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The Integrated Canadian Forces: An Architectural Approach

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Abstract

The Canadian Forces currently conduct more multifaceted operations than in the past. The predominance of information and information systems has made war fighting more complex. Individual military services can no longer operate independently. Historically, military equipment acquisition did not place high priority on joint interoperability. Emphasis was on operating with like services of other nations. Project managers focused on delivering platforms and stand-alone systems vice capabilities. The result is that the Canadian Forces has limited joint interoperable capability. The latest Defence Policy Statement and the Chief of Defence Staff have placed high priority on joint capability. A new equipment management process must be adopted in order to achieve this capability. The Canadian Forces should institutionalize the use of enterprise architectures, in order to conceive, design, develop and manage the integrated, information age military forces necessary to conduct operations in the contemporary operating environment.

This paper will examine the use of enterprise architectures for equipment acquisition and management. It will argue that by using enterprise architectures, the Canadian Forces can create the information age military required for today's battles. Architectures will facilitate top down direction, capability analysis and improve communication amongst all of the stakeholders. The Chief of Force Development, being created under Canadian Forces transformation, should be appointed the chief architect to provide the required guidance, direction and oversight of the force development using an enterprise architecture approach to capability management.

"*We can't solve problems by using the same kind of thinking we used when we created them*" – *Albert Einstein*

The world in which the Canadian Forces currently operates has significantly changed since the days of the cold war. Today's contemporary operating environment is a great deal more multifaceted. The predominance of information and the systems with which to process and manage information have made war fighting more complex. In this environment, single military services can no longer fight independently and often must work with non-military agencies. This new complex battle space requires an equally complex joint war fighting capability. Many western nations have identified this as an operational necessity and have made inter-service interoperability an essential high priority requirement. Canada has also identified this requirement in its Defence Policy Statement. There is a clear emphasis on the need for a fully integrated and unified approach to operations.[1] Further, the Canadian Forces' Chief of Defence Staff, has stated that the Canadian Forces needs to move beyond joint and become an integrated force in order to remain strategically relevant, operationally responsive and tactically decisive.[2]

During the past decades, the integration and interoperability of the Canadian Forces was not a priority. During the cold war, emphasis was on combined operations, thus the Army, Navy and Air Force focused on interoperability with allied forces of the same service rather than capability to operate in conjunction with other Canadian

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[1]Department of National Defence, Canada's International Policy Statement: A Role of Pride and Influence in the World, Defence (Ottawa: Public Works and Government Services Canada, 2005), 11

[2]Gen Rick J Hillier, *CDS Planning Guidance – CF Transformation*. (National Defence Headquarters: file 1950-9(CT)), 18 October 2005.

services.[3] Project managers and equipment program managers managed platforms and platform replacement rather than considering them capabilities. The result was a degree of interoperability within the services, with little to no interoperable capability at the joint level. In 2000, the Canadian Forces and the Department of National Defence attempted to change this single service philosophy by adopting Capability Based Planning at the strategic level. However, the benefits envisioned have not yet been realized. One of the missing pieces is an analysis capability with which to make acquisition decisions and identify capability options. The Canadian Forces can no longer procure systems as it has in the past and expect to resolve the interoperability deficiencies. It must adopt a new capability acquisition process. The Canadian Forces and the Department of National Defence should institutionalize the use of enterprise architectures, in order to conceive, design, develop and manage the integrated, information age military forces necessary to conduct operations in the contemporary operating environment.

This paper will highlight the predicament surrounding the current lack of military interoperability at the joint level. It will provide examples of weapon systems and programs that have been delivered that do not maximize their capability because of their stovepipe delivery. It will identify a sample of programs that are proceeding without overarching direction and guidance. Then after providing a brief overview of enterprise architectures, it will illustrate the advantages offered by enterprise architectures that could benefit the Canadian Forces equipment program. Lastly, it will briefly discuss how enterprise architectures could be institutionalized during Canadian Forces transformation.

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[3]Major-General D.L Dempster, "Generalship and Defence Program Management," in *Generalship and the Art of the Admiral: Perspectives on Canadian Senior Military Leadership*. (St. Catherines: Vanwell Publishing Limited, 2001), 450.

In order for a military force to be fully integrated, it must be considered as one entity. Since a military force comprises many different systems, the approach to achieve this unity is to consider the military capability as a system of systems. This has not been the case in the past. Systems were procured on a platform centric basis or as stand-alone applications. Platforms and systems were often procured as replacements to existing ones. Although technology was incorporated into the replacement an overall systems approach was not taken. This platform or single system mindset resulted in the procurement of the Army's COYOTE reconnaissance vehicle. The stated requirement was to replace the LYNX vehicle. During its development, no detailed thought was given to its concept of operations. One of the results is that the reconnaissance squadrons do not have sufficient internal communications to operate over the distances they can now deploy. Further, despite the technologically advanced sensor suite, soldiers pass the information via voice over combat net radio. Alarmingly, at the time the Army was designing the COYOTE it was also designing its replacement digital communications system. However, this new system was being designed to replace the old system and not necessarily to allow integration of the Army's new sensor capabilities. It is evident that as these projects were being delivered the Army was neither using a system of systems approach nor managing them as integrated capabilities.

