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EXERCISE NEW HORIZONS
THE CANADIAN APPROACH TO NETWORK CENTRIC WARFARE: DATA LINKS AND MULTI-SENSOR INTEGRATION

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ABSTRACT

This paper argues that to develop and maintain Canada's joint and coalition warfare fighting capability; the Canadian Forces (CF) must invest substantially into Network Centric Warfare (NCW) capabilities, based on data link and multi-sensor integration initiatives. The essay begins by exploring the characteristics of modern coalition warfare and by doing so will illustrate some of the challenges and warfare capability shortfalls faced by the Canadian military to operate within a Coalition. Within the coalition battlespace, a key to 21st Century transformation joint force interoperability and integration is being realized by the implementation of the Network Centric Warfare concept. Data Link technologies has facilitated a networked battlespace encompassing all combat services to bridge the time and space element of warfare. The efficiency and effectives of Joint Force capabilities have been enhanced to a significant degree where data links serve as a force multiplier in the effective application of combat power. If interoperability and the successful conduct of joint and coalition operations are key objectives for allied military powers, then advances in data link and sensor integration technologies, network-centric systems and doctrine are endeavouring to meet the interoperability issue challenging modern combat forces. Due to the lack of capital investment by Canada into NCW technologies, the Canadian military has found itself lacking essential warfare fighting capabilities such as Data Links and Multi-sensor Integration. The paper concludes that in order for the CF to develop and maintain effective coalition warfare fighting capabilities, it must embrace a course of action focused on a substantive collaborative procurement effort with the U.S. in regards to Network Centric War technologies, namely Data Links and multi-sensor integration.

Today's Commander exercises command and control (C2) in modern warfare by employing an array of electronic and non-electronic means. Developments in information data[1] link technologies have enabled the development of increasingly capable and sophisticated networked C2 systems that are being utilized by United States (U.S.) forces within the joint battlespace. Canada's future ability to operate with its allies in a Coalition depends largely on how Canada responds to the current Revolution of Military Affairs. The most tangible and warfighting concept to emerge from the U.S. Department of Defense focus on the RMA has been Network Centric Warfare (NCW). An evolving concept, NCW, combines the concepts of self-synchronizing forces, speed of command, and precision engagement. NCW seeks to transform information operations and superiority into an advantage on the physical battlefield. Information Operations (IO) integrate all aspects of information to support and enhance the elements of fighting power, with the goal of dominating the battlespace at the right time, at the right place and with the right weapons or resources.[2] The Defence Management Committee in the document *Shaping the Future of the Canadian Forces: A Strategy for 2020,* recognized the importance the "Revolution in Military Affairs and related changes in business management [as] the harbingers for

[1]Data are the raw material of C2 and originate from feedback of actions in the battlespace. They include signals from any kind of sensor, whether organic or non-organic, or communicated between any kinds of nodes in a system. Data are provided meaning through the act of processing. Processing involves aligning, organizing, formatting, collating, filtering, plotting and display, and any other similar conditioning function. Gilles Bérubé, "Technology and Decision," (Toronto: Canadian Forces College National Securities Study Course 4 Paper), 17.

[2]Michael Frater and Michael Ryan, "Communications Electronic Warfare and the Digitized Battlefield," Working Paper No. 116 (Australia, Land Warfare Studies Centre, October 2001), 10-11.

necessary change for the information age."[3] Recognizing the necessity to change, the authors of the document believe that innovation can only be realized by "combining dramatic changes in military doctrine and operational and organizational concepts" with new applications of technology.[4]

The 1991 Gulf War was heralded as the first "information war," in part due to the digital advantage that coalition forces enjoyed over the Iraqis.[5] Data Link technology[6] facilitated a networked battlespace encompassing all combat services to bridge the time and space element of warfare. The efficiency and effectives of Joint Force capabilities have been enhanced to a significant degree where data links serve as a force multiplier in the effective application of combat power.

This paper will argue that to develop and maintain Canada's joint and coalition warfare fighting capability; the CF must invest substantially into NCW capabilities, based on data link and multi-sensor integration initiatives. Initially the paper will explore the characteristics of modern coalition warfare and by doing so will illustrate some of the current challenges and warfighting capability shortfalls faced by the Canadian Forces to operate within Coalition. Due to the lack of capital investment into NCW technologies has found itself lacking essential warfare fighting capabilities. In particular, the paper will focus on the

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[3]Department of National Defence, *Shaping the Future of the Canadian Forces: A Strategy for 2020* (Ottawa: DND Canada, 1999), 2.

[4]*Ibid*.

[5]LtCol Walter Lossow, "Mission-type Tactics Versus Order-type Tactics," *Military Review* LVII, no. 6 (June 1977), 87.

