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Organizations have used business process reengineering, ERP and SaaS to create fast, inexpensive and accurate transaction processing systems within their own boundaries. Blockchains promise similar results for interfirm processes. We describe a blockchain-enabled invoice processing solution implemented by Walmart Canada and its freight carriers. Disputed invoices fell from 70% to under 2%, invoices are now finalized within 24 hours instead of days, weeks or longer, costs were reduced and relationships improved. Based on this case, we provide recommendations for using blockchains for interfirm process innovation.[1]

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Applying the Lessons from Intrafirm Process Innovation to Interfirm Processes with Blockchain Technology

Over the past four decades, IT management practices and technologies have aimed to create fast, inexpensive and accurate transaction processing systems that are based on a "single source of truth" *within* a firm's boundary. These innovations were driven by business process reengineering (BPR), enterprise resource planning (ERP) and software-as-a-service (SaaS).

When deploying these practices and technologies, IT and business managers learned to reengineer work before automating it. Many CIOs may recall the legendary example of Ford.[2] In the late 1980s, Ford had 400 people in its accounts payable department reconciling disparate records between its purchasing and receiving departments. Ford reengineered the process to reduce the need for accounts payable reconciliations. In the new process, the purchasing department posted purchase orders directly to a database shared with the receiving department. When goods arrived at the dock, the receiving department checked the database for a matching purchase order. If one was found, the receiving department clerk updated the database, which served as a single source of truth across Ford. (The clerk returned the goods if a matching purchase order was not found.) By reengineering the process before deploying IT, Ford eliminated 75% of accounts payable work. Other BPR success stories include Cigna, General Electric, Hewlett-Packard, Mutual Benefit Life, Sloan Valve Company and Walmart.[3]

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1   William Kettinger is the accepting senior editor for this article.

2   Hammer, M. "Reengineering Work: Don't Automate, Obliterate," *Harvard Business Review*, July-August 1990, available at https://hbr.org/1990/07/reengineering-work-dont-automate-obliterate.

3   See: 1) Davenport, T. H. *Process Innovation: Reengineering Work Through Information Technology*, Harvard Business School Press, 1992; 2) Hammer, M. and Champy, J. *Reengineering the Corporation: A Manifesto for Business Revolution*, Harper Business, 1993; 3) Ranganathan, C., Balaji, S. and Coleman, T. "IT-Led Process Reengineering: How Sloan Valve Redesigned its New Product Development Process," *MIS Quarterly Executive* (10:2), June 2011, pp. 81-92.

After the wave of business processing engineering, organizations deployed ERP systems, which became another major transaction processing innovation.[4] Instead of bespoke reengineering and IT projects as at Ford, IT managers *configured* ERP systems, which ERP vendors claimed were designed with best practices and processes built in. Again, ERP aimed to create a single version of the truth *within* a firm's boundary but in a less costly way than custom-built solutions. Then came ERP in the cloud using the software-as-a-service (SaaS) model.[5] SaaS aims to reduce internal IT infrastructure costs.[6]

Implementation journeys for BPR, ERP and SaaS were (and still are) fraught with challenges.[7] However, in adopting and deploying these practices and technologies, the IT practitioner community has learned some valuable lessons about using IT for intrafirm processes:

1. Reengineer processes before automation
2. Create single versions of the truth—every department should be using the same data
3. Configuring is faster and less expensive than building custom software
4. The SaaS model switches IT budgets from capital investments to operating expenses.

What if these lessons were applied *across* organizational boundaries to address interfirm process issues at the ecosystem level? Walmart Canada and its freight carriers did just that with a solution called DL Freight, a blockchain-based platform built and operated by DLT Labs.

The DL Freight case is described in this article[8] and shows that blockchain technology[9] is a key enabler of interfirm process innovations.

Walmart Canada's use of the DL Freight application is an illustration of a new way to approach broken processes at the ecosystem level. Any context where interfirm transactions are broken, where multiple writers update data, where updates need to be verified by another party and where business rules can be defined for automation is a potential use case for blockchain-enabled digital ecosystems.

Below, we describe the development of the DL Freight solution, highlight the changes in the freight invoicing process brought about by the solution, discuss governance issues, document the business value delivered and provide recommendations for deciding whether there is a business case for reimagining interfirm processes and, if so, for using blockchain technology for interfirm process innovation.

Overview of DL Freight, an Example of Interfirm Process Innovation

Walmart Canada is one of Canada's top four largest retailers by revenue[10] and operates over 400 retail stores. (An overview of Walmart Canada, together with the senior executives involved in our case study, is provided in the text box below.)

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4   Successful ERP implementations require considerable management effort. See: 1) Brown, C. and Vessey, I. "Managing the Next Wave of Enterprise Systems: Leveraging Lessons from ERP," *MIS Quarterly Executive* (2:1), March 2003, pp. 65-77; and 2) Davenport, T. "Putting the Enterprise into the Enterprise System," *Harvard Business Review* (76:4), July-August 1998, pp. 121-131.

5   For the value proposition of ERP as SaaS, see: 1) Johansson, B. and Ruivo, P. "Exploring Factors for Adopting ERP as SaaS," *Procedia Technology* (9), December 2013, pp. 94-99; and 2) Linthicum, D. "It's Time to Kick Your ERP System to the Curb and Go SaaS," InfoWorld, January 15, 2019, available at https://www.infoworld.com/article/3336178/its-time-to-kick-your-erp-system-to-the-curb-and-go-saas.html.

