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BLOCKCHAIN: APPLICATION WITHIN CANADIAN ARMED FORCES' SUPPLY SYSTEM

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**BLOCKCHAIN: APPLICATION WITHIN
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By Major Ryan F. Van Poppel

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AIM

1. Distributed ledger technology (DLT), more commonly known as blockchain became known with the advent of the cryptocurrency Bitcoin. DLT is an emerging disruptive information technology with applications in several industries.¹ The aim of this service paper is to examine the applications of blockchain and how it could be leveraged to improve the information infrastructure, specifically within the Canadian Armed Forces' (CAF) supply chain. The paper will provide an overview of blockchain technology, its characteristics, and the advantages the technology provides. The paper will discuss issues with CAF's supply system and supply chain management and how blockchain can improve the system.

INTRODUCTION

2. The Vice Chief of Defence Staff (VCDS) recently gave planning guidance on data and digitalization.² This was to invigorate the progress of digital transformation to move the DND and the CAF into the future and enable decision making. The planning guidance outline four priorities:

- a. data and digitalization;
- b. C4ISR spine;
- c. supply chain reformation; and
- d. a reimagined CAF Professional Military Education regime.³

¹ T.J. Willink, "On blockchain technology and its potential application in tactical networks," Defence Research and Development Canada Scientific Report – DRDC-RDDC-2018-R033, April 2018, Last accessed 01 Jan 2021, 1. <https://www-deslibris-ca.cfc.idm.oclc.org/ID/10101201>

² Vice Chief of Defence Staff, "VCDS/DMA Planning Guidance Data and Digitization," VCD2020-0015391, 02 Nov 2020, 1.

³ Ibid., 2.

The service paper serves to examine blockchain technology as an emerging information technology that can be leveraged to improve CAF's supply chain, while also meeting the first two VCDS priorities.

3. Knowledge of blockchain technology is not well known or understood within the CAF as a viable information technology with potential beneficial applications. This is due to blockchain being primarily attributed to cryptocurrencies or financial transactions. But as an emerging information technology, blockchain technology is being developed and leveraged by several industries, for various business processes. These include agriculture and food distribution, healthcare, utilities, human resources, and government public services.⁴ This paper will first provide a basic understanding of blockchain technology followed by the benefits of the technology. Next, it will be discussed where CAF could exploit the use of blockchain within its enterprise resource planning (ERP) system, the Defence Resource Management Information System (DRMIS), specifically looking at the supply chain. The paper will conclude with how blockchain technology could be integrated with other emerging technologies, as well as recommendations for future implementation.

DISCUSSION

4. It should first be noted that there are nuances between blockchain and distributed ledger technology (DLT). Blockchain is a type of DLT. For sake of ease, blockchain and DLT will be used interchangeably throughout the paper. A basic description of what

⁴ SAP Insights, "What Is Blockchain Technology?" (last accessed 20 Jan 2021)
<https://insights.sap.com/what-is-blockchain/>

blockchain entails is summarized here. Blockchain is an immutable, distributed digital database of transactions that are stored and shared across a peer-to-peer network.⁵ As the name implies, information of a transaction or record is stored in what are named blocks that contain certain data and is connected to the previous block in the transaction, thus creating a chain. Figure 1 depicts an example of a chain. Each block contains a timestamp and an identifiable hash or a digital fingerprint. A block also contains the hash from the previous block in the chain, allowing for someone to identify information in all the previous blocks. If a block is modified or deleted it changes the blocks after it, and the chain is broken.⁶