[6]Data Link technology – Tactical Data Links s are utilized to exchange information such as text messages, data, radar tracks, target information, platform status, imagery and command assignments. Department of Defense, *Command, Control, Communications, Computers, and Intelligence (C4I) Joint Tactical Data Link Management Plan* (Washington, D.C.: U.S. Government Printing Office, June 2000), ES-2.

concept of NCW enabled by data links to establish an understanding of the problems Canadian military forces face that are engaged in Coalition operations. Secondly, the concept of a digitized battlespace will be discussed to illustrate the advantages of NCW that can be realized by a Coalition Force in warfare. Thirdly, the paper will argue why CF make substantial investments in the NCW concept, based on data link and MSI technologies. The discussion will explore the real-time recognized tactical and strategic battlespace picture and the essential requirement for having such a capability. Moreover, the paper will illustrate that network-centric operations underpinned by data link technology and multi-sensor integration is an essential enabler to shared Situational Awareness (SA), the effective application of combat power from a C2 perspective and the effects a Joint Force multiplier. Finally, the paper will address the risk associated with network-centric operations and the burden it brings to the joint command structure – the human command element. In the present context of combat information and knowledge technology proliferation, the human command element in the loop risks becoming the weak link in the decision making process unless appropriate steps are taken to develop the advanced tools to process and present the information in such a way that the commander can assimilate it. Otherwise, technology, instead of reducing the friction and the fog of war or being a force multiplier could actually become an additional burden to the commander.[7] The paper will conclude that Canada's capacity to maintain and develop a warfighting capability with its coalition partners is dependant on necessary investments such as NCW concepts and its interoperability enablers - Data Link and MSI technologies.

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[7]Gilles Bérubé, "Technology and Decision," (Toronto: Canadian Forces College National Securities Study Course 4 Paper), 5.

The face of the modern battlespace has and will continue to change with technology. Coalition warfare within a battlespace is and will be focused on information superiority centered on the concept that the dominant factor in war is the ability to collect, analyze, disseminate and act upon battlefield information.[8] U.S. Joint Vision 2020 establishes a conceptual template, which addresses the transformation of U.S. forces to create a force that is dominant across the full spectrum of military operations such as conventional warfighting, peace enforcement, peacekeeping, counter-terrorism, humanitarian assistance, and civil support.[9] Essentially, the key to full-spectrum dominance is information superiority, and NCW will act as the force multiplier for the Joint Force to accomplish this aim.[10] With an increased focus on Coalition warfare, the ability of a coalition partner to be interoperable within the battlespace will necessitate an investment in the requisite technologies associated with the NCW operations.

In 1998, Vice Admiral Cebrowski described how American military forces "are in the midst of a Revolution in Military Affairs (RMA) unlike any seen since the Napoleonic age, when France transformed warfare with the concept of levée en masse."[11] The RMA was brought on by a proliferation of information technology and computer connectivity as manifested today in the extensive availability of Internet access – the World Wide Web.

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[8]Frater and Ryan, "Communications Electronic Warfare and the Digitized Battlefield"…, 1.

[9]*Ibid.,* 3-4.

[10]*Information superiority*—the capability to collect, process and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same. Information superiority can therefore be defined as 'that degree of dominance in the information domain which permits the conduct of operations without effective opposition'. *Ibid.*, 4.

[11]Vice Admiral Arthur K. Cebrowski and John J. Garstka, "Network-Centric Warfare: Its Origin and Future," *Proceedings Magazine* 124, no. 139, January 1998: 29.

Cebrowski argues that these advances in information technology are causing military operations to shift from platform-centric warfare to the concept of NCW.[12] From his perspective, this emergence of new technology will enable an evolution from attrition warfare to a style of warfare characterized by speed of command and self-synchronization.[13]

Modern warfare experiences derived from past campaigns in Bosnia, Kosovo, the Gulf Wars and Afghanistan have demonstrated that Joint and Coalition Forces are being exposed to higher-tempo operations, with more dispersed forces throughout the entire depth of the battlespace. During Operations Enduring Freedom and Iraqi Freedom, many joint in-theatre assets were capable of exchanging C2 messages utilizing joint tactical information distribution system text messaging capability – Link 16 technology.[14] The E-2C Hawkeye, the navy's Airborne Warning and Control System platform and the air force equivalent E-3, provided "an increased situational awareness and expanded … role in the joint operations environment."[15] In the modern battlespace the commanders must see, decide and act faster than the enemy to operate inside the enemy's decision cycle. Therefore, an objective of networked forces is to provide accurate, real-time information to the commander, significantly reducing his uncertainty and allowing him to instantaneously direct combat power against the enemy.[16]

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[12]*Ibid.*

[13]*Ibid.,* 32.

[14]David C. Hardesty, "Fix Net Centric for the Operators," *Proceedings Magazine* 129, no. 207 September 2003: 69.

[15]*Ibid., 70*.

[16]Major Jack Kammerer, "Preserving Mission-Focused Command and Control," *Military Review* 77, no. 5 (Sep-Oct 97): 65.