A system of systems approach is equally required on individual platforms. As recent as the fielding of the Light Armour Vehicle III or LAV III, the Army failed to adopt a systems approach to integrating its systems. On normal operations, a LAV III has two global position system (GPS) receivers. This would not be surprising if the system design required redundancy. Surprisingly, this is not the case. One is used for the

navigation system, while the second is a component of the situational awareness system. During deployment to the Canadian Manoeuvre Training Centre, these vehicles are fitted with a third GPS receiver for the weapon effect simulation system. A single GPS receiver could provide the positional data required by each of the three systems. This poor system engineering of a single platform is a symptom of the overall poor system of systems approach used within the Department of National Defence and the Canadian Forces.

Large multi-system programs are experiencing similar lessons. In particular, the Canadian Forces is experiencing challenge with their delivery of uninhabited aerial vehicles (UAV). Initial focus was on the delivery of the technology vice the capability. There was no over arching strategy or philosophy prior to commencement of these programs. The Army, Navy and Air Force are treating their projects somewhat as mutually exclusive endeavours. The Canadian experience is similar to that of the United States. In the United States, once the Office of the Secretary of Defense realised the gravity of duplication and the lack of coordination, it released a UAV Roadmap. This roadmap is directive in nature and stipulates a standardization of doctrine, development as well as the technological aspects of interoperability.[4] In Canada the Army, the Air Force and the former Deputy Chief of the Defence Staff (DCDS) organizations are developing concepts, spending on experimentation and in some cases procuring UAVs without an overarching strategy. In other words, without the roadmap that the United States deemed was so essential to ensure a unified and integrated effort. Although efforts

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[4]Major J.S.R. Mongeon, "Disjointed Capability Acquisition Process of Uninhabited Aerial Vehicles (UAV) in the Canadian Forces," (Toronto: Canadian Forces College Command and Staff Course New Horizons Paper, 2005), 5.

have been made to create a joint project office, Canada needs its own roadmap for her UAV program. The UAVs are part to the overall Command, Control, Communications, Computers, Intelligence, Surveillance, Target Acquisition, and Reconnaissance (C4ISR). The Canadian Forces C4ISR program is in desperate need of guidance and coordination.

A key part of the Canadian Forces transformation to a knowledge-based, information age force is the C4ISR capability. A number of organizations in the Canadian Forces are attempting to deliver C4ISR capability either to the joint war fight or to one of the services. In 2005, 91 projects were considered to be delivering C4ISR capability. These projects represent $10 billion of the capital equipment budget. In some years, the annual spending for these projects represents as much as 40% of the capital equipment budget. On their own, these figures are neither overly impressive nor alarming. The alarming piece of detail is that these projects are proceeding without any form of C4ISR doctrine, concept of operation, definition of interoperability, or even a common understanding of what C4ISR means.[5] Without this overarching direction, there is little guarantee that delivered systems will be interoperable on either the operational or the technical level. Without direction, the C4ISR systems that project managers deliver will be additional stovepipe systems that have not been conceived and designed to operate within the system of systems.

The C4ISR projects have been proceeding without clear direction or overarching doctrine. They lack the "roadmap" just as the United States UAV program did.

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[5]Auditor General of Canada Report to the House of Commons April 2005. *Chapter 4 National Defence- C4ISR Initiative in Support of Command and Control*. (Ottawa, ON: 200), 1. [on-line]; available from http://www.oag-bvg.gc.ca/domino/reports.nsf/html/20050404ce.html; Internet; accessed 14 January 2006.

Although there is a DCDS C4ISR Campaign Plan and Target Integration Model 2008, developed with the expectation that projects would self-synchronize. However, these documents are neither directive nor detailed enough to enable the coordinated development of the system of systems required in the C4ISR domain. Notwithstanding this lack of guidance, these 91 projects have expended almost 40% of their funding without knowing if the capability they are delivering will be required or will operate with other systems being delivered.[6] Inexcusably, some of these projects do not even have a statement of capability deficiency or a statement of operational requirement.[7]

One of the key elements of C4ISR is the command and control capability. Currently, there are no less than four command and control systems in use within the Canadian Forces. At the strategic level, the Canadian Forces Command System (TITAN) is used. At the operational and tactical level, the environments each use their own system. The Army uses the Land Forces Command System (LFCS), the Air Force uses the Theatre Battle Command Management System (TBMCS) and the Navy uses the Maritime Command Operational Information Network (MCOIN). These command systems are neither interoperable nor inter-connected. As the Canadian Forces transforms to a unified and fully integrated command structure it will be necessary to create a single integrated command and control capability. An architectural approach will facilitate this and overcome the technology focused stovepipe development of the past.

