependence, including remotely piloted systems for example, while topics including near-independent autonomy and advanced human-machine teaming are beyond the scope of this paper.

BACKGROUND OF RCN MARITIME UNCREWED SYSTEMS

The 2017 release of *Strong Secure Engaged (SSE): Canada's Defence Policy* initiated and directed the investment in "an extensive range of new [MUS] capabilities" to complement and integrate into naval task groups.[11] Before *SSE*, the RCN's use of uncrewed systems was limited to operating ScanEagle Uncrewed Aircraft Systems (UAS) by exercising the Canadian Army's (CA) remaining provision of service contract options for three deployments.[12] Despite relying on CA personnel and contractors to operate

[7] Australia. Department of Defence, "RAS-AI Strategy 2040," xi–xii, 25.

[8] Australia. Department of Defence, 2; USA. United States Navy, "Unmanned Campaign Framework," 1–2, 8.

[9] This paper refers to the RCN rather than the Canadian Armed Forces (CAF) due to the RCN being the lead sponsor for maritime capability, including MUS. While an MUS programme is led by the RCN, it requires collaboration from stakeholders across the Department of National Defence, and externally with defence industry, academia, and defence science and technology.

[10] Justification for the investment and adoption of MUS is beyond the scope of this paper and has previously been made and accepted. Investment in MUS has been directed in *Strong Secure Engaged: Canada's Defence Policy* and supported in the RCN's strategy *Leadmark 2050: Canada in a New Maritime World*.

[11] Canada. Department of National Defence, *Strong Secure Engaged: Canada's Defence Policy* (Ottawa: Department of National Defence, 2017), 15, 35.

[12] Canada. Department of National Defence, "Developmental Evaluation Report – HMCS Regina UAV Operational Capability and Employment" (Esquimalt: HMCS REGINA, RCN, January 2013).

ScanEagle, the RCN learned valuable lessons from the three shipborne deployments that have since shaped future MUS projects, mainly that the RCN requires MUS adapted to the maritime environment, integrated with the ships' combat management systems, interoperable with the existing fleets, and complimentary to the embarked maritime helicopter.[13]

The RCN's resulting efforts from *SSE* MUS initiatives and projects followed the traditional Department of National Defence (DND) acquisition processes outlined in the *Project Approval Directive*.[14] The RCN's MUS projects and associated investments have focussed primarily on UAS and, to a lesser degree, on Underwater Uncrewed Vehicles (UUV).[15] The only DND-owned operational UAS delivered to date are two Puma UAS, miniature UAS with limited capability operated from minor warships since 2019.[16] The RCN's flagship MUS project is Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS), a project still in the definition phase, planned to deliver up to six highly-capable ISTAR UAS to be integrated into and operated solely from the Halifax-class frigates.[17]

The RCN has made modest progress in the last decade in adopting MUS and could find efficiencies to overcome recurring challenges. For example, the issues impeding the RCN ISTAR UAS project's progress are shared across the RCN's MUS initiatives and illustrate that change is required to bring coherence and efficiency to the MUS programme. The project has faced delays of five years to the planned initial operating capability (IOC) due to: unrealistic requirements for existing military-off-the-shelf (MOTS) systems to fit tailored requirements which MOTS cannot meet, lack of a centralized leader to manage the lines of effort needed to coordinate MUS integration other than acquisition and ship installation, and policy barriers relating to certification of uncrewed systems.[18] Additionally, the MUS projects have been platform-centric and siloed. The requirements have focussed on acquiring specific types of vehicles that are not interoperable with each other or the existing crewed fleet's control and data

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[13] Canada. Department of National Defence, 5.

[14] Canada. Department of National Defence, "Project Approval Directive (PAD)" (Department of National Defence, August 16, 2019).

[15] The UUV projects have focussed on delivering four seafloor-mapping and survey UUV to the Fleet Diving Units, and two upcoming Remote Mine Disposal System (RMDS) UUV for Kingston-class vessels; Lookout, "New REMUS 100 for the Royal Canadian Navy," *Pacific Navy News* (blog), October 18, 2018, https://www.lookoutnewspaper.com/new-remus-100-royal-canadian-navy/; Kraken Robotics Inc., "Kraken Awarded $50+ Million Navy Contract for Royal Canadian Navy Minehunting Program," Kraken Robotics, December 7, 2022, https://krakenrobotics.com/kraken-awarded-50-million-navy-contract-for-royal-canadian-navy-minehunting-program/.

[16] Lookout Newspaper, "Navy Enhances Aerial Capability," Pacific Navy News, October 2, 2018, https://www.lookoutnewspaper.com/navy-enhances-aerial-capability/.

[17] Canada. Department of National Defence, "Business Case Analysis v2 - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS)" (Royal Canadian Navy, September 2021), 15, 32.

[18] Canada. Department of National Defence, "Senior Review Board 2022 ROD - RCN ISTAR UAS - C.003095" (DGMEPM, June 22, 2022), 2–3; Canada. Department of National Defence, "Programme Management Board 2021 Slide Deck - RCN ISTAR UAS - C.003095" (ADM(Mat), April 23, 2021), 3–10; Canada. Department of National Defence, "HRMB Input - RCN UAS Programme - Jun 2022" (RCN Human Resources Management Board, Ottawa, June 9, 2022), 3–6.

systems.[19] The slow progress of MUS projects further exacerbates the ability to capitalize on the latest and optimal technology due to requirements' inability to maintain pace with the rapidly evolving MUS technology. The RCN does not yet have a strategy to address these issues.