Increased availability of satellites, digital communications, data links and the World-Wide-Web will give not only coalition forces but also adversaries' new combat capabilities. Therefore, coalition forces should not expect opponents in 2020 to fight with strictly 'industrial age' tools.[17] If contemporary trends continue, it is feasible then that future enemies could by-pass Western militaries strength and target Western civilian societies – a weakness. Our advantage must, therefore, come from leaders, people, doctrine, organizations, and training that enables us to take advantage of developing technologies and future warfare operating concepts such as NCW based on data link technologies to achieve superior warfighting effectiveness.

The complexity and unpredictability of the future battlespace, and in particular the availability of Intelligence, Surveillance and Reconnaissance (ISR) assets, demand that commanders seek information superiority to attain a high level of battlespace SA. ISR Data Link technologies have and will play a significant warfare role in creating what is being called a "single integrated battlespace."[18] Experiences and lessons of past Coalition warfare operations leads to the conclusion that NCW based on Data Link and MSI technologies can empower a Joint Force and create the conditions necessary for success. After all network-centric operations are really about optimizing combat power—that is, combat efficiency, which leads to effectiveness.[19]

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[17]Director for Strategic Plans and Policy, J5; Strategy Division; Joint Vision 2020 Brief; [reference works on-line]; available from http://www.dtic.mil/jointvision/jv2020.doc; Internet; accessed 11 March 2004.

[18]Command and Staff Course 27*, Intelligence, Surveillance and Reconnaissance Air Symposium 2001* ed. Lieutenant-Colonel Dennis Margueratt and Dr. Allan English (Toronto: Canadian Forces College Command and Staff College Air Symposium, 2001), 19.

The applicability and benefits inherent to NCW and associated technologies represents an opportunity to realize the full potential of a military force to include Canada's current force structures. However, taking an inventory of Canada's military capabilities it can be concluded that Canadian Forces has not made the requisite capital investments in NCW enabling technologies such as data links and MSI. There in lies the problem facing Canada's military force. Without the current data link and MSI technologies the potential capabilities and full interoperability will not be reached because of the inability to share joint battlespace awareness – SA and the subsequent inability to share common intent. A network-centric environment enabled by data links and other supporting technologies could address these shortcomings in Canada's warfighting capabilities and force projection.

Recounting the discussion, this paper has illustrated that coalition warfare has and continues to employ and develop the NCW concept but what is NCW? The concept encompasses a myriad of computer networking and information sharing technologies that has been described as:

> … an information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision makers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self synchronization.[20]

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[19]Department of Defense, *Network Centric Warfare Department of Defence Report to Congress 27 July 2001*, [reference works on-line]; available from http://www.defenselink.mil/nii/NCW/ncw_exec_sum.pdf; Internet; accessed 11 February 2004.

[20]David S. Alberts, John J. Garstka and Frederick P. Stein, Department of Defense, *Network Centric Warfare: Developing and Leveraging Information Superiority,* (Washington, D.C., DoD C4ISR Cooperative Research Group, 1999), 2.

NCW is not about applying new technologies to current platforms, organizations and the doctrine of warfare, but rather it goes way beyond this scope.[21] NCW has increased the operational tempo within the battlespace by drawing on combat power, which lies in the real-time awareness of adversarial forces thereby providing essential insight into "what the enemy is doing, what his intention is and how to target him quickly before he makes his next move."[22] It recognizes the centrality of critical battlespace information and its potential as a source of power for forces engaged in warfare or even Operations Other Than War (OOTW).

In essence, the NCW concept translates information superiority into combat power by effectively linking knowledgeable entities in the battlespace, which brings some inherent advantages to coalition warfare. By facilitating vital information flow between sensors, decision-makers and shooters in a NCW environment, time-critical data will be carried on a series of grids, which include the information grids, sensor grids and engagement grids.

> The information grid provides the infrastructure…for Computing and Communications…[it] provides the means to receive, process, transport, store and protect information for the joint force. Sensor grids are comprised of air, sea, ground, space, and cyberspace based sensors… [to] provide the Joint force with a high degree of awareness of friendly forces, enemy forces, and the environment across the joint battlespace. Engagement grids…enable the Joint Warfighter to employ the speed of command and achieve overwhelming effect at precise places and time[s].[23]

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[21]LtCol Tan Kim Seng, "Book Review: Network Centric Warfare Developing and Leveraging Information Superiority," *Pointer* 27, no. 4 (Oct-Dec 2001), [journal on-line]; available from http://www.mindef.gov.sg/safti/pointer/back/journals/2001/Vol27_4/8.htm; Internet; 15 March 2004.

[22]*Ibid.*

[23]Joint Chiefs of Staff, Department of Defense, "Information Paper: Observations on the Emergence of Network Centric Warfare," [article on-line]; available from http://www.dtic.mil/jcs/j6/education/warfare.html; Internet; accessed 4 March 2004.