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[6]Auditor General of Canada…, 1.

[7]*Ibid*., 13.

The Joint Capability Review Board and the Command and Control Joint Capability Assessment Team have the mandate to provide oversight and approval of C4ISR projects. These boards have had difficulty in carrying out their mandates due to the requirement to compare a large number of dissimilar items. Further, the breadth of issues to be considered are vast and it is difficult to find a decision making body with sufficient knowledge of all the projects.[8] To address these specific issues, the Defence Science Advisory Board recommended that an architectural framework be developed to guide the design and development of the C4ISR system. This would enable the boards to determine how the various parts of the system will interrelate and how to achieve the desired capability.[9] The Auditor General echoes this recommendation stating that architecture is critical, especially to investments in information technology, which is exactly the realm of the C4ISR capability.[10]

In order to understand the benefits using enterprise architectures offers to the Canadian Forces, it is first necessary to have an understanding of enterprise architectures themselves. John Zachman, the author of the Zachman architecture framework defines architectures as "that set of design artifacts, or descriptive representations, that are relevant for describing an object such that it can be produced to requirements (quality) as

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[8] *Ibid*.

[9] Defence Science Advisory Board, Defence *Science Advisory Board Report 01/05 Intelligence, Surveillance and Reconnaissance Restructuring in the Canadian Forces*, (Ottawa, ON: 2005) [on-line]; available from http://www.vcds.forces.gc.ca/dgsp/pubs/rep-pub/dda/dsab/ES01-5ISR_e.asp; Internet; accessed 29 March 2006.

[10] Auditor General of Canada, …, 15.

well as maintained over the period of its useful life (change)."[11] The Institute of Electrical and Electronic Engineers defines architecture as "the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution."[12] Finally, the Department of Defense Architecture Framework used in the United States, defines it as "the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time."[13] These relatively technical definitions result in the false belief that architecture is purely an engineering tool not relevant to others in the system development process. Although it is true engineers use system architectures in system development and design, enterprise architectures are much more.

The enterprise architecture is created when the concepts used by engineers in system development are extrapolated to the organization or enterprise level.[14] The enterprise architecture provides the first level of design that can be used for discussion and analysis. It is operationally driven, not technical. The technical aspect of the enterprise architecture is only one component. The architects, operators and designers capture the architecture in what is known as the set of architectural products. The type

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[11]David P Brown, "Enterprise Architecture for DOD Acquisition," Acquisition Review Quarterly 7, no.2 (Spring 2000): 122. [on-line]; available from http://www.dau.mil/pubs/arq/2000arq/brown.pdf; Internet; accessed 17 April 2006.

[12]Alessio Mosto, "DoD Architecture Framework Overview." http://www.enterprise-architecture.info/Images/Defence%20C4ISR/DODAF.ppt; Internet; accessed 16 April 2006. Author refers to the IEEE std 1471-2000 definition of architectures in the presentation.

[13]C. Dickerson and S. Soules, "Using Architecture Analysis for Mission Capability Acquisition," (Monterey: 2002 Command and Control Research Symposium, 2002), 3 [on-line]; available from http://www.dodccrp.org/events/2002/CCRTS_Monterey/Tracks/pdf/123.PDF; Internet; accessed 16 April 2006.

[14]Brown, …, 122.

and number of products is based on a set of templates known as the architectural framework.[15] Regardless of the framework used, all make use of three basic "views" of the environment. These three critical views are the operational, system and technical views, which captures all aspects of the organization, the people, the processes and the technology. The interrelationship between these views is shown at Figure 1.