The RCN's current strategic concept document, *Leadmark 2050: Canada in a New Maritime World*, "[links] the navy's strategic functions to the political, legal and economic aspects of today's global system."[20] It provides oversight of the RCN's vision and sets goals and ways to achieve it; however, it remains incomplete concerning MUS despite recognizing that MUS "will also comprise an essential component of a joint force."[21] *Leadmark 2050* identifies the need to invest in shipborne MUS "vehicles in all three maritime dimensions" to create a balanced and "optimal 'fleet mix'" within naval task groups to be "employed across all intelligence functions."[22] Beyond its basic inclusion of MUS, the strategy mischaracterizes MUS simply as vehicles rather than an overarching capability of systems-of-systems enabled by vehicles that act as payload carriers.[23]

STRATEGY FOR A HOLISTIC APPROACH

Militaries need to manage the MUS technological revolution methodically through a holistic approach. Geoffrey Till highlights in *Seapower: A Guide for the Twenty-First Century* that beyond transforming warfare, the introduction of transformational technology, including MUS, must be innovative in including organizational and cultural.[24] Following established procedures focussing on the acquisition and implementation of capability alone is insufficient due to MUS's high complexity and challenges. Such challenges include establishing the required enablers, overcoming procedural barriers, addressing legal and regulatory issues, developing human-machine teaming, building a culture of trust in autonomy, and keeping pace in a rapidly evolving field.[25] Thus, as identified in the USN's *Unmanned Campaign Framework:*

> The path forward requires a holistic approach to developing and deploying [uncrewed] systems, ensuring that individual technologies can operate

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[19] Canada. Department of National Defence, "Statement of Operational Requirements AL2 - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition, and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS) Project C.003095" (Royal Canadian Navy, August 26, 2021), 16–17, 26–27.

[20] Canada. Department of National Defence, "Leadmark 2050: Canada in a New Maritime World" (Ottawa: Commander, Royal Canadian Navy, May 13, 2016), ix.

[21] Canada. Department of National Defence, 47, 58.

[22] Canada. Department of National Defence, 47, 58.

[23] Allied navies including the RAN and USN have had similar approaches and challenges with MUS until they reframed their understandings of MUS in their MUS strategies published in 2020 and 2021, respectively; USA. United States Navy, "Unmanned Campaign Framework," 24; Australia. Department of Defence, "RAS-AI Strategy 2040," 3.

[24] Geoffrey Till, *Seapower: A Guide for the Twenty-First Century* (Milton, UK: Taylor & Francis Group, 2018), 170.

[25] USA. United States Navy, "Unmanned Campaign Framework," 22; Australia. Department of Defence, "RAS-AI Strategy 2040," 3.

> within a broader architecture of networked warfighting systems, supported by the right people, policies, operational concepts, and other enablers.[26]

Similarly, the RAN, supported by research by the RAND Corporation, developed four lines of efforts for a holistic approach promulgated in the *RAS-AI Strategy 2040*.[27] The challenges which required a holistic approach beyond focusing on capability acquisition are emphasized in the first three of four lines of effort titled "People, Discover, Develop & Deliver."[28]

The complexity of synchronizing such a comprehensive approach requires a strategy. As Till noted, "Navies evidently need to develop a strategy for dealing with technological transformation." [29] Advancing a common goal and overcoming the challenges of the adoption and operationalization of MUS necessitates cooperation between military and governmental organizations in partnership with industry and academia.[30] The absence of strategy creates a significant risk that efforts will be uncoordinated and stall progress resulting in unachieved goals.[31]

The meaning and applicability of strategy within the context of force development should first be established before detailing how a MUS strategy could be beneficial and developed. The word "strategy" is often utilized improperly without understanding its meaning.[32] As a foundation, Colin Gray establishes that "strategy interconnects all of the different behaviours and capabilities that a security community commands."[33] Expressed differently, it is the "glue that holds together the activities of the purposeful activities of the state."[34] This glue is required to bring and maintain alignment and coordination toward a common goal. Bringing stakeholders together opens communication between internal and external stakeholders, which need to cooperate and synchronize to achieve the goals outlined in the policy. Furthermore, it creates formalized accountability to the strategy's owners while empowering decentralized yet coordinated execution. [35]

Beyond being a mechanism for coordinating efforts, strategy is the bridge that connects the military's resources to the government's goals outlined in the policy.[36] "Strategy provides the 'how'" to the policy's "what" or "to what ends."[37] Government policy provides end states to be accomplished, while the military must build a strategic plan detailing how to achieve those goals. Another common way of understanding the

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[26] USA. United States Navy, "Unmanned Campaign Framework," 2.

[27] Australia. Department of Defence, "RAS-AI Strategy 2040," 3; Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," xiii–xv.

[28] Australia. Department of Defence, "RAS-AI Strategy 2040," 3, 18–25.

[29] Till, *Seapower*, 171.

[30] Australia. Department of Defence, "RAS-AI Strategy 2040," 2.

[31] Colin S. Gray, *The Future of Strategy* (Cambridge, UK: Polity Press, 2015), 36–37.

[32] William C. Martel, *Victory in War: Foundations of Modern Strategy*, 2nd ed. (Cambridge: Cambridge University Press, 2011), 20, https://doi.org/10.1017/CBO9780511842443.

[33] Gray, *The Future of Strategy*, 23.

[34] Gray, 23.

[35] USA. United States Navy, "Unmanned Campaign Framework," 9.

[36] Gray, *The Future of Strategy*, 24.