Kenneth Watman wrote that the sensor grid was the single most important "force multiplier".[24] Clearly, the motivation for migrating to network architecture is to maximize the effectiveness of the passage of information between sensors, C2 elements and weapon systems. Moreover, it will permit dispersed and distant forces to prosecute a multitude of target types, centers of gravity, critical vulnerabilities, operational functions, and tactical forces simultaneously – executing parallel warfare.[25]

Structured around the concept of sharing information and assets, NCW accomplishes its overall objective by networking combat and support entities to develop information based alliances with and amongst the three military Services; Army, Navy and Air Force acting "'Jointly' to leverage on real-time information in the modern battlefield."[26] The NCW battlespace has the ability to spawn increased tempo of operations, increased responsiveness by an adaptive C2 structure, lower risks associated with warfare and increased combat effectiveness through an elevated situational awareness at all levels of combat operations.[27]

As alluded to earlier, there are inherent advantages to NCW operations. Network-centric forces will be better able to execute combat or operational tasks in a joint or coalition warfare environment to maintain the initiative, gain the advantage and achieve the strategic objectives. Its technological advances, underpin the ability of a force to detect, identify and track a multitude of targets or target sets within the battlespace; select, organize, and use the

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[24]Kenneth Watman, "Global 2000," *Naval War College Review* LIV, no. 2 (Spring 2001): 78.

[25]Paul Murdock, "Principles of War on the Network Centric Battlefield: Mass and Economy of Force," *Parameters* XXXII, no.1 (Spring 2002): 91.

[26]LtCol Tan Kim Seng, "Book Review: Network Centric Warfare Developing and Leveraging Information Superiority," *Pointer* 27 no. 4 (Oct-Dec 2001), [journal on-line]; available from http://www.mindef.gov.sg/safti/pointer/back/journals/2001/Vol27_4/8.htm; Internet; 15 March 2004.

[27]*Ibid.*

correct systems; generate desired effects; access results; and reengage with decisive speed and overwhelming operational tempo as required, throughout the full range of military operations.[28]

The combat capabilities realized by a networked force to react quickly and target effectively should result in a force multiplication effect of combat power within the battlespace. Data links and MSI facilitate the fundamental requirements by transmitting secure, digital displays and messages amongst network-centric platforms and battlespace participants. Through the digitization of the battlespace, the force is able to facilitate the transmission, collection and processing of information from the various platforms, and sensors to be amalgamated, sorted and redistributed to the warfighting entities within the battlespace lending to an effective and efficient networked combat force.

The speed and precision of combat realized by NCW make it feasible to exploit specific battlefield opportunities and operate at a pace calculated to overwhelm an enemy's capacity to respond. "To deal with changes in the enemy threat or take advantage of emerging battlefield opportunities, we must be able both to conduct rapid, semi-independent operations – parallel operations and to mass forces and effects as required."[29] A Joint Force's ability to exploit this agility, speed and precision will be derived from the amalgam of information, sensors, and communications that constitutes the 'information backplane' of network-centric operations.[30] The network supported by data links and senor integration

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[28]Raytheon, "Warfighter's Requirements: Precision Engagement;" [reference works on-line]; available from http://www.raytheon.com/feature/iasse/pdf/pinnypresentation.pdf; Internet; accessed 12 March 2004.

[29]Edward A. Smith, Jr., "Network Centric Warfare What's the Point?" *Naval War College Review* LIV, no.1 (Winter 2001): 63.

[30]*Ibid., 70-71.*

permits a force to execute more actions in a given time, to focus the efforts of the joint force, and to act and react faster and with more certainty.[31] In the business world, "Network Centric Warfare is to warfare what e-business is to business."[32] Given a fully functioning network, what part of the force 'knows' about the enemy or battlespace, the whole force knows; what one part 'sees', all parts see; and what one part 'thinks' is available to the entire force.[33] This in effect has an overpowering tempo and a precise agile style of manoeuvre warfare.[34] Moreover, it is argued that NCW and data links will enable us to create and exploit a common situational awareness (SA), increase our speed of command – decision-making, and "get inside the enemy's OODA [observe, orient, decide, and act] loop."[35]

The NCW concept is the best term developed to date to describe the way we will organize and fight in the Information Age.[36] Traditional warfare operations are considered platform-centric, in that, combat assets such as aircraft, ships and ground units operate virtually as independent entities. This is a contrast to NCW, which focuses on sharing information rapidly amongst different entities in order to increase their ability as a whole to

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[31]*Ibid., 61.*

[32]Dr. Ed Kruzins, Department of Defense - Defense Science and Technology Organization, "Network Centric Warfare: Connecting Sensors, Shooters, and Decision Makers," [reference works on-line]; available from http://questnet.scu.edu.au/uploads/49.pdf; Internet; accessed 4 March 2004.