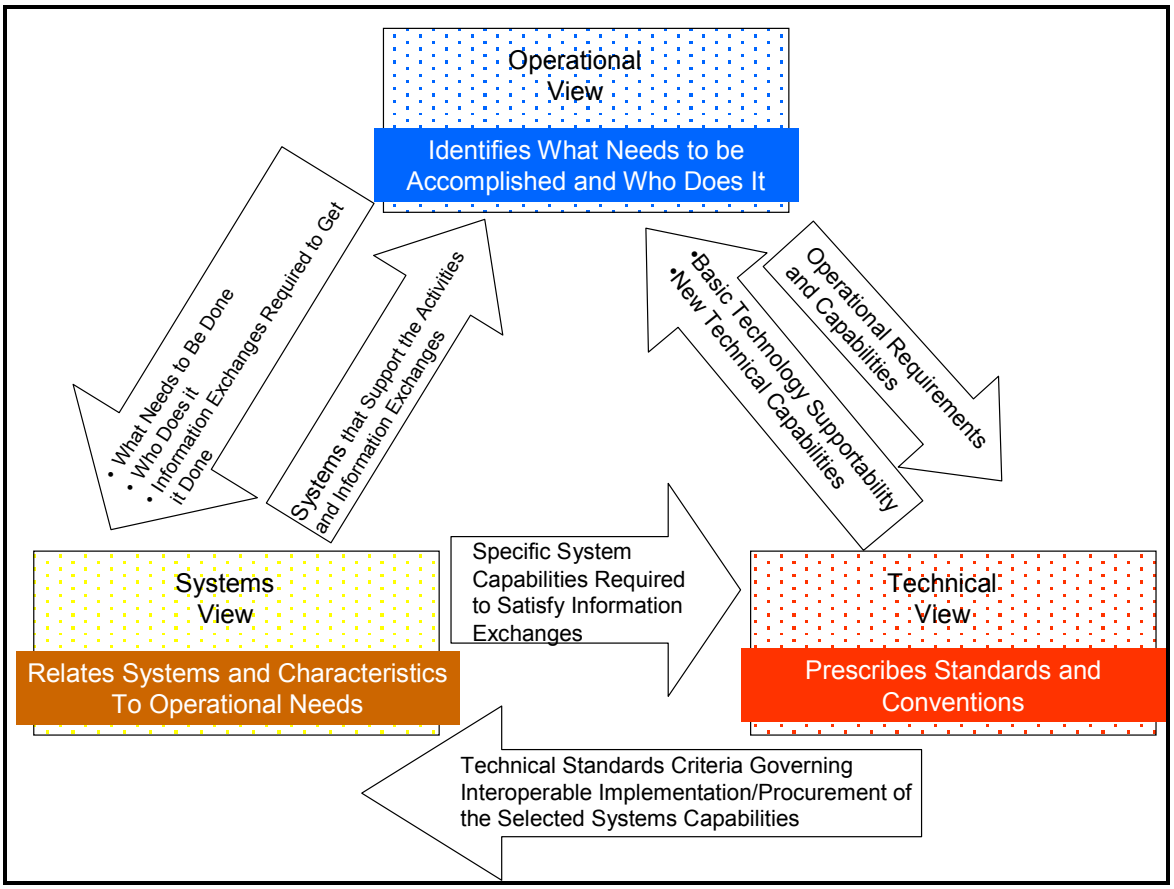

Figure 1 – Inter-Relationship of Enterprise Architecture Views

Source: United States Department of Defense, "*DoD Architecture Framework Version 1.0, Volume 1 – Definitions and Guidelines*," ES-1.

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[15]Rick Tucker and Dennis Debrosse, "Enterprise Architecture: Roadmap for Modernization," *The Edge MITRE Advanced Technology Newsletter*, (Fall 2003) [on-line] available from http://www.mitre.org/news/the_edge/fall_03/tucker.html; Internet; accessed 9 March 2006.

The operational view defines the system of systems as seen by the operator or user. This view has primacy. In other words, the use of enterprise architectures is a mission vice technology driven process. This view describes the tasks performed at the tactical, operational or strategic level. It includes the locations, facilities and organisations involved in the performance of the mission. It defines the type and frequency of information exchange necessary to carry out the functions. It includes, as required, the command and control relationships involved during the tasks. The operational views are depicted in a combination of architecture products that include graphics, tables, models and text descriptions. A sample listing of the operational view products is at Appendix 1.

The operational view is used to analyze capabilities at their highest level. It is this view that is used to determine among other things, requirements for new command and control relationships, new organizations, new systems or new processes. The operational view is primarily used to provide a clear operational picture for decision-making and to articulate the operational requirements.[16] Changes to the operational architecture normally imply changes to the system architecture to support the new mission, operational structure or process.

The systems view defines the same capability from a systems perspective. It provides a clear picture of the systems and communications requirements to support the operational concept. It includes the technology, hardware, software and communication paths used during the conduct of the tasks and missions being described. It includes the

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[16]Mary L Polydys, "Interoperability in DOD Acquisition Programs Through Enterprise "Architecting"," *Acquisition Review Quarterly* (Summer 2002), 193 [on-line] available from http://www.dau.mil/pubs/arq/2002arq/PolydysSM2.pdf; Internet; accessed 16 April 2006.

system interfaces and communication needs and capabilities. The systems view can change without necessarily causing alterations to the operational or technical architecture. The system architecture is used to analyze system performance from a system design perspective. It should be noted that although this view may be thought of as the "systems architecture" it is only a subset of the overall enterprise architecture and should not be considered a separate entity.[17] A sample list of the systems view architecture products is at Appendix 1.