[37] Gray, 23.

framework for strategy is the US military framework of "Strategy equals Ends (objectives towards which one strives) plus Ways (courses of action) plus Means (instruments by which some end can be achieved)," conceptualized by Colonel Arthur Lykke in 1987.[38] Critics of the model criticize it for being overly simplistic in that its formulaic nature is a "crutch" which limits creativity; however, in the absence of strategy, as is the case for MUS for Canada, the model is a reasonable basis for the initial development of a strategy ensuring the requisite courses of action with the appropriate allocation of available resources support the goals.[39] Although the ends (strategic goals) and means (resources) are often thought of as fixed with only room for creativity in the ways (concepts), ends and means are both dynamic and evolving from "successes and failures, lessons learned, new ideas" and changes in resource allocation.[40] Consequently, a strategy must be an iterative process to remain relevant in the evolving environments where navies operate.[41]

Although strategy in a military environment is frequently viewed as operational within the context of Clausewitz's combat-centric war, even Clausewitz conceded that strategy is broader than war in that it can apply to "all activities that exist for the sake of war, such as the creation of the fighting forces, their raising, armament, equipment, and training."[42] Beyond their "ends, ways, and means" model of strategy, Lykke reiterated Clausewitz's idea that there can be both "operational and force developmental [strategies]."[43] Force development strategy is inherently a long-term process compared to operational strategy.[44] Inclusive strategic planning has been found to maintain the unity of diverse groups and focus on common goals.[45] Therefore, a consideration for long-term force developmental strategy planners, such as for a MUS strategy, is the importance of transparency, communication, and considering the various stakeholders' interests during strategic planning and throughout the execution of the strategy.

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[38] United States Congress Senate Committee on Armed Services, *National Security Strategy: Hearings Before the Committee on Armed Services, United States Senate, One Hundredth Congress, First Session January 12, 13, 14, 20, 21, 27, 28; February 3, 23; March 25, 30; April 3, 1987* (U.S. Government Printing Office, 1987), 137; Abel Esterhuyse and Gerhard Louw, "The Practice of Strategy: South African Defence in Stasis," *Defense & Security Analysis* 34, no. 1 (January 2, 2018): 54, https://doi.org/10.1080/14751798.2018.1421403; Mauro Mantovani and Marcel Berni, "Visualizing Strategy: A Conceptual Framework for the Analysis and Teaching of the Conduct of War," *Defence Studies* 20, no. 4 (October 1, 2020): 375, https://doi.org/10.1080/14702436.2020.1807339.

[39] Jeffrey W. Meiser, "Ends + Ways + Means = (Bad) Strategy," *Parameters* 46, no. 4 (2017 2016): 81–82.

[40] United States. Marine Corps., "MCDP 1-1: Strategy" (Marine Corps Headquarters, 1997), 51, https://www.marines.mil/Portals/1/Publications/MCDP%201-1%20Strategy.pdf.

[41] United States. Marine Corps., 51.

[42] Mantovani and Berni, "Visualizing Strategy," 375.

[43] Mantovani and Berni, 374–75.

[44] Mantovani and Berni, 375.

[45] Paula Jarzabkowski and Julia Balogun, "The Practice and Process of Delivering Integration through Strategic Planning," *Journal of Management Studies* 46, no. 8 (2009): 1282, https://doi.org/10.1111/j.1467-6486.2009.00853.x.

Two additional essential premises of strategy are that strategy is hierarchical and comprehensive.[46] First, strategy is both hierarchical with other strategies as well as hierarchical within itself. For example, US National Military Strategy is subordinate to the National Defense Strategy, which is subordinate to the National Security Strategy.[47] Therefore, within the MUS context, it would be appropriate for the RCN to develop a MUS strategy subordinate to RCN's strategy and to amplify it by detailing the ways and means of the ends contained in the RCN's strategy. Within a strategy itself, the leader responsible for the strategy establishes a hierarchy by establishing authorities, responsibilities, and accountabilities for the execution of the strategy. Second, strategy is comprehensive. In formulating a strategy, all internal and external factors are to be considered and accounted for; consequently, an adequately devised strategy is inherently holistic.[48] Therefore, a MUS strategy would bring a holistic approach and way ahead to the MUS initiatives and projects.

A MUS strategy is required to formalize and impose discipline for "how" the RCN will adopt MUS as directed in *SSE*.[49] As Gray wrote, "policy … ends sought incompetently in unsuitable ways using inappropriate . . . means will generally fail."[50] Without this glue of strategy, the RCN's MUS activities will continue to lack progress due to a lack of coordination among the necessary stakeholders. They will continue to be driven by the acquisition of platforms that the RCN will not be prepared to employ once delivered. The level of effort that the RCN and other DND stakeholders commit to developing and implementing a MUS strategy will depend on how they evaluate the value of MUS for future operations and warfare. As per Clausewitz's concept of strategy in relation to the perceived nature of war, "how we develop military strategy… and equip combat forces" depends on our perception of war.[51]

LEARNING FROM ALLIES' MUS EXPERIENCE AND STRATEGIES

The experience, lessons learned, and recently altered trajectories of allies' MUS strategies and roadmaps should be leveraged. The USN and RAN, in particular, have aggressively pursued the adoption and operationalization of air, surface, and sub-surface MUS over the last two decades. While there are differences between the RCN and these allies regarding military resource availability, priorities, ambitions, and procurement policy, the RCN would benefit from applying their lessons in developing a strategy and overcoming the significant challenges of adopting MUS. There is no predicting how long the RCN would take to learn these same lessons alone from its limited MUS experience and slow ongoing MUS initiatives.

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[46] J. Boone Bartholomees, "U.S. Army War College Guide to National Security Issues. Volume 1. Theory of War and Strategy" (Carlisle Barracks, PA: Strategic Studies Institute, US Army War College, June 1, 2012), 46–47, https://apps.dtic.mil/sti/citations/ADA564450.

[47] Bartholomees, 47.

[48] Bartholomees, 47–48.

[49] Gray, *The Future of Strategy*, 16.

[50] Gray, 16.