[33]Watman, "Global 2000"…, 76.

[34]Commander Erik J. Dahl, "Network Centric Warfare and the Death of Operational Art," *Defense Studies* 2, no. 1 (Spring 2002): 3.

[35]Observe, Orient, Decide, Act—a cycle used by Colonel John R. Boyd, U.S. Air Force, to characterize fighter engagements and since then applied to the decision-making process in general. John R. Boyd, *A Discourse on Winning and Losing* (Maxwell Air Force Base, Alabama: Air University Press, August 1987). Smith, Jr., "Network Centric Warfare What's the Point?" …, 61.

[36]Alberts, Garstka and Stein, *Network Centric Warfare …,* 2.

respond to threats and afford the commander the opportunity to respond rapidly to adversarial forces. The NCW concept recognizes the central tenets of information warfare both offensive and defensive by specifying knowledgeable assets and by linking the combat and support forces into a single whole.[37] It focuses on the importance of interactions among battlespace players that are necessary to generate synergistic effects. NCW thus has the characteristics to cope with today's dynamic nature of warfare.[38] NCW is about the maintenance of battlespace SA and knowledge by taking advantage of processing capabilities and available real-time information and how it translates into a common recognized operating picture for the commanders to execute their campaign intelligently yet, with the intent to be void from enemy prosecution. "NCW is about developing collaborative working environments for commanders, and indeed all our soldiers, sailors, marines, and airman to make it easier to develop common perceptions of the situation and achieve coordinated responses to situations."[39] In a network centric operation, it is possible to pass sensor data to permit one warship to shoot down an incoming missile while using another ship's recognized radar picture.[40] NCW refers to the linking of military platforms and units, into a common shared awareness network in order to obtain information superiority and enhance decision-making.[41]

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[37]Seng, "Book Review: Network Centric Warfare Developing and Leveraging Information Superiority"….

[38]*Ibid.*

[39]Alberts, Garstka and Stein, *Network Centric Warfare* …, 12.

[40]Elinor C. Sloan, "Revolution In Military Affairs? An Assessment of US Force Transformation," Department of National Defence, Canada, D Strat A, Project Report No. 2001/05.

[41] Walter Perry, *et al*., Measures of Effectiveness for the Information-Age Navy: The Effects of Network-Centric Operations on Combat Outcomes (Santa Monica: Rand, 2002), p. xiv.

Frater and Ryan provide this summary of the inherent benefits of NCW by writing,

> Although the promise of command and control in the Information Age may stop short of completely dissipating the fog of war, it has significant potential to improve a commander's awareness, to achieve spans of control that can be measured in global terms, and to mass collective combat power without massing forces… The decisive advantage on the modern battlefield will go to the commander who can gather and exploit information most effectively. While this is greatly assisted by the technologies associated with the information revolution, the human element is arguably the most significant.[42]

Mastery of digital systems NCW operations facilitates decentralized execution by pilots, ships and crews, supporting the central tenet of basic Aerospace doctrine, "centralized control and decentralized execution."[43] According to Kahan, Worley and Stasz, a commander uses information to obtain, "a dynamic image [commander's mental model] of the battlefield that will lead him to understand what action needs to be taken."[44] Sharing this image with his subordinates helps the commander in establishing "a common intent to achieve coordinated action"[45] Clearly, tools that aid a commander in the command of combat power will most certainly have a multiplying effect and enhance warfighting capability.

Furthermore, enhancing battlespace SA should be a priority of any commander, especially in a combat situation where the consequences of error could be fatal. The

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[42]Frater and Ryan, "Communication Electronic Warfare and the Digitized Battlefield"…, 43-44.

[43]Department of Defence, *Out of the Sun* (Winnipeg: Craig Kilman & Associates LTD), 35-36.

[44]James P. Kahan, Robert D. Worley and Cathleen Stasz, "Understanding Commanders' Information Needs, (Santa Monica, CA: RAND Arroyo Center, RAND Corporation, 2000), viii.

[45]Bérubé, "Technology and Decision" …, 16-17.

application of data fusion[46] or MSI offers the opportunity to improve SA through the processing of data from multiple sources into actual information more usable by the commander such as a single target to be develop a common operating picture of the battlefield. NCW with its component elements such as data links, MSI will provide the critical tools to augment joint force operators to achieve the information superiority required to dominate modern warfare.

Current TDLs are generally optimized to serve a single class of user, an increasing number of different links have been established to meet specific user requirements. This has resulted in a number of legacy systems that do not always provide full Interoperability. In order to conduct more effective military operations and achieve RT/NRT exchange of control and surveillance information in both the joint and combined arenas, there is an identifiable CF requirement to invest in JTIDS/MIDS/Link 16/22 for a number of platforms and capabilities to provide a more interoperable multi-Link environment, over and above its current Link 11 capabilities.

