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Integrated Sensor-to-Shooter Operations Are Crucial for the CAF

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THESIS STATEMENT

Effective sensor-to-shooter operations requires multi-domain integration and interoperability. This paper will argue that the integration of sensors will empower commanders. This will be demonstrated by arguing that multidomain data fusion will be crucial and that network interoperability will provide a shared situational awareness.

JOINT TARGETING BACKGROUND

The targeting process throughout the past thirty years has evolved and adapted in response to the composition of the operations environment, varying from vast desert area to dense urban centres, and technological advancements. At its core, the concept of targeting appears rather simplistic; identify a list of potential targets using all available intelligence sources, fix their locations and allocate available assets to strike the target at a specified time. Deliberate targeting of fixed or non-fleeting targets such as infrastructure like Integrated Air Defence Systems(IADS) or Command and Control (C2) nodes enables planners to work within a specified Air Tasking Order (ATO) cycle (ranging from 24 hours to three days) and allocate targets to aircraft on the subsequent ATO[1]. During the planning and execution for Op DESERT STORM, the strategic target list grew to 862 targets; however, Battle Damage Assessments (BDA) were only able to be accomplished for 357 targets[2]. Throughout the campaign, air power was impacted by

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[1] Hew, Patrick Chisan "New Paths from Sensor to Shooter: How Digitization can Change the Formability and Topology of Information Flows in Systems that Acquire and Prosecute Targets" *Australian Government, Department of Defence Science and Technology* (October 2017) Pg 26. Retrieved on 16 May 20 from: https://www.dst.defence.gov.au/sites/default/files/publications/documents/DST-Group-TR-3417.pdf

[2] United States. General Accounting Office. *Operation Desert Storm: Evaluation of the Air Campaign.* Washington: National Security and International Affairs Division, 1997, pg 27. Retrieved on 16 May 20 from: https://www.gao.gov/assets/230/224366.pdf

the failure to gather intelligence on critical targets, and the inability to collect and disseminate BDA in a timely manner, thus resulted in targets being reallocated to subsequent sorties only to find that they had previously been hit[3]. This limited availability of post-strike sensor data led to the use of post mission cockpit recordings to augment sensor data for BDA[4].

Conversely, dynamic targeting of fleeting targets, which are anticipated to have an engagement window limited less than 24-hours[5], requires expedited means to identify and assess the target, seek engagement authority and re-task assets to prosecute it. The management of airborne strike assets to respond to dynamic targeting has varied from the on-call Close Air Support (CAS) utilized during the ground campaign portion of Op DESERT STORM, to combination tasked sorties with deliberate Air Interdiction while keeping reserve munitions available for dynamic targeting. Throughout Op ENDURING FREEDOM in Afghanistan, dynamic targeting was extremely reactive; "During the 2009-2010 surge, it was common for aircrew to brief a set of missions, but execute none of them. Instead they would be re-tasked multiple times while in a briefing, while stepping to the aircraft, during takeoff, and even while en route[6]". Coordination and building situational awareness upon arriving at the strike location was also extremely challenging. The aircrew would be provided initial target details by the AWACS during transit; on

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[3] Ibid. Pg 19
[4] Ibid. Pg 55
[5] Hew, Patrick Chisan "New Paths from Sensor to Shooter: How Digitization can Change the Formability and Topology of Information Flows in Systems that Acquire and Prosecute Targets" *Australian Government, Department of Defence Science and Technology* (October 2017) Pg 26. Retrieved on 16 May 20 from: https://www.dst.defence.gov.au/sites/default/files/publications/documents/DST-Group-TR-3417.pdf
[6] Benitez, Mike "How Afghanistan distorted Close Air Support and why it matters" *War on the rocks.* (29 June 2016) Retrieved on 20 May 2020 from: https://warontherocks.com/2016/06/how-afghanistan-distorted-close-air-support-and-why-it-matters/

descent, switch frequencies to the Joint Terminal Attack Crew (JTAC) for target talk-on, often while avoiding low-level helicopters either transiting the area or possibly also prosecuting the same target but operating on a different frequency[7].