[51] Antulio J. Echevarria, *Clausewitz and Contemporary War* (Oxford, UK: Oxford University Press, 2007), 58.

The RAN and USN have overhauled their MUS programs' narratives after nearly 10 and 20 years of operating shipborne MUS, respectively.[52] Within six months, they each released comprehensive MUS strategies for similar reasons and with parallel themes.[53] The RAN released its *RAS-AI Strategy 2040* in October 2020, and USN released its *Unmanned Campaign Framework* in March 2021. Despite the differences in terminology in their titles, they are both strategies for MUS with a common aim of providing an overarching "framework for defining how new capabilities should be developed and employed to complement the maritime fighting system."[54]

The USN's strategy is more conceptual in providing a robust, comprehensive framework while allowing flexibility. The US Acting Secretary of the Navy stated that "the path forward requires a holistic approach to developing and deploying [MUS]" and that the strategy is required to "ensure success" by coordinating "requirements, resources, and acquisition policies to develop, build, integrate and deploy effective [MUS] faster."[55] The USN Chief of Naval Operations noted that the USN is "mindful of past shortcomings, so therefore [their new] approach is deliberate, but with a sense of urgency."[56] Overall, the USN acknowledged "it is imperative that [it employs] new and different strategies to win the future fight," shifting from a siloed "platform-centric approach" to a holistic "capability-centric approach" for MUS.[57] There are eight synchronized pillars of the USN's holistic MUS strategy: platforms and enablers; strategy, concepts, and analysis; fleet capability, capacity, and wholeness; research, development, test, and evaluation; people, education and talent; logistics and infrastructure; policy, law and ethics; and, communication and messaging.[58] These comprehensive pillars require consistent coordination to achieve the USN's goals.

Although the RAN's strategy shares common themes and direction with the USN's, it offers greater detail and defines how the RAN will measure success. The RAN's additional details describing how it intends to adopt MUS capability likely result from its more constrained resources of institutional MUS expertise than the USN and that the RAN may require more external expertise support. The RAN also importantly acknowledges that the military only holds a part of the solution and must leverage the strengths of academia, industry, and allies to overcome the challenges of MUS.[59] It stresses the importance of all stakeholders' involvement throughout the strategy's implementation. Beyond openly communicating its MUS vision and the four lines of effort required to achieve it, the RAN has also openly published the supporting *RAS-AI*

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[52] Australia. Department of Defence, "822X Squadron," 822X Squadron, Royal Australian Navy, accessed April 22, 2023, https://www.navy.gov.au/about/organisation/fleet-air-arm/822x-squadron; Naresch Chand, "Blue-Water Unmanned Aerial Vehicles," SP's Naval Forces, May 2012, https://www.spsnavalforces.com/story/?id=231.

[53] Australia. Department of Defence, "RAS-AI Strategy 2040"; USA. United States Navy, "Unmanned Campaign Framework."

[54] USA. United States Navy, "Unmanned Campaign Framework," 2, 8, 9; Australia. Department of Defence, "RAS-AI Strategy 2040," 2, 3, 8.

[55] USA. United States Navy, "Unmanned Campaign Framework," 1.

[56] USA. United States Navy, 2.

[57] USA. United States Navy, 8, 23–24.

[58] USA. United States Navy, 9.

[59] Australia. Department of Defence, "RAS-AI Strategy 2040," 2.

Campaign Plan 2025, which amplifies the strategy. The campaign plan provides clear milestones and measurable performance indicators to implement the strategy.[60] Through its transparency in communicating goals, it can quickly gain early interest and engagement from external partners. The RCN's limited experience and expertise in implementing MUS could benefit from the RAN's detailed approach through open external communication to gain valuable assistance from key partners to break through the challenges of MUS.

Beyond the requirement for holistic strategy, the RAN and USN strategies share three critical and fundamental themes for success in adopting relevant MUS capability: focus on MUS as a capability vice individual platforms; key enablers need to be prioritized first and above all; and innovation is the key to acquiring and building the right capability.[61] While other more advanced themes emerge, including the path to full autonomy and weaponization, the three emphasized themes present the foundation that must be in place for the successful adoption of MUS, particularly by a navy with limited MUS experience and existing capability like the RCN.

MUS as a Capability, Not Platforms

Militaries need to change their MUS acquisition mindsets from the traditional acquisition of platforms, otherwise called vehicles, to focus on building complex integrated systems-of-systems of which platforms constitute only a part.[62] As identified in the USN's MUS strategy, "no mission outcome can be achieved through building the platform alone," a total solution is needed, including enablers.[63] A MUS system-of-systems includes all the interdependent and jointly optimized systems such as command and control (C2) systems and interfaces, integrated joint tactical network, data sharing infrastructure and libraries, common standard interfaces, sensor payloads, uncrewed vehicles, and sustainment facilities, to list a few, in addition to the people and organizational structures supporting the technical elements.[64] Tärnholm and Liwång note in their study of how navies can approach the MUS technological transformation that "focussing on one of these systems to the exclusion of the [others] is likely to lead to degraded system performance."[65] The standard platform-centric singular project approach

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[60] Australia. Department of Defence, 3; Australia. Department of Defence, "RAS-AI Campaign Plan 2025" (Australia: Royal Australian Navy, 2022), 37, 46–47, 52–53, https://www.navy.gov.au/media-room/publications/ras-ai-strategy-2040.

[61] Although the Royal Navy (RN) has not published details of its MUS strategy, the same three key themes are highlighted in the analysis of information provided by the RN to RAND in support of the development of the RAN's strategy. The RN has been routinely operating shipborne UAS since 2006 and has recently developed a MUS strategy and associated campaign plan of which details are unknown other than information provided to and published by RAND.

