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ENHANCING CANADIAN AIR POWER OPTIONS: CONTEXT FOR DEVELOPING RECONFIGURABLE AIRBORNE MULTI-MISSION KITS

LCol J.L.K. Armstrong

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AIM

1. To stimulate further consideration towards concept development and strategy formulation, this paper will show that there are significant benefits for the Department of National Defence (DND) / Canadian Armed Forces (CAF) in developing, in parallel to its major force development and acquisition projects, reconfigurable airborne multi-mission kits (RAM2Ks) that incorporate an open architecture. In particular, this paper frames the benefits in terms of enhancing a capacity to interoperate, enhancing the breadth and density of effects available per platform, and enhancing the ability to keep up with the pace of technology.

INTRODUCTION

2. This paper was produced as part of an academic exercise to identify potential ways and means to mitigate gaps that exist between Royal Canadian Air Force (RCAF) strategic objectives, such as those articulated in Air Force Vectors (AFV) and the Future Concepts Directive (FCD), and current capabilities. The intended audience of this paper is the Director General Air Force Development (DG Air FD), as the authority to establish an appropriate Concept Development Working Group (CDWG) and Concept Director.[1] The first section of this paper frames what could be conceived for RAM2K systems in terms of high-level operational intent and the advantages that could be derived from open architecture. The second section of the paper offers a start point for which capabilities to 'operationalize', and some further considerations towards a strategy for open-architecture RAM2K development.

[1] Canada. Department of National Defence. RCAF FCD 1.0, *Royal Canadian Air Force Future Concepts Directive* (Ottawa: Director General Air Force Development,[2013])., 5. In accordance with this reference, Commander RCAF has delegated authority to DG Air FD to appoint, direct, and issue terms of reference for Concept Directors and CDWGs under certain conditions detailed in section 1.12 therein.

DISCUSSION

High-Level Operational Intent and Advantages to be Derived

3. The development of reconfigurable mission kits for RCAF platforms (and optionally platforms common to coalition or interagency partners) could enhance the RCAF's ability: to 'plug-and-play' (i.e. interoperate) with other components internal and external to the CAF; to generate more breadth and density of effects within the operational context of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR), but also in nascent CAF functional areas like cyber and information operations; and to keep pace with technology changes.

4. The use of mission kits to enhance a platform capability is not a foreign concept. By way of context and example, the C-130 Open Skies Pod System (COPS) provides a roll-on/roll-off sensor and mission control capability for multiple countries to 'plug-and-play' their C-130 transport aircraft into multi-national observation missions in support of the Open Skies treaty.[2] Canada has operated its CC-130 transport aircraft with the COPS, including more recently, in May 2014, on the newer J-model CC-130 over Ukraine.[3] A significant high-level technical feature in this example is that part of this mission kit (i.e. the sensors permitted within the treaty agreement) is housed in a converted C-130 external fuel tank. This allows the mission-kit itself to be 'plug-and-played' into virtually any partner nation's C-130 aircraft, as long as they have certified its use. The repurposing of an existing component to house a mission kit also produces some economies with respect to aircraft engineering and certification efforts.

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[2] Open Skies POD Group, "Presentation to the Second Open Skies Review Conference (OSRC)" (Vienna, Open Skies Consultative Commission, 7-9 June 2010, 2010). Several open sources are available on the Internet to provide more details on the COPS. This is one source accessed online on 1 February 2015 at http://www.osce.org/secretariat/68392?download=true

[3] "Canadians Carry Out 'Open Skies' Mission Over Ukraine," Canada.com, last modified 29 May 2014, http://o.canada.com/news/canadians-carry-out-open-skies-mission-over-ukraine.