The technical view of the problem defines the environment from a standards perspective. Its purpose is to provide the rules governing the organization. This view defines the underlying authoritative sources that are used in the task or operation. It includes not only the technical standards such as communication protocols but also includes items such as taxonomies, laws and regulations as well as standard practices invoked.[18] A sample listing of the technical view architecture products is at Appendix 1.

Each of the architecture views is defined in at lease two instantiations. The first is the "As-Is" view. This is analogous to the "As-Built" view in systems architecture. It describes the organization, as it exists in the present, prior to making any modification. It can also be termed the baseline view, as it represents the start state for any analysis or transformation planning.

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[17]Murray Daniels and Ruth Sespaniak, "Lessons Learned in Applying Architecture to the Acquisition of Air Force Command and Control Systems," (Washington: 10th International Command and Control Research and Technology Symposium, 2005), 7 [on-line]; available from http://www.dodccrp.org/events/2005/10th/CD/papers/246.pdf; Internet; accessed 16 April 2006

[18]John Tieso and David McDaniel, "A Roadmap for Developing Architectures in a Net-Centric World," (Copenhagen: 9th International Command and Control Research and Technology Symposium, 2004), 3 [on-line]; available from http://www.dodccrp.org/events/2004/ICCRTS_Denmark/CD/papers/116.pdf; Internet; accessed 16 April 2006.

The second set of views represents the "To-Be" architecture. This is the planned architecture after the change. It is sometimes referred to as the target architecture. This "To-Be" view can involve amendment to one of the views or all of them. For example, a change to the underlying technology to increase system performance without necessarily changing the operational function would not necessitate altering the operational views. However, the views in their entirety are considered as "To-Be" in a temporal sense. There can be more than one "To-Be" view to represent system transformation over time. In other words, one or more intermediate "To-Be" architectures can be used to represent the chronological system transformation.

There are number of proprietary systems that can be used to develop enterprise architectures. Further, a number of architectural frameworks exist that can be used to capture the enterprise architecture. These tools capture the information and data in various forms, including object models, tables, graphics and plain text. The type of tool or software application is not important. The power of the architecture is the underlying data and not the products per se. What is important is that there be a common set of architectural data. Hence, the views must be common across the entire organization for each operation or function.[19] For example, the engagement of a time sensitive target must be viewed the same for the Army, the Air Force and the Navy.

The Canadian Forces and Department of National Defence adopted capability based planning to overcome the platform-based mentality that had permeated the equipment program. However, some of that thinking still exists, illustrated by the number of statements of deficiency that still articulate rust out and the need to replace the

existing equipment or system vice stating the need for a new capability. Project staffs have historically used "solutioneering."[20] This practice involves suggesting the solution early in project documentation thus potentially missing a better solution. Capability based planning requires that the capabilities be identified based on the tasks required not the platform, system or technology desired. The concept hinges on asking the question "what do we need rather than what equipment are we replacing?"[21] Further, capability based planning is a departure from the threat-based approach of acquiring a platform or system to defeat a known threat. It involves acquiring a mission capability to accomplish the expected mission and tasks through the development of a system of systems.[22] This type of procurement philosophy requires that decision makers be capable of managing the system of systems and be capable of analysing various technical, process and organizational options to address the capability deficiencies. An architectural approach is ideally suited for this very purpose.

Capability based planning requires high-level capability objectives from which to design the military force. One of the key benefits of using an architectural approach is its

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[19]Daniels, …, 9.

[20]Ministry of Defence, *The Equipment Capability Customer Handbook*, (London: Deputy Chief of Defence Staff (Equipment Capability), 2005), 16 [on-line] available from http://www.ams.mod.uk/ams/content/docs/ecchandb.pdf; Internet; accessed 16 April 2006. Solutioneering is described as the creep from framing questions to suggesting answers. Settling on or leaping to a solution too quickly.

[21]Peter Kossakowski, "Capabilities-Based Planning: A Methodology for Deciphering Commander's Intent," (Washington: 10th International Command and Control Research and Technology Symposium, 2005), 3 [on-line]; available from http://www.dodccrp.org/events/2005/10th/CD/papers/319.pdf; Internet; accessed 16 April 2006.

[22]C Dickerson, S. Soules, M. Sabins and P. Charles, Using Architectures for Research, Development, and Acquisition, Report for the Assistant Secretary of the Navy for Research, Development and Acquisition. (Washington: 2004), 131. [on-line] available from http://handle.dtic.mil/100.2/ADA427961; Internet; accessed on 17 April 2006.

top down philosophy. The enterprise architecture provides an overall roadmap of where the organization is going. This foundation provides guidance and direction against which analysis in support of acquisition can be performed. It enables the aligning of this guidance with the concepts and equipment procurement.[23] The use of enterprise architecture will facilitate this "Top-Down" approach to Canadian Forces development and capability procurement. Previously, the approach was to first design and build the components, be they vehicles, aircraft, information technology or command and control systems and then attempt to integrate them. This bottom-up approach results in sub-optimum overall system performance and is not cost effective.[24] By utilizing a system engineering philosophy, which views the Canadian Forces holistically as a system of systems, the design of the future forces will be optimized at the enterprise level vice at the individual platform, function or service level. The result will be a more efficient use of the capital budget to deliver the desired integrated military force. Military capabilities will be conceived, designed and built integrated from project initiation, as opposed to after delivery.