Advancements of technology over the past decade have vastly increased the sensor capabilities and data sharing of multi-domain platforms, while digital friendly force tracking capabilities are increasing situational awareness of the battlefield. Digitally aided CAS enables the sharing of the video feed from the aircraft's target pod with the ground JTAC who can then provide amplifying information back to the aircrew digitally[8]. Interoperability at all levels (across domains, and multinational partners) within the sensor-to-shooter chain is key to executing Multi-Domain Operations (MDO)[9]. With greater emphasis for shared situational awareness during the tactical execution phase to enable more efficient and effective joint targeting by multinational forces.

JOINT INTELLIGENCE SURVEILANCE and RECONNAISANCE (ISR) ENABLING MDO

The first process to enable joint targeting is the ability to leverage sensor data from multi-domain ISR platforms, routing this raw intelligence data to the appropriate data fusion cells within command centres for processing, exploitation and dissemination (PED) of their analysis. The processed data shapes the situational awareness of the operational environment enabling commanders and their entire operations team to make

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[7] Ibid.
[8] Hew, Patrick Chisan "New Paths from Sensor to Shooter: How Digitization can Change the Formability and Topology of Information Flows in Systems that Acquire and Prosecute Targets" *Australian Government, Department of Defence Science and Technology* (October 2017) Pg 14. Retrieved on 16 May 20 from: https://www.dst.defence.gov.au/sites/default/files/publications/documents/DST-Group-TR-3417.pdf
[9] US Army. TRADOC Pamphlet 525-3-1 The US Army in Joint Domain Operations 2028 (6 Dec 2018) Pg 23. Retrieved on 16 May 20 from https://www.tradoc.army.mil/Portals/14/Documents/MDO/TP525-3-1_30Nov2018.pdf

timely informed decisions. There are many challenges to accomplish this; sensor data sources and formats vary significantly; capacity to process the vast amounts of data are limited; and classification levels of the data sources can inhibit information sharing. Within each domain nearly every platform has a sensor capability tailored to their primary mission, advancements of technology enabling sharing their data for broader use results in multiple mediums leveraged, such as space-based, ground-entry sites (GES) or direct communications. A prime example of this are the modifications to our CP-140 Aurora with advanced Beyond Line of Sight (BLOS) satellite communications enabling secure high-speed data to be streamed from the aircraft sensors[10]. This new capability was immediately employed supporting expeditionary operations with over-land ISR capabilities, a significant leap from their typical maritime roles. The vast employment, and variants, of Unmanned Aerial Vehicles (UAVs) by Army, Air Force and Navy also provides a multitude of cross-domain ISR sources; while space-based sensors remain the primary source. "Data from signals intelligence and imagery satellites have the reach to fill critical intelligence gaps in denied areas that other air, sea, and land assets cannot observe without significant risk of interdiction or destruction[11]". With this multitude of ISR capabilities, cross-domain interdependence and integration is necessary to enable responsive prosecution of fleeting targets[12].

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[10] Van Wagenen, Juliet "IMP delivers first BLOS-fitted Aurora aircraft to Canadian Air Force" *Avionics International.* (17 Dec 2014) Retrieved on 22 May 20 from: https://www.aviationtoday.com/2014/12/17/imp-delivers-first-blos-fitted-aurora-aircraft-to-canadian-air-force/

[11] Harris, Albert III. "Preparing for Multidomain Warfare" *Air and Space Power Journal* Vol 32, No. 3 (Fall 2018): Pgs 50. Retrieved 17 May 20 from: www.airuniversity.af.edu/Portals/10/ASPJ/journals/Volume-32_Issue-3/V-Harris.pdf

[12] Atkins, Sean A. "Multidomain Observing and Orienting, ISR to Meet the Emerging Battlespace" *Air and Space Power Journal* Vol 32, No. 3 (Fall 2018): Pgs 26, 29 Retrieved on May 16 from www.airuniversity.af.edu/Portals/10/ASPJ/journals/Volume-32_Issue-3/F-Atkins.pdf