TDLs are pivotal in supporting CF tactical C2 functions within a Coalition Operation. By virtue of their ability to exchange information quickly and efficiently between participating units TDLs provide the CF and its subordinate C2 agencies with real and near real-time (RT/NRT) data on battlespace information. This data necessarily includes the precise location of land, maritime, and air platforms – friendly or otherwise – that can be extrapolated to compile a tactical or Common Operating Picture (COP), along with

[46]Data fusion is the seamless integration of data from disparate sources. The data have been integrated across data collection "platforms" and geographic boundaries, and blended thematically, so that the differences in resolution and coverage, treatment of a theme, character and artifacts of data collection methods are eliminated. David Hastings, World Data Center-A, National Geophysical Data Center, “Data Fusion, What is it?” [reference works on-line]; available from http://www.ngdc.noaa.gov/seg/tools/gis/fusion.shtml; Internet; accessed 4 March 2004.

information on weapons control and engagement status, intelligence, and Electronic Warfare (EW) and C2 directives. Moreover, a high degree of interoperability is essential to ensure that the fullest range of tactical information can be shared across the TDL domain with accuracy and common understanding lending itself to the self-synchronization of the force. Furthermore, Canada's allies, the U.S. and NATO have selected Link 16 as the main TDL for Theatre Missile Defense, not withstanding its enhanced operational warfare application throughout the battlespace as attested to in past and present campaigns as a Joint Force multiplier.[47]

The Link 16 J-series messaging will be used as the primary TDL for exchanging tactical and operational data, in conjunction with the Link 16 M-series until at least 2015.[48] It follows that there will be a continuing requirement for Link 16/Link 11 data forwarding for the near future. With the procurement of the 5 KHz Satellite Communication (SATCOM) DAMA equipment and the Canadian Military Satellite Communication project, Canada will continue to support the deployment of Satellite TDL Data Communications with CF, U.S. and Allied partners.[49] C2 units should have Link-16 UHF and SATCOM capability and with a future Link 22-growth capability. A progressive TDL procurement and implementation plan which is consistent with Standardized Agreements (STANAG's) 5516, 5522, 5616 for data forwarding and STANAG 4175 for the Multi-Function Information Distribution System

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[47]Department of National Defence, *Draft - Canadian Forces Tactical Data Link Concept of Operations* (Ottawa, DND Canada, 27 January 2003), 2.

[48]*Ibid*., 4.

[49]DMA – Demand Assigned Multiple Access. *Ibid.,* 3.

(MIDS)/Joint Tactical Information Distribution System (JTIDS) terminals will ensure the required interoperability with allied Coalition forces.[50]

Though older link technologies are being employed in the battlespace, the interconnectivity and interoperability provided by data links are proving to be central to effective enablers for modern warfare. Data links go hand in hand with a force capability to collect, process, and disseminate an uninterrupted flow of battlespace data while exploiting or denying an enemy's ability to do the same enables a force to achieve a domain of information superiority.[51] Accordingly, Links 16 and 22 should be procured for the CF 18's, Iroquois Class ships and Land Based Units. Furthermore, planning should be done for implementation in the Canadian Destroyer Replacement Programme (CADRE)/Frigate Extended Life Project (FELEX)/Maritime Helicopter Project (MHP)/Maritime Patrol Aircraft (MPA) & ALSC programmes currently be staffed within National Defence Headquarters.[52]

In principle, the Data Link of choice must have a continuous Over-the-Horizon capability component with or without the requirement for dedicated satellite resources or aircraft. Network design requirements should initially be sourced out to US Network Design Facilities in order to define and make available appropriate JTIDS/Multi-Function Information Distribution System (MIDS)/Link networks in support of National, Multi-National or Coalition network requirements. The CF will have a requirement to operate

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[50]*Ibid.*

[51]Wanja Eric Naef, *IWS – The Information Warfare Site*; [Reference Works on-line]; available from http://www.iwar.org.uk/rma/; Internet; accessed 10 March 2004.

[52]ALSC – Afloat logistics Sealift Capability Project (AOR replacement). Department of National Defence, *Canadian Forces Tactical Data Link Concept of Operations …, 19.*

normal day-to-day Multi-TDL operations at home to include exercises and training and out-of-area in support of Coalition operations.

Canada is a credible military power within the world and as such,

> plays an important role in the maintenance of peace and security. Canada has traditional military links within NATO and Partners for Peace (PfP) countries; however; its strengthened alliance with the U.S. is paramount. Today, the CF operates in close parallel with U.S. forces, operationally, worldwide and in regional exercises. The CF's interoperable warfighting capability and development must be in alignment with our Coalition partners with significant focus and collaboration with the U.S. military.[53]

Information exchange via real time TDLs will remain the backbone of tactical C2 systems well into the 21st century.[54] This is recognized with the emerging technical architecture for NCW discussed earlier in this paper. In this context, TDLs provide the means by which elements of the CF may exchange tactical data by electronic means with sufficient timeliness, relevance, quantity and compatibility to enable the commander of the force to make the best use of the sensor and weapons capabilities of those elements within the battlespace. Furthermore, the accurate and timely transfer of data between tactical systems and shore-based strategic and operational information systems from National, Other Government Departments and Alliance sources will prove critical to the development of a COP and to the seamless flow of information at all levels of warfare – Tactical, Operational and Strategic.