Enterprise architectures enable effective communication between operators, designers and engineers. The United States Air Force has found that the use of architectures "fosters significant communications between the user, acquirer and the developer."[25] This was not the case when text-based documentation was exclusively

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[23]The Technical Cooperation Program Technical Report TR-JSA-TP3-2-2004, Guide *to Capability –Based Planning*, (Alexandria VA: 2004), 14 [on-line]; available from http://www.mors.org/meetings/cbp/read/TP-3_CBP.pdf; Internet; accessed 16 April 2006.

[24]Brown, …, 122.

[25]Daniels, …, 1.

used. One of the difficulties with the use of textual based requirement documents is their level of ambiguity and potential for miscommunication. Often they are too cumbersome, too brief and leave room for misinterpretation or assumption because information is missing. The use of architecture provides for clearer understanding and context. This provides for improved communication for all stakeholders.[26]

This improved communication capability crosses projects and initiatives. The use of an architectural framework requires project teams and defence analysts to use the existing architecture and nomenclature. Imagine trying to compare several documents that deal with automobiles. If one of them categorizes tires as rotating equipment while a second defines them as performance and handling enhancement devices and yet a third refers to them as safety subsystems, how would a reader be able to compare them?[27] Although this example may be extreme, it illustrates the difficulty with text-based documents. Enterprise architecture would force the use of standard taxonomies, facilitating improved communications by providing a common language used by operators, engineers and procurement staff as well as decision makers and policy makers. This ability to share information across programs is critical in performing analysis on the system of systems to better support acquisition decisions in order to achieve the mission capability.[28]

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[26]C.W. Bailey and R.M. Garbutt, "Developing Coherent, Concise And Comprehensive User Requirements Using The MoD Architectural Framework (MODAF)," (Washington: 10th International Command and Control Research and Technology Symposium, 2005), 2 [on-line] available from http://www.dodccrp.org/events/2005/10th/CD/papers/112.pdf; Internet; accessed 16 April 2006.

[27]Peter Coffee, "Mastering DODAF Will Reap Dividends." http://www.eweek.com/article2/0,1895,1744550,00.asp; Internet; accessed 16 April 2006.

[28]Dickerson, *Using Architectures for Research…,* 16.

Another advantage of the use of architectures is the use of the "To-Be" architectures bounded by time to form the foundation for analysis of future capabilities. Designating several "To-Be" architectures via time horizons, the future architecture can be used to analyze potential requirements and improvements or the impact of an idea or initiative to the future capability. This ability to "look into the future" provides decision makers with knowledge to make decisions against the future force capability.

A number of Canada's allies have adopted an architectural approach to integrated capability and capability procurement.[29] Foremost is the United States, which in 1996 approved the Clinger-Cohen Act requiring that federal agencies use architectures.[30] Their Department of Defense Architecture Framework (DoDAF) has become the flagship of architectural frameworks for military application. This framework was the genesis of those used by a number of countries that have adopted a version for their own purpose. Strangely enough, DoDAF was originally called the C4ISR architecture and was created to address the issues of C4ISR interoperability, the very issue facing the Canadian Forces. If other countries are discovering the benefits of architectures, why hasn't the Canadian Forces institutionalized their use?

To date the Department of National Defence is only exploring the use of enterprise architectures. The first activity is in the scientific community. Defence Research and Development Canada have a technical demonstrator project entitled Collaborative Capability Definition, Engineering and Management or CapDEM for short.

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[29]Some of the countries that have adopted architectures include the United States (Department of Defense Architecture Framework), the United Kingdom (Ministry of Defence Architecture Framework), and Australia (Defence Architecture Framework).

[30]Polydys, …, 192.