5. Northrop Grumman, one of the major American global aerospace and defence technology corporations, announced in June 2015 the availability of their OpenPod™ system. They promote the system as consisting of "line-replaceable units and a set of interchangeable sensors that can be swapped out in minutes"[4], and Figure 1 provides an illustration of the pod and the types of interchangeable packages they intend to be able to integrate with OpenPod. The open architecture principles and design standards that Northrop Grumman has incorporated in the OpenPod implementation are intended to facilitate evolution of the pod as more capable sensors become available with technological advances. The open architecture also offers potential for a wider range of host platforms. Thus, while Figure 1 shows OpenPod developed for a fighter aircraft, Northrop Grumman could develop the pod for host platforms like bombers, unmanned aerial systems, or even transport aircraft like the C-130 or the C-17.[5] Of note, Northrop Grumman's initial iteration of OpenPod incorporates an infrared search and track capability (IRST) geared towards a United States Air Force (USAF) requirement to add IRST capability to its legacy F-15 fighters. Additionally noteworthy is their intent to produce a fifth to forth generation fighter aircraft communications link, which would provide the means for F-22 and F-35 fighters to "exchange tactical information"[6] with legacy fighters. These applications of open architecture illustrates this paper's position that an open architecture and scalable approach can provide the way and means to keep up with technology changes and facilitate interoperability.

[4] "News Release: Northrop Grumman Announces OpenPod(TM), the Next Generation of Podded Sensor Systems," Northrop Grumman Corporation, last modified 2 June 2015, http://www.globenewswire.com/newsarchive/noc/press/pages/news_releases.html?d=10137030.

[5] "Northrop Unveils OpenPod as USAF Seeks F-15 IRST," Flight Global, last modified 2 June 2015, https://www.flightglobal.com/news/articles/northrop-unveils-openpod-as-usaf-seeks-f-15-irst-413022/.

[6] Ibid.