Understandably, this significant increase of multi-domain data sources inundates the data fusion centres striving to analyze the it and provide meaningful information to command teams. Towards this challenge, technological advancements in data analytics are able to be leveraged such as target recognition software and Artificial Intelligence or machine learning to quickly analyze the raw data and restructure it into a more useable format[13]. Depending on the tactical circumstances and situational awareness, cross-domain analysis and action could be empowered at lower command levels enabling immediate action to prosecute fleeting opportunities[14], supported by appropriate Rules of Engagement (ROEs) and delegations of authority. Empowering decisive actions at the lowest level can significantly improve multi-domain operations.

Classification of information relative to the data sensor classification often leads to delayed response times to act upon the information and limits data-sharing with multi-national partners. For instance, sensor data from higher classification sources may have earlier indicators of information requiring action; however, relaying this information to an operations team with lower classification clearances requires cross-referencing the information with lower-classified sensors prior to releasing the information for action to be initiated. I can attest, that as an operator, having the radar plots displayed on our screens be our first indications of an active track while the intelligence section had known of its presence significantly prior, severely inhibited our ability to respond and accomplish our mission. With broader accessibility to multi-domain sensor systems and leveraging an open architecture for interoperability of these systems, the classification

[13] Ibid. Pg 37.
[14] Ibid. Pg 30.

levels could shift to be more data centric rather than sensor centric[15]. Recent recommendations by MITRE, a non-partisan science and technology research corporation for the United States, suggests developing an architecture with "loose couplers" to enable sharing of the core (lower-classified) data while limiting the higher classified rich data[16]. This design would enable widespread interoperability facilitating multi-domain operations with allied and partner systems.

TACTICAL SA FOR MDO

Building upon the sensor to shooter timeline, this next section will focus on the coordination and shared situational awareness (SA) capabilities enabling more efficient and effective joint targeting. The importance of shared SA cannot be over-stated. At the operational command and control (C2) level, tactical data-link positional and status information of assets are displayed in near-real time to inform supporting and supported commanders of the common operational picture (COP). This enables the C2 team to re-allocate resources to provide quick response in prosecuting a dynamic target[17], noting that dynamic re-tasking of assets requires careful evaluation of the impacts of diverting from their current mission[18]. At the operational level, this big-picture granularity of SA functions well to keep the command team informed of asset management. As the dynamic targeting tasking flows through to the tactical level though, the coordination process and establishing SA tends to resemble managed chaos, as alluded to earlier from

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[15] Ibid. Pg 40.
[16] Niewood, Eliahu; Grant, Greg; and Lewis, Tyler"A New Battle Command Architecture for Multi-Domain Operations" *The MITRE Corporation* (Dec 2019) Retrieved on 20 May 20 from: https://www.mitre.org/sites/default/files/publications/Joint-All-Domain-Command-Control.pdf
[17] USJCS "Joint Publication 3-09 Joint Fires Support" (10 April 2019) Pg 65. Retrieved on 16 May 20 from https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_09.pdf
[18] USJCS "Joint Publication 3-30 Joint Air Operations" (25 July 2019) Pg 79. Retrieved on 16 May 20 from https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_30.pdf

the first-hand accounts of aircrew in Afghanistan 2009 – 10[19]. The target details would be relayed to the strike aircraft by a combination of verbal and digital information while transiting to the area; however, the air and ground SA, historically have been rather limited in their ability to establish shared SA. The air-picture would leverage tactical data-link information of other link-enabled aircraft, while the ground picture would be shaped verbally from the observer or JTAC while the strike aircraft is descending and maneuvering for ingress to the target. Cross-domain sharing of digital positional information at the tactical-level is limited due to incompatibilities of systems but advancements to bridge these differences and field cross-domain data solutions are being developed and fielded. One such solution was the Situation Awareness Data Link which would display plots on a heads-up display to depict positions of friendly forces; while more recent developments of the Remotely Operated Video Enhanced Receiver (ROVER) enable the JTAC to view the Video Data-Link (VDL) streaming video of the strike aircraft's targeting pod[20]. This facilitates a shared view of the target and as well as enables the JTAC to provide amplifying digital marking of the exact target to be engaged.

