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SPACE DOMAIN MISSION ASSURANCE

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Service Paper

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SPACE DOMAIN MISSION ASSURANCE

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SPACE DOMAIN MISSION ASSURANCE

AIM

1. The aim of this service paper is to evaluate the space domain mission assurance (SDMA) framework adopted by the United States Air Force (USAF) in terms of applying it within the Canadian Armed Forces (CAF). The United States' Department of Defense (DoD) has formalized the doctrinal framework for space domain mission assurance (SDMA) based on the 2015 White Paper which conceptualized it. Given our close ties to the DoD in space operations, it is logical to adopt the same framework in our doctrine with the necessary differences. Future areas of study will be necessary to determine all existing activities that pertain to SDMA and how to apply space domain mission assurance to the processes and space systems used by the CAF.

INTRODUCTION

2. The space domain is critically important to all nations and Canada is no exception. The demand for space based effects is higher than ever and will only continue to increase in support of CAF operations. "The effects delivered in and from this environment are fundamental to the success of modern military operations worldwide."¹ As this domain continues to become more congested, contested and competitive, there are specific and unique challenges to the military use of space. Many military systems and capabilities in the space domain are so relied upon that there is now a dependency on them. Recent developments in the space security environment are challenging the previous perception that we will always have access to allied space capabilities.

¹ Royal Canadian Air Force, Doctrine Note 17/01, *Space Power* (Trenton: RCAF Canada, 2017), 16.

With the realization that there is no guarantee of access to space capabilities, steps must now be taken to mitigate this threat.

3. This was the catalyst for the 2015 *Space Domain Mission Assurance: A Resilience Taxonomy* White Paper by the Office of the Assistant Secretary of Defense for Homeland Defense & Global Security. With continued expansion of the CAF defence space portfolio, ensuring compatibility with our allies is critical. This, coupled with the DND policy direction to “defend and protect”² our space assets, provides the conditions to formalize the CAF’s policy on space domain mission assurance. This paper will evaluate the USAF SDMA framework in terms of applying it to the CAF. Mission assurance spans a broad range of activities, processes, mission sets and equipment. It is intended to be an all-encompassing approach to ensuring mission critical capabilities remain available throughout the spectrum of conflict. The U.S. DoD policy describes MA “. . . as a process to protect or ensure the continued function and resilience of capabilities and assets by refining, integrating, and synchronizing the aspects of the DoD security, protection, and risk-management programs that directly relate to mission execution.”³

DISCUSSION

4. The SDMA approach is necessary to maintain an advantage in this challenging domain. It is broken down into three categories of measures, defensive operations, reconstitution and resilience. As the name of the White Paper suggests, the authors placed a premium on the resilience aspect of SDMA, however, it is only one third of the taxonomy. To further emphasize, “resilience is not the end which we seek to assure; it is the warfighting mission assurance benefit

² Department of National Defence. *Strong, Secure, Engaged: Canada’s Defence Policy* (Ottawa: Canada Communications Group, 2017), 72.

³ Under Secretary of Defense for Policy, DoD Directive 3020.40, *Mission Assurance*, (Washington, D.C.: Under Secretary of Defense for Policy, 2016), 18.

derived from resilience, which we seek to assure.”⁴ Whether it is our contribution to the U.S. Space Surveillance Network (SSN) or imagery support to deployed commanders, there is also a capability stewardship aspect of implementing the SDMA framework.

5. The tendency to focus solely on the operational equipment must be guarded against. This taxonomy not only applies to the equipment but must also be considerate of the people and processes involved in space operations. “Mission assurance is a common integrative framework - - not a single policy or program -- to prioritize protection and resilience efforts and reduce risks from a range of complex threats and hazards.”⁵ As an example, not only must the operators be proficient in their duties, the developers, procurement specialists and staff officers must be considerate of MA within their respective spheres of control.

Defensive Operations

6. Satellite manoeuvres and proximity operations are becoming more frequent and demonstrate the contested dynamic of the space domain. The need to have a defensive posture has become necessary. These are perhaps the more intuitive aspects of mission assurance and bring to mind the notion of system self-defence or reacting to a particular situation in space. Defensive operations, are described in Joint Publication (JP) 3-14 as “. . .activities undertaken to neutralize or reduce the effectiveness of hostile action against US, allied, and partner space systems.”⁶ In particular, when paired with the language used in SSE, i.e. “defend and protect”⁷,

⁴ Assistant Secretary of Defense for Homeland Defense and Global Security, *Space Domain Mission Assurance: A Resilience Taxonomy*, White Paper, (Washington, D.C.: Assistant Secretary of Defense for Homeland Defense and Global Security, 2015), 3.

⁵ Deputy Secretary of Defense, *Mission Assurance Strategy*, (Washington, D.C.: Deputy Secretary of Defense, 2012), 1.

⁶ Joint Chiefs of Staff, *Space Operations*, JP 3-14, (Washington, D.C.: Joint Chiefs of Staff, 2018), I-7.