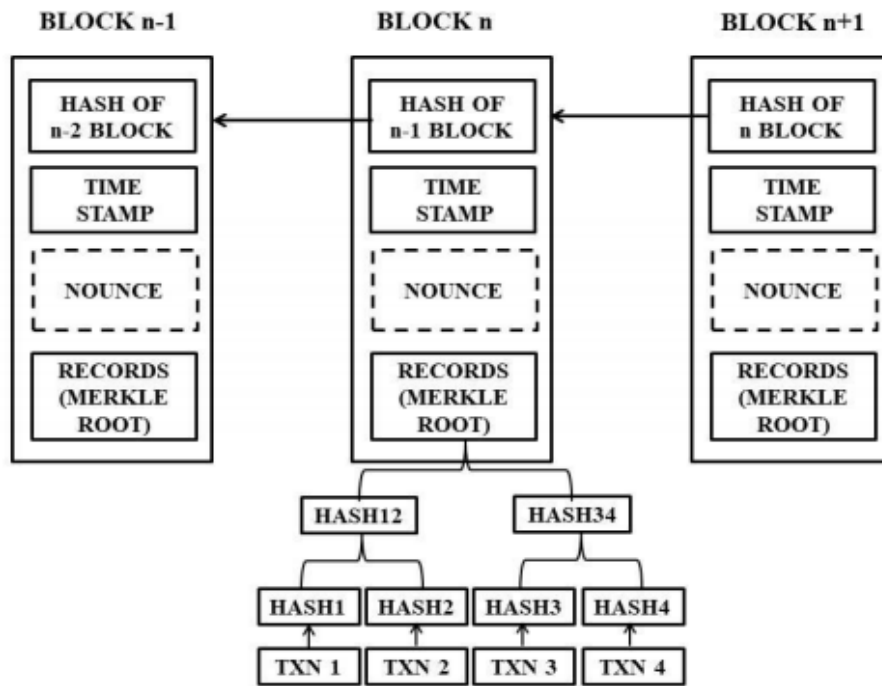


Figure 1: Blockchain example with three blocks.⁷

⁵ Sarah, Underwood, "Blockchain Beyond Bitcoin." *Communications of the ACM* 59, no. 11 (2016): 1, <http://web.b.ebscohost.com/cfc.idm.oclc.org/ehost/pdfviewer/pdfviewer?vid=1&sid=9b5f8017-ecb8-4df9-8942-b754439094fc%40pdv-v-sessmgr06>

⁶ Sudhan, Amool and Manisha J. Nene, "Employability of Blockchain Technology in Defence Applications" *International Conference on Intelligent Sustainable Systems (ICISS)*, Palladam, 2017: 632, <https://ieeexplore-ieee-org.cfc.idm.oclc.org/document/8389247>

⁷ Ibid., 633.

5. Gartner, a world-leading enterprise research and advisory company outlines five elements of blockchain technology depicted in Annex A and described as follows:

- a. Distribution: Users are connected by a network. Each user has access to a copy of the ledger that is updated in real-time;
- b. Encryption: Blockchain uses cryptography such as public or private keys. Any data is digitally signed with a key;
- c. Immutability: As mentioned, data is stored in blocks that are timestamped and contain sequentially identifiable hash or signatures. Information cannot be manipulated or removed unless users agree to;
- d. Tokenization: This allows users to control personal data and transfer of transactional value; and
- e. Decentralization: The network and information are maintained by nodes. In essence, no single entity controls all of the nodes or information. This adds a layer of security, as there is no single point of failure.⁸

These elements when integrated into business processes provide advantages to organizations that require trust amongst multiple parties, and to store and disseminate information securely and transparently.

⁸ Gartner, “The CIO’s Guide to Blockchain,” last accessed 21 Jan 2021, <https://www.gartner.com/smarterwithgartner/the-cios-guide-to-blockchain/>

6. Those that are concerned with full decentralization of control or information access can note that Blockchain networks can be configured primarily three ways:
- a. Public/permissionless: There are no restrictions to access to this type of network. Anyone can join the network, read the data, and conduct transactions. This is the type of network Bitcoin is run on.
 - b. Private: A user cannot just join the network. The network is controlled by a single organization. Specific privileges such as levels of access to reading data and the ability to conduct transactions are controlled.
 - c. Consortium: Similar to a private network, a consortium network is controlled by a select group. The access to read or conduct transactions may be public or restricted. The network is also known as “permissioned.”⁹
7. To understand how blockchain could revolutionize the CAF’s supply chain some of the challenges and issues of the current system will be addressed. The CAF supply system is complex and cumbersome. Several organizations under various levels of command play a role in CAF’s supply chain. The evolution of CAF’s supply system has been non-existent. What was the material acquisition and support information system (MASIS) was integrated with the financial management system (FMAS) within DRMIS, but several components of the supply chain continue to be run off of separate, non-integrated, and aging systems. What may be most surprising to those that work in a

⁹ SAP Insights, “What Is Blockchain Technology?”; Memon, Muniba, et al, "Blockchain Beyond Bitcoin: Blockchain Technology Challenges and Real-World Applications." *2018 International Conference on Computing, Electronics & Communications Engineering (iCCECE)*, Southend, United Kingdom, 2018: 30, <https://ieeexplore-ieee-org.cfc.idm.oclc.org/stamp/stamp.jsp?tp=&arnumber=8658518>

private sector supply chain or operations management, is that several pieces of CAF's supply chain are analog or done on ad-hoc systems or excel spreadsheets.