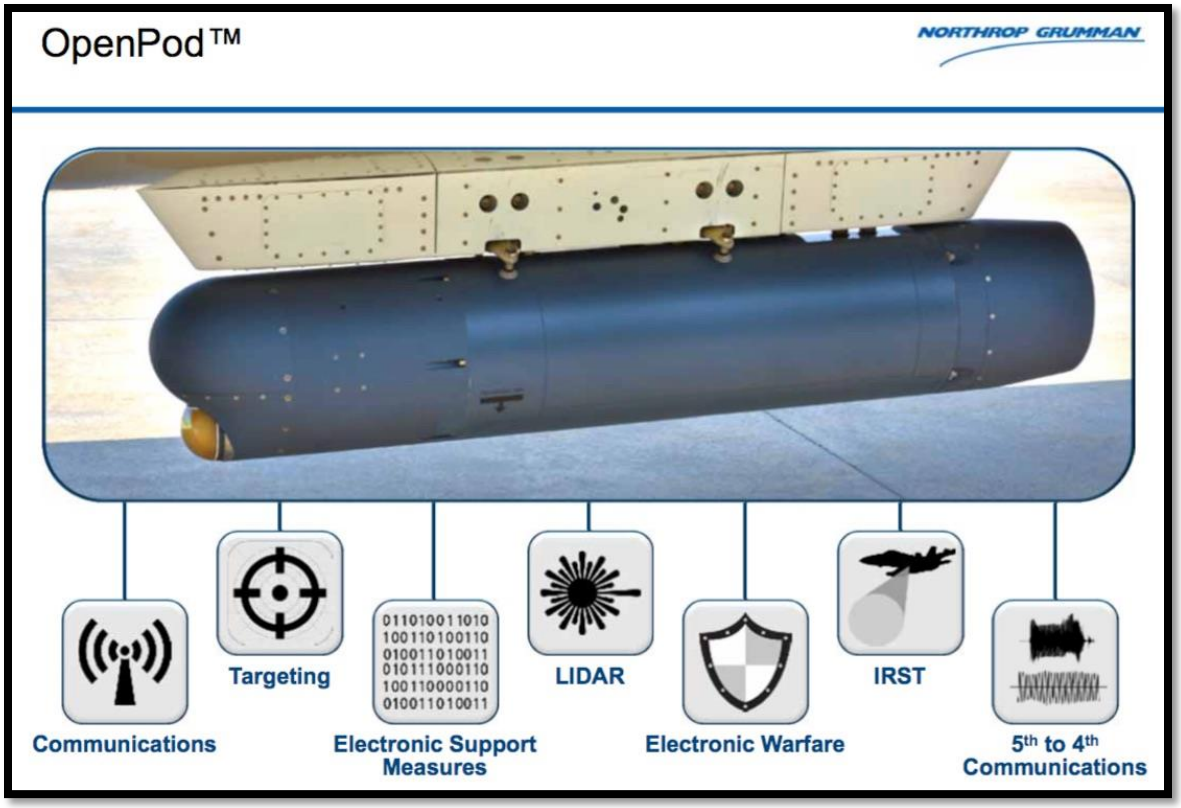

Figure 1 – Northrop Grumman OpenPod™ System
Source: James Mocarski, "OpenPod™: Opening a World of Mission Flexibility." Last modified 2 June 2015. http://www.northropgrumman.com/MediaResources/MediaKits/OpenPod(TM)/Documents/OpenPod.pdf

6. Open architecture principles also apply to other portions of a RAM2K, such as developing reconfigurable on-board workstations to capture sensor or communications data, and thereby enable the processing, exploitation and dissemination functions within the operational context of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR). The RCAF could benefit from a common C4ISR workstation that can roll-on/roll-off its rotary wing (maritime or utility) or fixed wing (transport, maritime, or search and rescue (SAR)), and provide the means to interface with the different models of sensor and data links that already exist on some of these platforms. Platforms that do not have sensors could potentially have the technology inserted with the open architecture pod or external store. A

significant implication of this approach is that RCAF could have the agility to reconfigure a wide range of RCAF aircraft in to a C4ISR node, which in turn aligns with one of the core themes in the RCAF FCD to enable "networked sensors with a shared picture."[7]

7. In addition to providing the flexibility to repurpose pods and RCAF aircraft for C4ISR mission effects, an open-architecture RAM2K could also integrate technology for other evolving operational domains like electronic warfare (EW), cyber warfare, and information operations. The USAF 24th Air Force have publicly revealed that they have successfully modified their EC-130 Compass Call aircraft, built for EW effects such as jamming, to conduct offensive cyber attacks on a network from the air, and that successfully demonstrated the capability.[8, 9] American military services have articulated a recognition of the convergence of cyber operations and EW operations in various forms of academic[10, 11] and strategic guidance[12] documents. In particular, the United States Army Communications-Electronics Research, Development and Engineering Center (CERDEC) developed a conceptual illustration of their assessed functional overlaps, which is reproduced at Figure 2 and highlights potential requirements for "combined EW and computer network operations (CNO) effects" and "multidiscipline effects" (that can achieve EW, CNO, and / or signals intelligence (SIGINT) effects). The significance of these convergences and overlaps to the RCAF is that there will likely be demand for airpower to evolve and enable or deliver such "combined" or "multidiscipline" effects.

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[7] Canada. Department of National Defence. RCAF FCD 1.0, *Royal Canadian Air Force Future Concepts Directive*, 22.

[8] 24th Air Force Public Affairs, "Integrated Operations Hit Cyber Bull's-Eye," *Inside 24AF*11/5/2014, .

[9] Sydney J. Freedberg Jr., "Wireless Hacking in Flight: Air Force Demos Cyber EC-130," *Breaking Defense*, 15 September 2015, .

[10] Harold T. Cole, *Warfare in the Electromagnetic Spectrum and Cyberspace: United States Air Force Cyber/Electromagnetic Warfare Command Construct* (Maxwell Air Force Base, Alabama: United States Air War College, Air University, 2014), 27.

[11] Michael Senft, "Convergence of Cyberspace Operations and Electronic Warfare Effects," *The Cyber Defense Review* (4 January 2016, 2016).

[12] United States. Naval Aviation Enterprise, *Naval Aviation Vision 2014-2025* (Patuxent River, Maryland: NAE Publication Distribution,[2014]).