During large-scale operations and exercises, CF units will be dispersed over considerable geographical distances both at home and abroad. The timely dissemination of

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[53] *Ibid*., 3.

[54] *Ibid*., 46.

intelligence and surveillance information to in-theatre forces will be reliant on the availability of robust networks and strategic communications, data links, including satellite communications.[55] If SATCOM Links are not available, secure HF/UHF/Ground data Links between individual C2 entities will be operationally essential.

The successful conduct of operations will hinge, in part, on the CF's ability to exchange tactical information between individual forces, platforms and equipments on a RT/NRT basis, to the CF Joint Force Commander (JFC), his Joint Headquarters staff and his Component Commanders during the prosecution of missions. The complete exchange of data between C2 entities, weapons systems and platforms will facilitate mutual support, information gathering, dissemination, coordinated offensive/defensive action and the requirement for Command, Control, Communications Computers Intelligence (C4I) and ISR Data Fusion of the COP. It will also assist to minimize interference between friendly forces, thus enabling the effective application of combat power and reducing the risk of fratricide. Of equal importance, TDLs will offer the JFC the means with which to accurately husband and employ the active weapon systems under his control, also to capitalize on the strengths of sensor and weapons platforms within any Task Organization.

A robust Canadian Force's TDL operations will facilitate the continuous exchange of information on friendly, hostile, neutral and unidentified tracks within the three-dimensional Sensor, Information and Engagement battlespace grids. Furthermore, tactical data on the disposition of friendly units, and the status of active weapons and engagements may be exchanged. In larger scale operations, information on the progress of land, maritime and air operations within the designated CF's TDL Area of Operations can be provided to the JFC

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[55] *Ibid*., 4.

and his subordinate Component Commanders. TDL and its supporting equipment will also provide commanders with the ability to transmit time-critical orders to subordinates and requests to other agencies equipped with an equivalent TDL capability such as Coalition Forces.

In essence, TDLs are standardized communication's links suitable for transmission of machine-readable, digital information among airborne, land based and Maritime platforms which use these standard message formats to transfer defined elements of operational information between data link participants. Since current TDLs are generally optimized to serve a single class of user, an increasing number of different links have been established to meet specific user requirements. This has resulted in a number of legacy systems that do not always provide full Interoperability. In order to conduct more effective military operations and achieve RT/NRT exchange of control and surveillance information in both the joint, coalition and combined arenas, the CF has a requirement or need to invest in JTIDS/MIDS/Link 16/22 for a number of platforms and capabilities to provide a more Interoperable Multi-Link environment, over and above its current Link 11 capabilities.

> Canada's Tactical Data Link (TDL) Migration Strategy follow from those outlined by the US Department of Defense and NATO specifically to:
>
> a. Establish a J-series Family of Tactical Data Links;
> b. Improve Interoperability by suing standard messages and standardized data elements;
> c. Reduce interfaces between Tactical Data Links;
> d. Reduce data loss due to message and data element translation differences;
> e. Exchange the J-series Family of messages independent of specific communications media;
> f. Improve information dissemination; and
> g. Allow the introduction of emerging technology into the joint and combined operating environment.[56]

[56] *Ibid.,* 5.

Although CF maritime, air forces, and land Force units currently use Link 11, it does not support all the Information Exchange Requirements that are essential for the conduct of operations in a joint/coalition environment. Moreover, it does not have the capacity, speed and resilience to enable the timely exploitation of that data which is essential for the effective application of military force during a rapidly evolving tactical situation. Within the CF, the implementation of different C2 software versions for Link 11 among individual platforms has resulted in the compromise of interoperability in a number of operational areas.[57] Link 11, therefore, does not fully meet the future data link requirements for the CF. Other than maintain its simple house-keeping software or legacy hardware change requirements, further major implementation changes to currently-equipped Link 11 platforms is unlikely.