8. In 2014, Chief Review Service (CRS) audited CAF's warehouse management. Key findings from the audit were that inventory managers were not carrying out disposal of surplus material and that the system had no means to track inventory movement within the warehouse, or between different buildings. The former was leading to a buildup of material which impacted the department's financial statements as well as potential additional costs of creating new areas for storage. The latter affected time to locate items and increased the risk of loss of items.¹⁰ Both have second and third-order effects throughout the supply chain. A 2020 report of the Auditor General of Canada found that the CAF supply system often (50% of the time) did not deliver supplies in a timely and efficient manner. This was found to be due to poor stock management, inefficient processing of requests, and inadequate control over transportation costs.¹¹ As noted in the report, "Canada's national security and the success of Canadian military operations [both domestically, and] abroad depend on National Defence's ability to supply the Canadian Armed forces with the material they need...when they need it."¹²

9. Looking at some of the benefits of blockchain, the technology has the potential to reform the supply system and mitigate the deficiencies identified. Some of the benefits are as follows:

¹⁰ Department of National Defence, Canada, "Audit of Warehouse Management," Chief Review Services report 7050-59 (CRS), January 2014: iv, https://www.canada.ca/content/dam/dnd-mdn/migration/assets/FORCES_Internet/docs/en/about-reports-pubs-audit-eval/p0967-eng.pdf

¹¹ Canada, Office of the Auditor General of, "Supplying the Canadian Armed Forces – National Defence," Spring 2020 - Reports of the Auditor General of Canada to the Parliament of Canada – Report 3, 2020: 3,6, <https://opencanada.blob.core.windows.net/opengovprod/resources/>.

¹² Ibid., 3.

- a. Transparency/accountability: Information is viewable by all members of the network. Data cannot be manipulated without consensus. This forms an audit trail and creates trust in the data and reduces the risk of fraud;
- b. Asset Visibility/Traceability: Data is coded into the blockchain and is updated as it moves through the supply chain. As data can be made widely available and updated in realtime through a distributed network, members, staff, and commanders will have knowledge of what resources are in location, in-transit, or available throughout the supply system. This includes material, spare parts, and equipment. This could improve inventory management, processing of requests, and sustainment planning at all levels. Blockchain also provides the ability to trace the origin of information or transactions. In 2013 there were reports of counterfeit parts in CAF's CC-130J Hercules.¹³ Blockchain could mitigate this issue from occurring in the future. CAF could give permissions to manufactures and distributors to provide information into the blockchain information, such as place of manufacturing, safety inspection certificates, etc. This can be done for each component. Linking a distributor or manufacturer's blockchain to CAF's would further enhance asset visibility and traceability. This not only reduces the potential of counterfeit fraud. It also allows CAF to trace faulty components back to their origin or to where they are located within the supply system;

¹³ National Defence and the Canadian Armed Forces, "Alleged counterfeit parts in Canada's CC-130J Hercules aircraft," Feb. 2013, www.forces.gc.ca/en/news/article.page?doc=alleged-counterfeit-parts-in-canada-s-cc-130j-hercules-aircraft/hie8w7n7