⁷ Department of National Defence. *Strong, Secure, Engaged: Canada’s Defence Policy* (Ottawa: Canada Communications Group, 2017), 72.

it is logical to be initially focused on this aspect of SDMA. While some satellites do have on board defence capabilities, many of the activities for the defence of space systems occurs external to the satellite. It is therefore a combination of activities whose sum is the defence of a particular system. This combination has a logical separation based on the basic architecture of space systems, namely the ground segment and space segment. The fact that there are components of the system in two different domains blurs the lines of responsibility and requires extensive coordination between stakeholders, e.g. space, cyber, intelligence, and infrastructure. Based on the current relationships with our allies through partnerships such as the Combined Space Operations (CSpO) initiative⁸, there are already many defensive space activities that occur. There is a delineation that occurs with systems that the CAF owns and operates and with the allied systems that we use. Canadian unique systems, such as Sapphire, were not developed in a climate where defending it was a necessary mindset. This makes it difficult to apply defensive technologies and procedures retroactively. Conversely, allied systems such as GPS have been developed and employed with defending it as a priority.

7. Contributions to the defence of space on a macro level also falls within this category of SDMA. No different than the traditional domains, the space domain requires warning and threat characterization in order to employ its defensive tactics, techniques or procedures. The CAF is already a key contributor to defensive operations through Sapphire's employment in the SSN.

Reconstitution

8. A day without space would have global repercussions. Re-establishing the lost capability would not be able to happen quickly enough. Reconstitution is defined as “plans or operations to

⁸ Royal Canadian Air Force, Doctrine Note 17/01, *Space Power* (Trenton: RCAF Canada, 2017), 26.

bring new assets on line [sic] . . . in order to replenish lost or diminished functions to an acceptable level for a particular mission, operation, or contingency after an attack or catastrophic event.”⁹ At first glance this category within the SDMA construct seems very challenging to enact if not specifically included in the early stages of a system’s life. Depending on which segment, ground or space, is degraded to the point of operational impact, the feasibility of reconstituting it is affected. Practically speaking, it is more feasible to replace ground segment equipment than the space segment given the lack of space lift capability in Canada. It is also problematic to reconstitute the space segment when systems are unique, such as Sapphire. Unless multiple units are part of the project’s scope, there will be a capability gap during the time it takes to generate a replacement system. In considering the capability and not just the system, the relationships with allies where partners can use each other’s’ capabilities can be leveraged to reconstitute a degraded capability within the CAF. It is also through innovation and strong relationships with defence industry partners that the time to bring back a capability will be reduced.

9. There are a host of constraints and restraints placed on projects that impact what is able to be delivered to the force employer. There is an underlying relationship between reconstitution and resilience. “the more quickly you can reconstitute your space capabilities, the less resilient those capabilities need to be on their own . . . the less quickly you can reconstitute . . . the greater your need for those capabilities to be inherently resilient.”¹⁰ An understanding this relationship between SDMA categories is important so that as resources are traded, the net impact to mission assurance is minimized. This relationship is represented in figure 1.

⁹ Assistant Secretary of Defense for Homeland Defense and Global Security, *Space Domain Mission Assurance: A Resilience Taxonomy*, White Paper, (Washington, D.C.: Assistant Secretary of Defense for Homeland Defense and Global Security, 2015), 3.

¹⁰ *Ibid*, 6.

Figure 1
Reconstitution vs. Resilience



Resilience

10. In a perfect world, space based capabilities and effects would always be available. This is not the reality modern militaries operate within. Space effects need to be available as much as possible, they need to be resilient. Resilience is defined as “the ability of an architecture to support the functions necessary for mission success with higher probability, shorter periods of reduced capability, and across a wider range of scenarios, conditions, and threats, in spite of hostile action. . . .”¹¹ This covers such a vast range of activity so it is then subdivided in to six characteristics that encompass the aspects of resilience as a whole.

- a. Disaggregation is an enabler of resilience by bolstering it through the separation of dissimilar capabilities into separate platforms or payloads.¹² This is a situation that implies that you have enough organic capabilities across enough missions in the first

¹¹ *Ibid*, 3.

¹² *Ibid*, 6.

place. The current CAF capabilities in space are few and unique enough that there aren't likely any opportunities to apply this characteristic. CAF space assets are therefore inherently disaggregated. However, disaggregation does mitigate some of the risks brought forth by the cost saving measure of having multiple payloads on one bus. It isn't unrealistic, in a resource constrained environment, to design a satellite system with dissimilar capabilities in cooperation with other departments. Considering disaggregation would force planners into a risk benefit analysis to determine which capabilities should be combined and which should be on its own satellite.

b. Distribution refers to having multiple nodes that work together to perform the same function in either the ground or space segment.¹³ Without a constellation, distribution of the space segment is not currently applicable to the CAF. In terms of the ground segment, there is much more opportunity to apply this characteristic to current and future systems. In particular, where the CAF is contributing unique space sensor systems and niche capabilities, increasing the resilience of the ground segment should be a significant consideration. There is an added vulnerability to having a non-distributed system which, depending on the threat, may pose significant levels of risk.

c. Diversification “[contributes] to the same mission in multiple ways, using different platforms, different orbits, or systems and capabilities of commercial civil, or international partners.”¹⁴ The CAF is well poised to be diversified by leveraging its relationships with allies and industry. Having access to information through multiple sources also reduces the dependency on any one source. Using space surveillance as an

¹³ *Ibid*, 6.