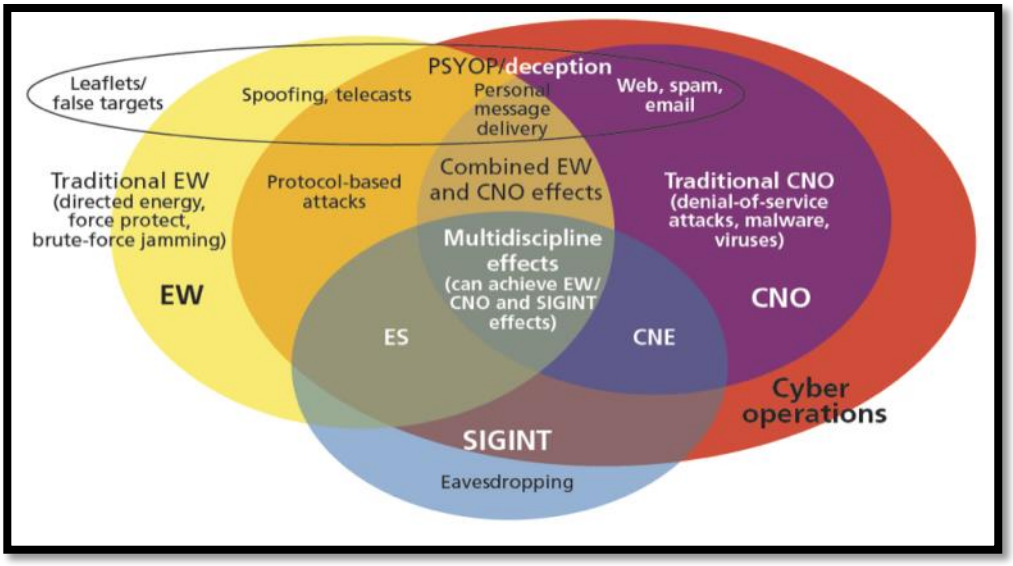

Figure 2 – Functional View of Coverging Areas According to CERDEC Draft
Source: Reprinted from Isaac R. Porche III et al., *Redefining Information Warfare Boundaries for an Army in a Wireless World* (Santa Monica, CA: RAND Corporation, 2013), 51.

8. The apparent EC-130 cyber attack capability illustrates the manifestation of this convergence and the evolution that the USAF undertook to enhance the projection of airpower and cyber power. RCAF AFV articulates that the RCAF will closely monitor capability development in the cyber environment in order to learn "how to best exploit cyber operations and technology for air operations", and will also "increase its awareness of the impact of cyber activity on its operations and contribute to CAF cyber operations capability."[13] Should the RCAF determine a need to provide an airborne cyber effects, an appropriately engineered open-architecture RAM2K could enable a more rapid integration of the requisite "cyber module", and provide options to conduct the operation from a variety of RCAF platforms.

9. The RCAF FCD is informative in terms of considering the issue of which RCAF platforms to pursue development of open-architecture RAM2Ks. It recognizes the need "for controlling the level of ambition" and that there are "certain fleet types and roles that lend

[13] Canada. Department of National Defence. A-GA-007-000/AF-008, *Air Force Vectors* (Ottawa: Director General Air Force Development,[2014])., 21.

themselves to multi-roling [sic], [such as a secondary surveillance and reconnaissance role]."[14] The RCAF FCD suggests considering the pairing of:

> Sensors to [Air-to-Air Refuelling] platforms, taking advantage of extended high altitude loitering. . . . Sensors to Transport platforms, taking advantage of lift capacity, range and loiter time, and roll-on / roll-off mission pods. . . . Sensors to SAR platforms, by selecting sensors that may be optimized for SAR missions (primarily the search phase), but would be procured and integrated for such missions as arctic and maritime approach surveillance. . . . Sensors to fighters, taking advantage of their speed of response and penetration ability.[15]

The insertion of sensor technology into this potential sub-set of the RCAF inventory, also requires the insertion of appropriate data link and processing modules to fuse information and create the shared domain awareness desired. It is unlikely that these platforms can afford (in terms of engineering, resources, and downtime due to modification) an extensive modification to insert these modules. Accordingly, a RAM2K approach could reduce the amount of actual aircraft-level modifications required to reconfigure the platform mission, and thereby preserve a better level of operational availability for the asset.