- c. Automation: Blockchain is programmable to trigger actions when certain conditions are met. This has to do with the evolution of what is termed smart contracts. These are agreed upon terms stored in the blockchain. Blockchain would enable verification of the terms and conditions as well as self-execute the negotiated actions.¹⁴ This can be beneficial both internal to the supply system, but also with transactions with service and material providers. Smart contracts can be established with manufacturers and distributors. There would be one source of data available to all parties. Purchase orders can be produced and automatically available to supplies based on consumption levels. Reconciliation of payment can be triggered once goods are received or the terms of the contract are met. One can examine the disposal process to better understand the benefits of automation once items are internal to CAF. Given the example of challenges with warehouse management and asset disposal, information on materials and equipment such as lifecycle or depreciation rate could be inputted in the blockchain. When specific terms are met the blockchain could initiate the disposal process or other actions such as predictive maintenance or replacement purchase order;
- d. Data Integrity/reliability: based on its elements, blockchain is resilient. Because data is distributed there is no single point of failure. This will prove valuable as adversaries may attempt to attack networks or vulnerable points such as supply chains; and

¹⁴ Willink, "On blockchain technology and its potential application in tactical networks," . . . , 14.

- e. Fewer intermediaries: Blockchain can reduce the need for some intermediaries. Data is widely available and stored digitally. The network can validate transactions and conditions. It can also initiate certain processes. This can make processes within the supply chain more efficient and reduces the risk for data loss and entry errors.¹⁵

10. Integration with other information within the ERP or other systems such as the number of personnel or assets, entitlements, locations, etc. blockchain could reform the supply system. As noted, specific information from other systems could be programmed within the chain and could trigger actions, such as resupply, purchasing, etc.

Furthermore, these actions can be precise to locations so as to not have an abundance of inventory stocked in certain locations in Canada, where it is not needed. When combined with other emerging technologies, blockchain could also advance other aspects within the supply system or other CAF applications. Additive manufacturing, more formally known as 3D printing, the Internet of Things (IoT), as well as Artificial Intelligence (AI), could be enabled by the integration of blockchain technology to securely store, manage and widely disseminate data. For example, Walmart known for its supply chain management has implemented a blockchain network with its third-party freight carriers. The network is integrated with IoT sensors and GPS in the trucks, as well as a mobile app for manual input. The blockchain allows for tracking of shipments, analytics and modeling, and invoice reconciliation and payment.¹⁶ This builds trust between the user (CAF) and the

¹⁵ SAP Insights, “What Is Blockchain Technology?”

¹⁶ Lucas, Mearian, “Walmart launches ‘world’s largest’ blockchain-based freight-and-payment network” Computerworld, 19 Nov 2019, last accessed 21 Jan 2021, <https://www.computerworld.com/article/3454336/walmart-launches-world-s-largest-blockchain-based-freight-and-payment-network.html>

service provider. It would also allow CAF to ensure freight shipments were as per the agreed contract using a smart contract, as well as create efficiencies and savings.

11. CAF's DRMIS can be integrated with blockchain technology. Several companies, including SAP, are providing "Blockchain-as-a-service" (Baas). The concern of availability of data in technology constrained environments could also be alleviated with cloud platform blockchain. "BaaS supplies the accountability, transparency, and security of blockchain already noted without using in-house resources, as service providers maintain the BaaS network in the cloud."¹⁷

CONCLUSION

12. In today's information age, data should be considered as a currency. Data is valuable, and there are risks to poor data management. The CAF's supply chain contains and transmits a vast amount of data. The CAF's supply system is made up of several systems that are not integrated, with some transactions still being done manually. The system is outdated, inefficient, and requires modernization. This poses risks in accountability, as well as in supplying resources to CAF personnel, both domestically and abroad. Blockchain technology provides characteristics and benefits that could make CAF's supply system more efficient, agile, and responsive. Blockchain enables greater audibility, data accuracy, and can improve asset visibility, traceability, amongst other benefits mentioned in this paper. The CAF should consider the value proposition of implementing distributed ledger technology (blockchain) into the supply system information infrastructure and enterprise systems. As identified in this paper, blockchain

¹⁷ SAP Insights, "What Is Blockchain Technology?"

can improve CAF's supply system and could allow the CAF to sustain a future force. Blockchain coupled with other emergent technology could modernize CAF's business processes and enterprise, meeting three of the VCDS' four priorities.