The mission of this project is "to demonstrate and validate a process that would provide decision makers with the ability to incrementally evolve operational capabilities more quickly while improving their integration at an enterprise system of systems level."[31] This project has already identified that key to enabling improvements is using architectural models. Moreover, it has also identified the need for top down guidance and direction. In their view, "top-down architecture enables bottom-up innovation."[32]

Secondly, the use of enterprise architecture is being explored within the Assistant Deputy Minister (Information Management) (ADM (IM)) Group. The Defence Planning Guidance 2001 tasked ADM (IM) with implementation of a defence enterprise architecture process and standardizing the management process by October 2001. This has not been achieved mostly due to DND/CF institutional inertia and internal prioritization within ADM (IM). The Director of Enterprise Architecture (DEA), established in 2000 with the mandate of integrating the Department of National Defence and Canadian Forces corporate management information systems has been investigation enterprise architecture. Resulting from their experience, DEA has become the champion for the adoption of enterprise architectures, making several presentations to the Vice Chief of Defence Staff (VCDS) and the Joint Capability Review Board attempting to have enterprise architecture institutionalized across the Department of National Defence. To that end DEA released draft guidance in the spring of 2005 advising that the Department of National Defence Architecture Framework (DND AF) was still in

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[31]J. Pagotto and R.S. Walker, "Capability Engineering – Transforming Defence Acquisition in Canada," (Ottawa: Defence Research and Development Canada, 2004), 4 [on-line]; available from http://www.capdem.forces.gc.ca/docs/e/spie_e.pdf; Internet; accessed 16 April 2006.

[32]*Ibid*., 9.

development and suggesting that in the interim the United States DoDAF be used. This guidance was not directive in nature and only recommended that projects adopt an architectural approach. To be entirely effective an architectural approach must be adopted institutionally. It will not be effective if only a few program and project managers adopt the process. To date DEA has not provided further direction on the use of enterprise architectures as a DND/CF management tool.[33]

Thus far, DEA has not been successful in convincing the VCDS or ADM (IM) that the investment in creating the enterprise architecture and managing the Canadian Forces capability program through its use is an effective and efficient way to achieve the benefits envisioned by capability based planning. A large part of the challenge DEA faces is the perception that enterprise architectures are the purview of the "techies" or engineers. As discussed, enterprise architecture starts with the operational view. The systems and technical views are supporting views. This is the view of DEA. In fact, in all of the presentations to senior management, it was recommended by DEA that the enterprise architecture be the purview of the VCDS with only the technical architecture for information systems being managed by ADM(IM).[34] However, since DEA remains in the Information Management Group, the perception remains. The opportunity to rectify the misconception that enterprise architectures are an engineer's tool exists with the ongoing Canadian Forces transformation.

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[33]LCol Bruce Picard, former Director Enterprise Architectures, conversation with author 13 April 2006.

[34]*Ibid*.

The transformation of the Canadian Forces will see the creation of the Chief of Force Development.[35] Although the terms of reference for this organization have yet to be written, it is an ideal opportunity to create the organization to provide overall guidance and direction for future force development and capability delivery. The Chief of Force Development should be appointed as the chief architect for the Canadian Forces. This organization should be responsible for providing the top down guidance and direction for force development. The use of architectures would provide clarity, consistency and enable improved communication amongst all stakeholders. Top down architectures originating from the Chief of Force Development could provide the absent direction required of the aforementioned Canadian Forces UAV and C4ISR programs.

Other organizations would contribute to the overall architecture. Once the top down direction is given, other capability organizations would provide refined operational views. Systems designers and equipment program managers would provide the systems and technical views. This approach is not to be confused with a bottom up approach. The approach proposed is a centrally controlled, decentrally executed approach. The Chief of Force Development would be viewed as the supported agency with others providing their expertise.

As the chief architect, Chief of Force Development would have the mandate to ensure that all components of the architecture are synchronized. This approach would ensure interoperability is conceived and designed into the system of systems. Project teams would be required to substantiate initiatives by producing their views of the "To-Be" architectures to allow the Chief of Force Development analysts to ensure that the

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[35]Hillier, …, 5.

projects align to priorities and the desired direction of the Canadian Forces. These architectures would also be used to ensure no overlap with other initiatives and to assess the impact of the project on existing projects and other initiatives. As mentioned the use of architecture would improve capability based planning in so far as they would provide the ability to compare different proposals for achieving the desired capability The requirement for projects to produce architecture products required to analyze their proposals will force them to address concerns and potential issues early in the project approval process. The creation of the architectural products requires that a formal process of planning, defining and understanding occur.[36] The result will be that decision-making authorities will be better informed by having more relevant information presented in analytical fashion. This will enable a better understanding of the impacts and risks of the project at initiation and throughout the project life.

The Department of National Defence and the Canadian Forces has created a force structure and military capability that is not integrated, due to decades of mutually exclusive force development and stovepipe project delivery. Project managers focused on delivering platforms and stand alone systems vice capabilities. The complex operating environment in which the Canadian Forces finds itself today requires an integrated force capability. The Defence Policy Statement and the Chief of Defence Staff have stated this as part of the transformation efforts to be undertaken. The delivery of the integrated force requires a change to the manner in which military capability is conceived, prioritized, assessed and ultimately delivered and managed. Using enterprise

[36]Teiso, …, 3.

architecture will facilitate the delivery of an integrated military force that aligns with the stated objectives of the Canadian government.