¹⁴ *Ibid*, 7.

example, through initiatives such as the Build in Canada Innovation Program (BCIP), the CAF can continue to explore commercial alternatives to military sensors and develop mutually beneficial partnerships. The CSpO initiative also provides opportunities for the CAF to be diversified in its access to information through its closest allies. The Combined Space Operations Center (CSpOC) at Vandenberg Air Force Base, employs a commercial integration cell which solidifies the partnership with industry that contributes to diversification through strong partnerships.

d. Protection has many contextual definitions. With reference to SDMA, it is defined as “. . . measures to ensure those U.S. space systems, and those of our partners upon which we rely, provide the required quantity and quality of mission support in any operating environment or condition.”¹⁵ There is a mutually beneficial aspect to this definition. The CAF’s contribution to the SSN through Sapphire will provide support in return given that it is a system upon which they rely. There is a similarity in capability to defensive operations. The difference is in that resilience as the third category to SDMA is solely internally focussed, vice the external focus of the defensive operations category in this framework¹⁶. Protection is a characteristic that if at all possible needs to be applied early on in the system’s design. It is impossible to add protective characteristics to a satellite once launched and difficult to do the same to the ground segment once operational. As the CAF works to replace the Sapphire satellite system, protection of the space and ground segment is of critical importance in the planning stages of the new system with regard to this characteristic of resilience.

¹⁵ *Ibid*, 7.

¹⁶ *Ibid*, 5.

e. Proliferation is difficult to apply in that developing satellite systems in large numbers has a significant impact on the cost. There are only a select number of armed forces that have the resources to “[deploy] larger numbers of the same platforms, payloads or systems of the same types to perform the same mission.”¹⁷ This characteristic lends itself to the large super power countries. There are still opportunities for proliferation to be a factor in smaller militaries. A military application of a micro satellite constellation is a case where proliferation would be possible and contribute to an increase in resilience. Applying this characteristic to current systems is not practical but should there be a capability deficiency where a constellation of small satellites would satisfy the requirement, there would be an increase in resilience.

f. Deception in the context of space resilience is not any different than the methods used by ancient armies to deceive its adversary. It is through this characteristic that a seemingly inferior and outnumbered opponent has vanquished a superior adversary. This characteristic is unique in that it be applied prior to and after launch. It can be applied to the space and the ground segment. It can involve technology or tactics. There is a creative aspect to incorporating deception into your system that is technology and system agnostic. It also can be continuously evolved based on the adversary’s response to it. It is limited only by the innovation of those involved in its development. This characteristic is one that can be applied to current and future systems to affect an increase in system resilience.

¹⁷ *Ibid*, 7.

11. Some characteristics directly impact resilience while others require a combination of characteristics to affect a deliberate change to resilience. It is the relationship between them and various combinations of them that can provide the most benefit to overall resilience. The characteristics of resilience and their relationships are described in the White Paper along with possible combinations for maximum benefit.

CONCLUSION

12. The era of uncontested use of space is over. SDMA is the means by which the CAF will maintain its involvement and credibility by ensuring its systems and capabilities are available when needed. The threefold approach covers a broad range of activities which relate to SDMA. Many activities in the framework are already occurring making maximum adherence to SDMA practices very realistic. In consideration of the SSE direction to “protect and defend”¹⁸ space assets, using this SDMA framework will ensure a wholesome approach to both current and future space systems. Applying these concepts will allow for decisions to be made with a more informed perspective and to reconsider current systems through the lens of resilience taxonomy. SSE further directs to “enhance the resilience of space capabilities”¹⁹. The further study and subsequent application of the SDMA framework is aligned with the policy direction, ensures congruence with allied practices and most importantly, delivers the best capability to the joint war fighter.

RECOMMENDATIONS

¹⁸ Department of National Defence. *Strong, Secure, Engaged: Canada’s Defence Policy* (Ottawa: Canada Communications Group, 2017), 72.

¹⁹ *Ibid.*

13. Adopt the SDMA framework from JP 3-14 and formalize it by adding it to CAF space doctrine with the necessary changes in language to reflect CAF policy.
14. Include SDMA in the DG Space roadmap as its own line of effort that spans across force development, force employment and force generation.
15. Conduct further analysis to determine the full extent to which current relationships with allies and industry fit within the categories of SDMA.
16. Apply SDMA categories to current CAF space systems to develop the necessary and steps to improving space system resilience.
17. Collaborate with appropriate staff as mission assurance is developed in the cyber domain.

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