However, Link 16 has a high message capacity and transmission speed, and inherent Electronic Counter Measures (ECM) resistance and cryptographic security. Its system capacity and comprehens(oun2tn(ecticityifabili)]TJ0.00011 Tc -0.0013 Tw 9.1065 0 Td[atce dvtancnd itfoi)-7(r

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friendly units will be automatically exchanged. Link 16 is the preferred CF data link for the exchange of tactical information.[58]

Link 11 A/B are the predominant CF TDLs currently fitted in most of CF units. Link 11 will also be fully integrated into the Victoria Class SSK's and is being considered initially for the Maritime Helicopter Project earmarked to replace the aging Sea King Helicopter fleet. With the future improvements of Link capability – Link 16/22 the CF should consider its applicability and procurement with the view of the continuing requirement to interoperate with U.S. forces, NATO, and PfP assets, the CF will retain as a TDL capability, Link 11 until at least 2015.[59]

Inline with this thinking is the proposed strategy for the CF structure, defined in *Shaping the Future of the Canadian Forces: A Strategy for 2020* that is to position the force structure of the CF to provide Canada with modern, task-tailored, and globally deployable combat-capable forces that can respond quickly to crises at home and abroad, in joint or combined operations.[60] With the growing interoperable demands faced by Coalitions forces to operate within the modern battlespace, Canada must invest in NCW capabilities such as Links 16 and 22 capabilities to maintain and develop a relevant and capable coalition warfighting capability. By migrating to the previously discussed Tactical Data Link architectures, the CF can and will realize an enhanced interoperability warfighting capability with its coalition partners.

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[58]*Ibid.*, 47.

[59]*Ibid.,* 18.

[60]Department of National Defence, *Shaping the Future of the Canadian Forces: A Strategy for 2020* (Ottawa: DND Canada, June 1999): 8.

Seeing the battlefield better than the enemy sees it does not itself guarantee victory.[61] While there may continue to be a role for direct links from sensor-to-shooter, the ultimate aim of NCW is that the employment of future precision-weapons is designed around information. No single sensor has the ability to direct the application of these precision weapons—data must be integrated from a number of sensors and databases. The information network must be ubiquitous across the battlespace and must be fluid, flexible, robust, redundant and real-time; have integrity and security; have access and capacity; and be joint and coalition-capable.[62] Of course the essential factor to be considered is interoperability amongst the forces within the battlespace; commonality of current data link technology and the growing advancements in NCW will avert any negative impact discussed.

C2 architecture embodied by NCW systems will be heavily reliant on communications and information systems that cannot operate if access to the electromagnetic spectrum is denied. It then becomes a critical vulnerability for the joint force, sort of like a double edge sword. Yet no man or machine can ever operate with complete perfection, nor can we reach total certainty of information. Clausewitz's "fog and friction of war" will forever intrude, even on an enhanced digital battlefield.[63] As argued by Gilles Bérubé, technology could have counter effect on the force; instead of reducing the friction and the fog of war, it could actually become an additional burden.[64] However, most recent conflicts such

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[61]Hans Bennendijk and Richard L. Kugler, Center for technology and National Security Policy, "Adapting Forces to a New Era: Ten Transforming Concepts," *Defense Horizons*, No. 5, November 2001, [Article on-line]; available from http://www.ndu.edu/inss/DefHor/DH5/DH_05.htm; Internet; accessed 13 March 2004.

[62]Frater and Ryan, "Communications Electronic Warfare and the Digitized Battlefield"…, 7.

[63]Kammerer, "Preserving Mission-Focused Command and Control"…, 66.

as Operation Iraqi Freedom and Allied Force dispel this argument for with training and continued exposure commanders and forces will become proficient.

This paper has argued that to develop and maintain Canada's joint and coalition warfare fighting capability; the CF must invest substantially into NCW capabilities, based on data link and multi-sensor integration initiatives. Network-centric systems capable of drawing together and transmitting images, data of the entire battlespace hold promise to improve operational tempo, SA and command performance at all levels of warfighting. If interoperability is a key objective for the world's military powers, then advances in data link such as Links16/22, and sensor integration technologies, network-centric systems and doctrine are endeavouring to meet the interoperability challenge facing today's coalition militaries.[65] The key to 21st Century transformation of CF's Joint and Coalition Force interoperability and integration can and will be made possible by NCW and its enabling technologies. The speed and precision of Link technologies make it feasible to exploit specific battlefield opportunities and operate at a pace calculated to overwhelm an enemy's capacity to respond. They also offer a highly agile force, able to change from one rapid, precise operation to another at will and the ability to compress complex targeting processes to fit the nearly real-time dimensions of the battlefield. These emerging possibilities signal changes in how we wage war.[66] The measure of our success will be not the quality of the networking or the quantity of firepower we can bring to bear but the effect that networking

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[64]Bérubé, "Technology and Decision"…, 5.

[65]Canada, Defence Research and Development Canada, "Network Centric Warfare: Exploiting An Information Edge," *Issues: In Defence Science & Technology,* [Article on-line]; available from http://www.drdc-rddc.dnd.ca/publications/issues/issues_index_e.asp; Internet; accessed 13 March 2004.

[66]Smith, Jr., "Network Centric Warfare What's the Point ….

that is based on data links enables us to have on our would-be enemies in peace and in war.[67] Canada must embrace a course of action focused on a substantive procurement effort in regards to NCW technologies namely data links and multi-sensor integration initiatives.

[67] *Ibid.*

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