10. While it is not within the scope of this paper to comprehensively delve into them, this study recognized that there are many more levels of detail involved to consider across the dimensions of technical feasibility, doctrine, training, personnel, and maintenance and support. The introduction of more requirements for configurations on a given RAM2K system will likely drive up complexity and level of effort. However, not all configurations need to be implemented all at once. Relating back to this paper's position, an open-architecture RAM2K framework is

[14] Canada. Department of National Defence. RCAF FCD 1.0, *Royal Canadian Air Force Future Concepts Directive*, 23.
[15] Ibid.

intended to be an enabler for the RCAF *to generate more airpower options* by providing a scalable framework that can incrementally evolve diverse mission kits for a range of platforms. The examples and context presented in this section highlight that there are significant benefits to derive from the development of open-architecture RAM2Ks in terms of:

a. Enhancing capacity to interoperate. The RAM2K could integrate an appropriate communications link to commonly interface the different standards of data links that exist in the CAF inventory, or amongst coalition members. RCAF AFV deduced that interoperability with the Canadian Army of Tomorrow (AoT) concept will require "interdependent reliance on mutual C4ISR capability to detect and target threats", and "connectivity with RCAF tactical assets for voice, data, and video exchange."[16] The same deductions also apply to the special operations force (SOF) component of the CAF.[17] If these two components end up operating different communication systems (for example if SOF updates its equipment faster than the Army), a readily reconfigurable RAM2K framework can enable the RCAF to flexibly adapt its communications network to maintain its ability 'plug-and-play'. In another vein, as illustrated by the Open Skies COPS, a RAM2K sensor package could be scaled to operate on aircraft belonging to another partner (e.g. coalition nation, United Nations, or other governmental department / agency), which then provides a means for contributing or interoperating in a joint, interagency, multi-national, and public (JIMP) context.

b. Enhancing the breadth and density of effects. The reconfigurable and scalable approach would enable the RCAF to offer more types of effects per pod and per

[16] Canada. Department of National Defence. A-GA-007-000/AF-008, *Air Force Vectors*, 20.
[17] Ibid.

aircraft. This approach may be essential as RCAF fleet sizes reduce and new fleets take longer to come into service, while domains such as C4ISR, cyber, and information operations exert demand for airpower to integrate them.

c. Enhancing ability to keep up with pace of technology. As illustrated in the Northrop Grumman OpenPod proposal for the USAF F-15s, an open-architecture mission kit can facilitate the retrofit of legacy platforms to provide new sensors and communications links to keep the aircraft relevant.

In light of the context presented in this section and the breadth of potential advantages of an appropriately scalable implementation of open-architecture RAM2Ks, consideration should be given to further concept development and strategy formulation.

Towards a Canadian Strategy for Open-Architecture RAM2K Development

11. This section suggests a start point for which capabilities to 'operationalize', and then highlights some ways and means for further consideration. In terms of further concept development within the framework of the RCAF FCD, this paper posits that the DND/CAF should invest efforts into developing open-architecture RAM2K capabilities with a priority on utility rotary- and fixed- aircraft and effects that support light forces and dispersed operations. Additionally, in order to enable open-architecture systems, the broader DND and RCAF institutions will need to develop viable business and technical strategies amongst the relevant science and technology and logistics entities within the DND/CAF and aerospace industry.