Enterprise architectures will enable improved communication amongst all the stakeholders. They facilitate capability gap analysis to determine which capabilities are required to fulfill the military tasks envisioned. In this manner, they are ideally suited to support the concept of capability based planning. They will allow analysts to compare different technical, operational, structural and procedural solutions to the stated capability deficiency. As recommended by the Auditor General and the Defence Science Advisory Board, an architectural approach will provide the guidance and direction required of the UAV and C4ISR projects.

The Canadian Forces and the Department of National Defence are in the midst of transformation. The time is right to adopt this approach with the creation of the Chief of Force Development. By appointing this position as the chief architect and providing it with the requisite skills and analytical capability, the Canadian Forces can begin to deliver the integrated capability desired. The Canadian Forces and the Department of National Defence should institutionalize the use of enterprise architectures, to conceive, design, develop and manage the integrated, information age military forces necessary to conduct operations in the contemporary operating environment.

Appendix 1

The Department of Defense Architecture Framework outlines the architecture products required to capture the environment of the system or weapon systems. The architecture products are listed at Table 1.1. Architects use those architecture products applicable to their specific problem and solutions space to articulate the "As-Is" and "To-Be" architectures. These products are used to capture requirements, conduct gap analysis, and assess impacts as well as other program and project management tasks.

Table 1.1 - Department of Defence Architecture Framework (Architecture Products)

Applicable View	Framework Product	Framework Product Name	General Description
All Views	AV-1	Overview and Summary Information	Scope, purpose, intended users, environment depicted, analytical findings
All Views	AV-2	Integrated Dictionary	Architecture data repository with definitions of all terms used in all products
Operational	OV-1	High-Level Operational Concept Graphic	High-level graphical/textual description of operational concept
Operational	OV-2	Operational Node Connectivity Description	Operational nodes, connectivity, and information exchange need lines between nodes
Operational	OV-3	Operational Information Exchange Matrix	Information exchanged between nodes and the relevant attributes of that exchange
Operational	OV-4	Organizational Relationships Chart	Organizational, role, or other relationships among Organizations
Operational	OV-5	Operational Activity Model	Capabilities, operational activities, relationships among activities, inputs, and outputs; overlays can show cost, performing nodes, or other pertinent information
Operational	OV-6a	Operational Rules Model	One of three products used to describe operational activity— identifies business rules that constrain operation
Operational	OV-6b	Operational State Transition Description	One of three products used to describe operational activity— identifies business process responses to events
Operational	OV-6C	Operational Event-Trace Description	One of three products used to describe operational activity— traces actions in a scenario or sequence of events

Applicable View	Framework Product	Framework Product Name	General Description
Operational	OV-7	Logical Data Model	Documentation of the system data requirements and structural business process rules of the Operational View
Systems	SV-1	Systems Interface Description	Identification of systems nodes, systems, and system items and their interconnections, within and between nodes
Systems	SV-2	Systems Communications Description	Systems nodes, systems, and system items, and their related communications lay-downs
Systems	SV-3	Systems-Systems Matrix	Relationships among systems in a given architecture; can be designed to show relationships of interest, e.g., system-type interfaces, planned vs. existing interfaces, etc.
Systems	SV-4	Systems Functionality Description	Functions performed by systems and the system data flows among system functions
Systems	SV-5	Operational Activity to Systems Function Traceability Matrix	Mapping of systems back to capabilities or of system functions back to operational activities
Systems	SV-6	Systems Data Exchange Matrix	Provides details of system data elements being exchanged between systems and the attributes of that exchange
Systems	SV-7	Systems Performance Parameters Matrix	Performance characteristics of Systems View elements for the Appropriate time frame(s)
Systems	SV-8	Systems Evolution Description	Planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation
Systems	SV-9	Systems Technology Forecast	Emerging technologies and software/hardware products that are expected to be available in a given set of time frames and that will affect future development of the architecture
Systems	SV-10a	Systems Rules Model	One of three products used to describe system functionality— identifies constraints that are imposed on systems functionality due to some aspect of systems design or implementation

Applicable View	Framework Product	Framework Product Name	General Description
Systems	SV-10b	Systems State Transition Description	One of three products used to describe system functionality— identifies responses of a system to events
Systems	SV-10c	Systems Event-Trace Description	One of three products used to describe system functionality— identifies system-specific refinements of critical sequences of events described in the Operational View
Systems	SV-11	Physical Schema	Physical implementation of the Logical Data Model entities, e.g., message formats, file structures, physical schema
Technical	TV-1	Technical Standards Profile	Listing of standards that apply to Systems View elements in a given architecture
Technical	TV-2	Technical Standards Forecast	Description of emerging standards and potential impact on current Systems View elements, within a set of time frames

Source: United States Department of Defense, "*DoD Architecture Framework Version 1.0 Volume 1 – Definitions and Guidelines*," 1-4.

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