[62] Australia. Department of Defence, "RAS-AI Strategy 2040," 7; Therese Tärnholm and Hans Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," *Journal of Military Studies* 11, no. 1 (November 30, 2022): 41, https://doi.org/10.2478/jms-2022-0004.

[63] USA. United States Navy, "Unmanned Campaign Framework," 27.

[64] USA. United States Navy, 24; Tärnholm and Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," 41.

[65] Tärnholm and Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," 41.

to capability acquisition, as remains the approach for the RCN, creates silos that "degrade integration and interoperability."[66] A RAND study supporting the RAN's MUS strategy found that MUS "capabilities need to be developed collectively and systemically (rather than having numerous systems designed in isolation from one another) to increase effectiveness, accelerate timelines and reduce costs."[67] It is only achievable if the navies formulate capability requirements holistically rather than individually for specific platforms or projects. As an integrated and interoperable capability, MUS capability is a toolbox of flexible systems able to be tailored to provide mission packages suitable to the dynamic operating environment.[68]

BUILDING A TECHNOLOGICAL FOUNDATION FOR MUS

Establishing a foundation of technological enablers for interoperability is the first of two critical keys to effectively operationalizing and integrating the MUS emerging technology with the crewed fleets. These enablers form the building blocks of the foundation that supports the capability.[69] Experience from the USN and RAN in integrating MUS with proprietary C2 systems, data management systems, and sensors which are not interoperable with other MUS or existing ship systems is ineffective, slow, and costly.[70]

The RCN faced these challenges in integrating the temporary Canadian Armed Forces UAS Provision of Service (CAF UPS). CAF UPS was a three-year provision of service contract meant for UAS deployments from Halifax-class frigates from 2018 to 2021. Although no operational assignments occurred during the contract period, the RCN learned valuable lessons from the engineering change of *HMCS Toronto* to accommodate the UAS. Modifying *Toronto* required a work period which cost the RCN nearly one million dollars and 17 weeks of ship unavailability, primarily to install the specific UAS' proprietary C2 system, which did not integrate with the ship's combat and data management systems.[71] Every future MUS adopted similarly without a pre-established common technological architecture would require a similar time and financial investment to deliver platforms not interoperable with other RCN systems or other future MUS. The RCN identified some of the same lessons espoused by the USN: "a robust interoperable foundation provides the very 'structure that will allow for future [MUS] advances in warfighting," and a "'solve once and scale' [mindset]" needs to be adopted to allow rapid scaling up of MUS across domains.[72] A 2022 US Government Accountability Office

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[66] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 44.

[67] Dortmans et al., 61.

[68] Dortmans et al., 45; Australia. Department of Defence, "RAS-AI Campaign Plan 2025," 7.

[69] Australia. Department of Defence, "RAS-AI Campaign Plan 2025," 64.

[70] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 59.

[71] Canada. Department of National Defence, "Info Brief - CAF UAS Provision of Service (CAF UPS) History" (Ottawa: Director Naval Requirements, Royal Canadian Navy, November 2021), 6.

[72] USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, "Unmanned Systems Integrated Roadmap 2017-2042" (Department of Defense, August 2018), v, https://apps.dtic.mil/sti/citations/AD1059546; USA. United States Navy, "Unmanned Campaign Framework," 8, 24.

study of the USN's MUS strategy concluded that "to execute its strategy, the Navy needs to make significant investments in the development of technologies to enable these [MUS] to operate . . . [and interact with] the existing fleet."[73]

A Common Control System for Interoperability

Two fundamental technological enablers for interoperability must be in place before integrating vehicles and other subsystems. First is a common multidomain control system with open architecture.[74] Without a fleet-wide MUS common control system, integration of every MUS would continue to require costly and lengthy ship modifications, as experienced for CAF UPS. Based on the RCN's small fleet sizes and requirement to maintain two operational naval task groups consisting of four ships each, it is unsustainable to regularly take ships out of commission for months beyond existing maintenance requirements.[75] A common control system requires only one installation per ship and enables plug-and-play integration of future MUS through a standardized open architecture without requiring further ship installations.

Additionally, a common control system provides a standardized user interface, which reduces the users' cross-platform training requirements, further easing the integration of different MUS.[76] Tärnholm and Liwång found that these familiar interfaces between humans and machines build a reliable system within a complex MUS system-of-systems.[77] Beyond providing commonality across the RCN's fleet, a common control system utilizing the same open architecture as allies can facilitate seamless interoperability with allies' uncrewed systems across all domains. The RAN, USN, and Royal Navy (RN) have recognized the need for interoperable common control systems. Each is prioritizing the development and implementation of these systems ahead of further adopting MUS.[78]

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[73] United States. Government Accountability Office, "Uncrewed Maritime Systems: Navy Should Improve Its Approach to Maximize Early Investments," Report to Congressional Committees (Washington, DC: US GAO, April 7, 2022), 1.

[74] USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, "Unmanned Systems Integrated Roadmap 2017-2042," 4–7; Australia. Department of Defence, "RAS-AI Strategy 2040," 3, 22; Tim Fish and Aaron Mehta, "Meet MAPLE, the Brain That Will Run the UK's Autonomous Naval Fleet," *Breaking Defense* (blog), April 1, 2022, https://breakingdefense.sites.breakingmedia.com/2022/04/meet-maple-the-brain-that-will-run-the-uks-autonomous-naval-fleet/.

[75] Canada. Department of National Defence, *Strong Secure Engaged*, 34.

[76] Linda Slapakova et al., "Supporting the Royal Australian Navy's Campaign Plan for Robotics and Autonomous Systems: Emerging Missions and Technology Trends" (RAND Corporation, April 4, 2022), 14, https://www.rand.org/pubs/research_reports/RRA1377-1.html.