MDO INTEGRATION FOR THE CAF

Within the US, and equally in Canada, each service / element historically pursues capability development through the lens of their specific operational domain, this results in disparity of systems hampering their interoperability thus requiring adaptations to

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[19] Benitez, Mike "How Afghanistan distorted Close Air Support and why it matters" *War on the rocks.* (29 June 2016) Retrieved on 20 May 2020 from: https://warontherocks.com/2016/06/how-afghanistan-distorted-close-air-support-and-why-it-matters/

[20] Hew, Patrick Chisan "New Paths from Sensor to Shooter: How Digitization can Change the Formability and Topology of Information Flows in Systems that Acquire and Prosecute Targets" *Australian Government, Department of Defence Science and Technology* (October 2017) Pgs 13-14 Retrieved on 2 May 20 from: https://www.dst.defence.gov.au/sites/default/files/publications/documents/DST-Group-TR-3417.pdf

enable cross-domain solutions[21]. Moving forward, Canada's Defence Policy 2017, has a significant number of investment initiatives which will directly support MDO and improve our sensor to shooter capabilities. Joint ISR has been recognized as a dominant enabler with resources to be allocated expanding these capabilities. Specifically, initiative 67 focuses on investments of Joint ISR next-generation aircraft, remote-piloted systems and space-based surveillance assets; while initiative #68 focuses on integration of existing and future systems into a networked joint system-of-systems architecture to enable flow of information among platforms and headquarters[22]. Further supporting the expansion of Joint ISR capabilities are targeting initiatives 70 through 72 which focus on the intelligence PED functions by establishing the 120 new military and 180 new civilian positions bolstering CFINTCOMs capacity to provide advance intelligence support leveraging multi-domain platforms and specifically shaping their targeting capability to support military operations[23]. Initiatives 44 and 91 directly support the shooter capacity through the future replacement of our fighter aircraft and the addition of an armed aerial surveillance remote piloted system[24].

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[21] Perkins, David G. and Holmes, James M. "Multidomain Battle Converging Concepts Toward a Joint Solution" *Joint Force Quarterly* Vol 88, 1st Quarter 2018: Pg 54. Retrieved on 20 May 20 from https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-88/jfq-88_54-57_Perkins-Holmes.pdf?ver=2018-01-09-102340-943

[22] National Defence. *Strong Secure Engaged. Canada's Defence Policy* (2017) Pg 65. Retrieved from https://www.canada.ca/en/department-national-defence/corporate/policies-standards/canada-defence-policy.html?utm_source=dgpaapp&utm_medium=referral&utm_campaign=redirect

[23] Ibid. Pg 66.

[24] Ibid. Pgs 39 & 73.

CONCLUSION

In conclusion, our allies are transforming sensor to shooter operations to leverage multi-domain capabilities enabling seamless interoperability. Joint ISR capacity has experienced the largest growth with nearly every platform leveraging their sensors and routing their data feeds directly into intelligence data-fusion cells. These additional sensors, augmenting the vast array of remote piloted ISR systems and space-based surveillance are surpassing the processing capacity to analyze the raw data and provide timely reports. Implementing big-data analytics and exploring AI solutions will empower these intelligence processes, while exploring open-architecture network designs will facilitate broader sharing of the information with multinational partners. A more detailed COP is possible through the fusion of data-link feeds from multi-domain sources, thus enabling supporting and supported commanders to respond more effectively to dynamic targeting situations. Better air-land integration during the tactical phase will enable more effective and efficient prosecution of targets. If the MDO-centric investment initiatives identified within Canada's Defence Policy 2017 are supported and implemented in a timely manner, Canada would be well equipped to support MDO with our allies. It is imperative, however that we develop these capabilities in collaboration with our coalition partners and jointly within our elements.

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