12. Special operations task forces (SOTF) deployed on recent CAF operations to conduct special reconnaissance (SR) and defence, diplomacy, and military assistance (DDMA) tasks some provide example and context for the need to focus support on light forces and dispersed operations. It is likely that the CAF will need to continue generating options for light force

deployments in support of the new Government mandate for the DND/CAF that emphasizes tasks such as "training of local forces and humanitarian support" and to "work with the Minister of Foreign Affairs to renew Canada's commitment to United Nations peace operations."[18] As the previous section alluded, such deployments into likely austere environments will increase the demand for C4ISR capability and connectivity with RCAF tactical assets for voice, data, and video exchange, in order to sense and act upon threats. As some platforms, such as the CH146, already have some tactical ISR capability, a natural start point for RAM2K development could be an open-architecture scalable workstation that can interface with the CH146 electro-optical / infrared (EO/IR) sensor turret, enable bolt-on communications equipment (for voice, data, secure and non-secure, line-of-sight and beyond) that are not resident on the CH146 or compatible with existing operations networks (Army, SOF, or coalition), and provide a re-configurable human-computer interface (potentially akin to having different apps on a tablet). Subsequent versions of the workstation could enable interfacing with different platforms and other open-architecture pods (e.g. a CC130 with an OpenPod-like sensor suite). In sum and relation to this paper's central position, an open-architecture scalable workstation system that can provide a common interface for existing platforms, sensors, and communications equipment is reasonable start point for a RAM2K, as it could enable interoperability, expand air power options in terms of creating a C4ISR node, and facilitate faster technology insertion.

13. Although the end-state in terms of requisite capabilities will continually evolve from this proposed start point, this paper posits that common underpinning ways and means to consider in an open-architecture RAM2K strategy includes developing viable business and technical approaches amongst the relevant science and technology and logistics entities within the

[18] "Minister of National Defence Mandate Letter (Issued November 2015)," , accessed 1 February, 2016, http://pm.gc.ca/eng/minister-national-defence-mandate-letter.

DND/CAF and aerospace industry. This study found that the American experience with developing open-architecture systems involved significant effort to adapt government and industry means in the functional areas of acquisition and technology development. For example, the United States Under Secretary of Defence for Acquisition, Technology, and Logistics emphasized evolution of government acquisition processes to improve their ability to procure and industry's incentive to develop competitive sub-systems.[19] With respect to technology strategy, they emphasize evolving practices to lower and share development risk through design disclosure (so that industry has access to key interfaces) and leveraging government and academia reviews.[20] It is not within the scope of this paper to further situate potential changes required to DND/CAF procurement, systems engineering, and logistical practices. However, these example and principles highlight that the development of open-architecture RAM2Ks will require engagement with procurement organizations (e.g. within Assistant Deputy Minister (Materiel) and Public Works and Government Services). The technology development strategy should leverage means within science and technology organizations (e.g. Defence Research and Development Canada, National Research Council, aerospace design organizations and technical organizations within Director General Aerospace Equipment Program Management) to establish the open-architecture standards and liaise with industry.

CONCLUSION

14. This paper illustrated potential concepts for open-architecture RAM2K systems in terms of high-level operational intent, and it showed that such systems could enhance the RCAF's capacity to interoperate, breadth and density of effects available per platform, and ability to keep

[19] United States. Under Secretary of Defense for Acquisition, Technology, and Logistics, *Implementation Directive for Better Buying Power 3.0 - Achieving Dominant Capabilities through Technical Excellence and Innovation* (Washington D.C.: Under Secretary of Defense for Acquisition, Technology, and Logistics, [2015]).

[20] "Open Systems Architecture (OSA)", accessed 1 February, 2015, http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=450&ct=2.

up with the pace of technology. The second portion of the paper offered a start point for which capabilities to 'operationalize', and it also highlighted that an open-architecture RAM2K development strategy would need viable business and technical approaches amongst the relevant science and technology and logistics entities within the DND/CAF and aerospace industry. Given an environment of evolving mission demands and a climate of uncertainty that pervades major DND/CAF procurement projects, the development of reconfigurable and readily adaptable mission kits and the procurement of lower-cost and faster release-to-service sub-systems merits increasing consideration.

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