[77] Tärnholm and Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," 42.

[78] Slapakova et al., "Supporting the Royal Australian Navy's Campaign Plan for Robotics and Autonomous Systems," 14; Fish and Mehta, "Meet MAPLE, the Brain That Will Run the UK's Autonomous Naval Fleet."

A Digital Backbone for Data

The second technological enabler is a data management and processing infrastructure. "Data has become the currency of success on the battlefield."[79] The RCN's strategy, *Leadmark 2050,* sets intelligence, surveillance, and reconnaissance (ISR) as the primary mission for MUS, similar to the USN's and RAN's MUS strategies.[80] MUS employed in ISR primarily gather sensor data for use by humans to inform and make tactical decisions. Therefore, the overwhelming data that MUS sensors collect must be quickly consolidated and converted into useful information that humans can use to make timely decisions.[81] Although existing MOTS MUS have integrated data management and processing systems, these systems are proprietary and data rights tend to be retained by the industry.[82] As such, navies are constrained in their ability to centrally fuse, store, and process data gathered by different MUS, which inhibits effective decision-making. Similarly to common control systems, the RAN, USN, and RN prioritize developing interoperable open architecture "digital backbone" capability to overcome the challenges.[83]

A recognized challenge for implementing the technological enablers is the lack of standardization across MUS platforms and supporting subsystems.[84] As noted in the US *Unmanned Systems Integrated Roadmap 2017-2042*, overcoming this hurdle requires cooperation and consensus among services and allies in establishing standardized MUS architecture requirements.[85]

BUILDING AN ORGANIZATIONAL FOUNDATION FOR MUS

The second critical enabler to MUS integration and operationalization is an organization ready to operate MUS; therefore, organizational change is required. Till proposed that navies' adoption of MUS is transformational if paired with organizational change.[86] Tärnholm and Liwång further found that effective implementation of transformational technology such as MUS requires organizational change. They noted that navies should avoid taking the unsuitable shortcuts used when replacing obsolete

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[79] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," xiii.

[80] Canada. Department of National Defence, "Leadmark 2050: Canada in a New Maritime World," 49; Australia. Department of Defence, "RAS-AI Strategy 2040," 11; USA. United States Navy, "Unmanned Campaign Framework," 14–16.

[81] USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, "Unmanned Systems Integrated Roadmap 2017-2042," 11.

[82] USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, 16.

[83] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 34.

[84] Slapakova et al., "Supporting the Royal Australian Navy's Campaign Plan for Robotics and Autonomous Systems," 14; USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, "Unmanned Systems Integrated Roadmap 2017-2042," 7.

[85] USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, "Unmanned Systems Integrated Roadmap 2017-2042," 7.

[86] Till, *Seapower*, 164; Tärnholm and Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," 40.

technology with newer systems.[87] The organizational change necessary to successfully adopt MUS capability can be organized into three categories.

Workforce Transformation

First, a workforce transformation is required. Fundamentally, the assumption that uncrewed platforms decrease the number of personnel needed to operate platforms is false. Uncrewed systems instead relocate operators elsewhere than in the platform.[88] While this reality may appear to negate a perceived benefit of MUS, it presents a substantial opportunity to increase the operator pool to personnel who would not usually be eligible to operate the platform type.[89] In the CAF, for example, operators of any trade or occupation can fly UAS weighing less than 600 kilograms, while only a qualified pilot can fly a crewed aircraft.[90]

The personnel who will operate and support MUS will require specialized skill sets due to the new complexities of MUS.[91] Establishing a specialized MUS workforce, including operators, technicians, test and evaluation staff, instructors, and regulatory oversight staff, will be required, in addition to instilling general MUS literacy across the organization.[92] The finite personnel resources will require trade-offs in reallocating personnel to MUS.[93] A phased approach to workforce transformation has been successful in the RAN. The RAN established a UAS squadron at the beginning of its MUS programme.[94] Before the RAN acquired any MUS, the squadron forged the way ahead for MUS. It built subject matter expertise, formed a detailed understanding of potential MUS capabilities via experimentation and evaluation, developed training and support requirements, and validated and established doctrine and crewing models.[95] As the core team of the RAN's MUS capability, their role has since expanded as the RAN's programme continues to scale up. The RCN could learn from the RAN's phased approach to the required workforce transformation for the development and execution of a strategy for MUS adoption led by a core team.

Fostering a Culture of MUS

Second, a change in organizational culture is needed to adopt MUS effectively. Building trust in uncrewed systems is the first and most crucial area requiring cultural

[87] Tärnholm and Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," 44.
[88] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," xvii.
[89] Dortmans et al., xvii.
[90] Canada. Department of National Defence, "CAF UAS Categorization Table" (Winnipeg: RCAF, 2018).
[91] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 42.
[92] Australia. Department of Defence, "RAS-AI Strategy 2040," 19.
[93] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," xvii.
[94] Australia. Department of Defence, "822X Squadron."
[95] Australia. Department of Defence.

change. MUS need to be trusted by the organization to utilize them effectively.[96] Establishing this trust in uncrewed systems to act predictably and safely under legal and ethical obligations has been challenging for militaries but needs to be prioritized.[97]

Trust in uncrewed systems must be established in their technical performance and socially in their perceived use.[98] Technical trust is built through thorough testing of all subsystems in all situations where militaries may use them operationally before entering service and then continuous validation.[99] This validation will increase in complexity in verifying predictability as increased autonomy is introduced; however, starting with MUS with minimal levels of autonomy and gradually increasing autonomy allows testing and evaluation to be appropriately scaled.[100]

Socially, militaries can establish trust in uncrewed systems through demonstrated regular safe use, which normalizes their use.[101] The RAN, USN, and RN have each established regularly occurring multinational MUS exercises that publicly promote their use of MUS, partly to normalize their use and build social acceptance of MUS.[102] Furthermore, the institution's promotion and acceptance of MUS can lead to securing further investment in building the capability.[103]

Trust and normalization for MUS can also catalyze change in adapting the currently incomplete and overly constraining regulations and laws to uncrewed systems. For example, within the regulatory framework, unlike potential adversaries, the CAF prohibits swarming UAS by limiting control of UAS to no more than one aircraft per operator.[104] An example of legal constraints includes the ambiguity surrounding the

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[96] Tärnholm and Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," 46.