RECOMMENDATION

13. A list of recommendations follows in no particular order:
 - a. Distributed ledger technology or blockchain be further analyzed as a viable option for improving CAF's supply system. This should be led by SJS Strategic J4, Assistant Deputy Minister (Data, Innovation, Analytics) (ADM (DIA)), and ADM (Information Management) (ADM (IM));
 - b. Discussion with SAP on user cases of their blockchain cloud platform (SAP Leonardo). SAP Leonardo provides the ability to leverage technologies such as blockchain, big data, analytics, and machine learning;¹⁸
 - c. As the CAF looks towards data and digitization modernization, the implementation of blockchain technology into CAF's enterprise system (SAP), specifically DRMIS, and other applications within the CAF should be studied. At the very least, enterprise system modernization should include blockchain cloud capability to allow for future applications if desired; and

¹⁸ Adreas Schmitz, "What is SAP Leonardo?" SAP news Center. Last accessed 15 Jan 2021. <https://news.sap.com/2017/07/what-is-sap-leonardo-2/>

- d. Industry leaders in supply chain management that are currently using or integrating DLT be leveraged for best practices.

Annex A: Elements of blockchain technology

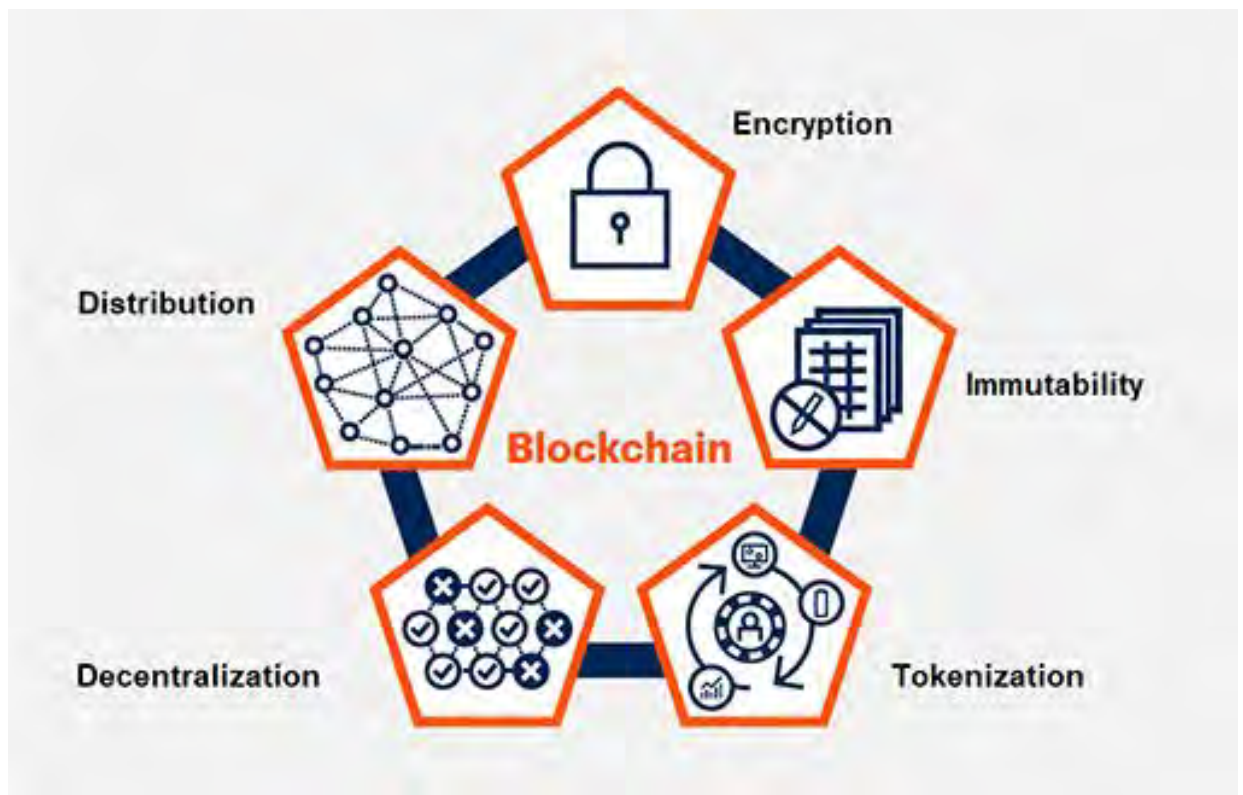


Figure A-X-1: Elements of blockchain.¹⁹

¹⁹ Gartner, "The CIO's Guide to Blockchain."

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