[97] Tärnholm and Liwång, 41; Australia. Department of Defence, "RAS-AI Strategy 2040," 24; USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, "Unmanned Systems Integrated Roadmap 2017-2042," 21.

[98] Tärnholm and Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," 41; Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 43.

[99] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 43; USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, "Unmanned Systems Integrated Roadmap 2017-2042," 22.

[100] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 43.

[101] While there are concerns of trust and ethics in the use of weaponized uncrewed systems, in that they may lower the threshold of starting wars due to political disconnect or turning war into a spectator sport, these are longer term issues that can wait to be resolved based on the RCN's current MUS ambitions excluding weaponized MUS.

[102] Canada. Defence Research and Development Canada, "Exercise UNMANNED WARRIOR: An International Exercise Using Autonomous Tech to Detect Underwater Mines," DRDC, December 13, 2016, https://www.canada.ca/en/defence-research-development/news/articles/exercise-unmanned-warrior-an-international-exercise-using-autonomous-tech-to-detect-underwater-mines.html; United Kingdom. Royal Navy, "Unmanned Warrior," Royal Navy, accessed April 4, 2023, https://www.royalnavy.mod.uk/news-and-latest-activity/operations/united-kingdom/unmanned-warrior.

[103] United Kingdom. Royal Navy, "Unmanned Warrior."

[104] Canada. Department of National Defence, "Interim Uncrewed Aircraft Systems (UAS) Open Category Flight Rules" (Commander Royal Canadian Air Force, April 14, 2022), A-2, A-12.

legality of operating an uncrewed surface vessel (USV) as a standalone vessel, which is effectively a vessel without a crew.[105] Technologies for both examples listed currently exist, but awareness and acceptance of MUS must be increased through normalized usage to build justification to amend regulations and laws to use MUS to their full potential.[106]

This culture change for MUS needs strong advocacy within senior leadership to be successful, as concluded by both the RAN and USN from challenges in overcoming resistance and building support.[107] Coordinating and driving a strategy forward relies on having a champion for MUS within senior leadership.[108] Resource constraints limit the scope of militaries' capability ambitions, and militaries must therefore make tough decisions concerning where to invest the limited resources.[109] Advocacy from a champion is also vital to secure investment in the critical technological enablers, which rarely get attention and investment due to not being tangible acquisitions like MUS platforms.[110] "Without a champion, funding will not be forthcoming and sustained, and support will likely be little more than lip service."[111] Military organizations' typical resistance to change needs a champion as a driver for change.[112]

Adapting and Leveraging Processes

Finally, the third category of organizational change required is the adaptation of acquisition processes to suit MUS. The rapid technology advancements require an acquisition strategy which is suitably flexible and coordinated to deliver MUS, including the enablers, which are technologically relevant when operationalized.[113] It is not achievable through the traditional acquisition processes.[114] As noted by the RAN, "'game changing' technological advantage is only temporary," so agility is required to gain and maintain the advantage.[115] Canada's average military acquisition timeline is 15.8 years from initiation to full operational capability (FOC) and close-out.[116] At the pace of

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105 Rodriguez Delgado and Juan Pablo, "The Legal Challenges of Unmanned Ships in the Private Maritime Law: What Laws Would You Change?," SSRN Scholarly Paper (Rochester, NY, December 5, 2018), 521, https://doi.org/10.2139/ssrn.3297487; Tärnholm and Liwång, "Military Organisations and Emerging Technologies – How Do Unmanned Systems Find a Role in Future Navies?," 41.

106 Slapakova et al., "Supporting the Royal Australian Navy's Campaign Plan for Robotics and Autonomous Systems," 9–16.

107 Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 35; United States. Government Accountability Office, "Uncrewed Maritime Systems: Navy Should Improve Its Approach to Maximize Early Investments," 259.

108 Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 42.

109 Leung Chim, Rick Nunes-Vaz, and Robert Prandolini, "Capability-Based Planning for Australia's National Security," *Security Challenges* 6, no. 3 (2010): 81.

110 United States. Government Accountability Office, "Uncrewed Maritime Systems: Navy Should Improve Its Approach to Maximize Early Investments," 24.

111 Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 42.

112 Dortmans et al., 35.

113 Dortmans et al., 45.

114 Dortmans et al., 45.

115 Australia. Department of Defence, "RAS-AI Strategy 2040," 4.

116 Alan S. Williams, *Reinventing Canadian Defence Procurement: A View from the Inside*, Book, Whole (Montreal: McGill-Queen's University Press, 2006), 95.

evolving MUS technology, systems and platforms would be obsolete and technologically irrelevant when delivered more than a decade after the navy has formulated requirements. Existing acquisition processes can be leveraged and used parallel to traditional processes through creativity and persistence.

Militaries can achieve increased acquisition pace through agile procurement, innovation, and a "whole-of-defence" approach, including close partnerships with the defence industry, academia, and science and technology communities.[117] In the case of RAN, their transparency with industry, academia, and defence partners through the publication of their detailed MUS strategy and campaign plan, regular exercises open to partners and allies, and embracing shared innovation and experimentation enables the acquisition of technologically modern and relevant capability.[118]

Middle-power navies like the RAN and RCN with limited internal expertise need external assistance to understand and maintain pace with the advancing technological MUS field.[119] The RAN's *Autonomous Warrior* exercise series has brought together defence community partners to "demonstrate, evaluate and trial emerging [MUS] capabilities at a variety of [technology readiness level]," including prototypes.[120] This exercise series enables the RAN to experiment and prototype with the latest technology, incentivizes the industry to produce systems to the navy's requirements, and "delivers evidence on which to base investments," which the RAN can then rapidly acquire through agile procurement.[121] This approach of open exercises, trialling and validating prototypes, has also been embraced by the USN and US Government Accountability Office as a measure to de-risk MUS acquisition.[122]

A shift in mindset for acquisition processes is required to embrace innovation and prototyping to acquire the optimal technology. Current RCN MUS projects are attempting to de-risk technology by requiring MOTS systems, contrary to the lessons learned by its allies.[123] "MOTS technologies developed by other . . . services or international partners do not necessarily provide the right capability" for the requirements of a navy, including the maritime environment and interoperability.[124] MOTS systems provide an unfavourable long-term business model due to their proprietary C2 and data

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[117] Australia. Department of Defence, "RAS-AI Strategy 2040," 7–8.

[118] Lee Willett, "RAN Melds Unmanned Systems into New Model Navy," Asian Military Review, April 20, 2021, 5–8, https://www.asianmilitaryreview.com/2021/04/ran-melds-unmanned-systems-into-new-model-navy/; Australia. Department of Defence, "RAS-AI Strategy 2040," 5.

[119] Slapakova et al., "Supporting the Royal Australian Navy's Campaign Plan for Robotics and Autonomous Systems," 16.

[120] Willett, "RAN Melds Unmanned Systems into New Model Navy," 5.

[121] Dortmans et al., "Supporting the Royal Australian Navy's Strategy for Robotics and Autonomous Systems," 45–46.

[122] United States. Government Accountability Office, "Uncrewed Maritime Systems: Navy Should Improve Its Approach to Maximize Early Investments," 6, 51.

[123] Canada. Department of National Defence, "Business Case Analysis v2 - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS)," 14; Canada. Department of National Defence, "SOR AL2 - RCN ISTAR UAS," 7.

[124] Willett, "RAN Melds Unmanned Systems into New Model Navy," 3.

frameworks, which compound costs when upgrades are required.[125] In Canada, the existing Innovation for Defence Excellence and Security (IDEaS) framework is intended to enable this type of innovation.[126] It could be leveraged in a coordinated manner by the RCN's MUS community to foster innovation and the development of the right capability for the RCN.[127]

Finally, MUS acquisition processes should group MUS projects into a formal programme instead of the traditional separate project approach. As defined in DND's *Project Approval Directive*, a programme, formerly known as "omnibus projects," is "a group of related projects and change management activities that together achieve beneficial change for a department."[128] Grouping projects into a programme provides a navy with a "mechanism by which it can collectively work together on shared aspects of its [MUS] efforts to optimize its ability to achieve its objectives."[129] As recognized by the RAN, which is taking a MUS programmatic approach, MUS "requires a system-of-systems acquisition methodology."[130] While the USN has not yet grouped its MUS projects, the US Government Accountability Office strongly recommended in 2022 that the USN do so.

The overall advantage of a programmatic approach to acquisition is that "programmes provide a coordinated management approach as well as control of interdependencies to realize specific benefits." [131] This coordinated management approach is necessary for MUS, which has critical interdependencies between projects that deliver separate parts of the MUS system-of-systems, such as projects for vehicles and technological enablers. Programmes enable comprehensive management of the delivery of interdependent systems. In the traditional single-project approach, the de-prioritization or cancellation of a project, like the common control system, could have catastrophic effects on its interdependent projects. Programmes bring coherence to related projects and de-risk the delivery of the capability.[132] A comprehensive MUS programme can execute a MUS strategy's coordinated capability delivery.

CONCLUSION

A shift in approach and mindset is needed to gain and maintain a competitive edge in adopting MUS. The experience and lessons learned in establishing MUS capability by Canada's allies, particularly Australia and the US, should be leveraged and not overlooked. A solid foundation is essential to successfully adopting the right MUS at the necessary pace to catch and maintain pace. The building blocks of technological enablers for interoperability and organizational change form that foundation.

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[125] USA. Office of the Assistant Secretary of Defense for Acquisition Washington United States, "Unmanned Systems Integrated Roadmap 2017-2042," 16.

[126] Canada. Department of National Defence, *Strong Secure Engaged*, 77–78.

[127] Canada. Department of National Defence, 77–78.

[128] Canada. Department of National Defence, "PAD," 45.

[129] United States. Government Accountability Office, "Uncrewed Maritime Systems: Navy Should Improve Its Approach to Maximize Early Investments," 21.

[130] Willett, "RAN Melds Unmanned Systems into New Model Navy," 7.

[131] Canada. Department of National Defence, "PAD," 45.

[132] Canada. Department of National Defence, "SOR AL2 - RCN ISTAR UAS," 46.

Interoperability is the key to unlocking the potential of rapid, seamless integration of emerging MUS. The organizational change composed of workforce transformation and culture change trusting of MUS and open to innovation, and led by a champion in senior leadership is crucial to be ready to prioritize, operationalize, support, and build upon MUS's capability going forward. Through the comprehensive development and execution of a MUS strategy, the RCN could accomplish the systematic, holistic approach needed to effectively adopt and support the capability, effectively overcoming the challenges of MUS introduction. By grasping and leveraging the hard-learned lessons from its allies, Canada could succeed in establishing and maintaining a competitive MUS capability.

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