6   Califf, C. Sarker, S. Sarker, S. and Skilton, M. "The Role and Value of a Cloud Service Partner," *MIS Quarterly Executive* (15:3), September 2016, pp. 231-242.

7   For example, see Soh, C. and Sia, S. "The Challenges of Implementing "Vanilla" Versions of Enterprise Systems," *MIS Quarterly Executive* (4:3), September 2005, pp. 361-372.

8   Walmart is a founding member of the Blockchain Center of Excellence's (BCoE's) Executive Advisory Board and is an active participant in the University of Arkansas' blockchain research and events. This case study is based on a Fall 2020 BCoE closed workshop called "Practical Blockchain: Lessons learned from Walmart Canada," and follow-up interviews, a demonstration of DL Freight and secondary sources.

9   A blockchain application is a peer-to-peer system for validating, time-stamping and permanently storing transactions on a shared distributed ledger. For an overview of blockchains, public vs. permissioned networks and promised business value, see Lacity, M. C., Sabherwal, R. and Sørensen, C. "Special Issue Editorial: Delivering Business Value through Enterprise Blockchain Applications," MIS Quarterly Executive (18:4), December 2019, pp. ix-xix.

10   *Canada's Top 100 Retailers*, Retail Council of Canada, March 4, 2020, available at https://www.retailcouncil.org/community/store-operations/canadas-top-100-retailers/.

11   "Walmart Canada," Wikipedia, available at https://en.wikipedia.org/wiki/Walmart_Canada.

12   All dollar amounts in this article are in U.S., not Canadian, dollars.

13   Walmart Inc, 2020 Annual Report, available at https://corporate.walmart.com/media-library/document/2020-walmart-annual-report/_proxyDocument?id=00000171-a3ea-dfc0-af71-b3fea8490000.

Overview of Walmart Canada and Personnel Involved in our Case Study

Walmart Canada, the Canadian division of Walmart, was founded in 1994 by acquiring 122 stores from Woolworth Canada.[11] Approximately 1.2 million customers visit one of Walmart Canada's more than 400 retail stores each day. Net sales for 2020 were $18.4 billion, [12] or about 3.5% of Walmart's overall revenues of $524 billion. [13] Walmart Canada employs 85,000 associates and the firm's motto is "Save money. Live better."

The president and CEO of Walmart Canada is Horacio Barbeito. Senior executives involved in our case study were: John Bayliss, who was senior VP of Logistics and Supply Chain Management and is now executive VP chief transformation officer; Francis Lalonde, VP of Transportation; Alexey Shlykov, senior director of Information and Analytics; and Sergei Beliaev, who was chief information officer of Walmart Canada when blockchain technology was adopted but is now executive VP and chief strategy officer at DLT Labs, the firm that developed DL Freight.

Walmart Canada has its own fleet of 2,000 trailers used for shipments to the stores, but also relies on 70 third-party freight carriers—some large-sized and some small-sized—to move over 500,000 loads per year.[14] Before DL Freight, Walmart Canada and its freight carriers disputed up to 70% of invoices. It took days, weeks and even months to settle them, resulting in administrative expenses rising to about 20% of transportation costs.[15] Freight carriers were not getting paid in a timely manner and both sides were spending too much money on reconciliations. After DL Freight was implemented, Walmart Canada and its 70 freight carriers achieved the following outcomes within a year:

- Invoice finalization within 24 hours of final delivery
- Disputed invoices fell to under 2%
- Walmart Canada achieved substantial cost savings
- Cash flows improved for freight carriers
- Relationships between Walmart Canada and freight carriers improved
- New opportunities for revenue generation and additional supply chain improvements.

As described below, the parties achieved these results by:

1. Reengineering invoice processing across firm boundaries—instead of freight carriers creating an invoice after final delivery, Walmart Canada and the freight carriers start building the invoice during the tender process and automatically update it from Internet of things (IoT) data feeds as charges are incurred during shipment. The automation is enabled by smart contracts,[16] a key feature of blockchains.

2. Creating a single version of the invoice—Walmart Canada and the freight carrier share the same invoice on the blockchain's distributed ledger.[17] The permissioned[18] blockchain ensures that only authorized parties can read/write on an invoice.

3. Configuring an existing platform rather than building custom software—DL Freight is a configurable solution, similar to ERP. The parties went from conception to live deployment with the first freight carriers in eight months.

4. Providing freight carriers with DL Freight as a SaaS application, which minimizes their IT investments costs.

Table 1 provides a high-level summary of invoice processing before and after implementing DL Freight.

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14 "Walmart Uses Blockchain to Fix "Broken" Freight Audit and Payment Process," SupplyChainBrain, November 1, 2020, available at https://www.supplychainbrain.com/articles/32130-walmart-canada-fixing-a-broken-freight-audit-and-payment-process-with-blockchain.

15 Ibid.

16 For a blockchain, a smart contract is a piece of software that stores and executes rules agreed by trading partners on when and how to update the distributed ledger.

17 As a component of a blockchain application, a distributed ledger is a time-stamped, permanent record of all valid transactions that have occurred within the application. Each authorized node of the blockchain network has an identical copy; no node is in charge.

18 Permissioned blockchains provide additional security by maintaining an access control layer that allows certain actions to be performed only by certain identifiable participants. As such, they differ from public blockchains.

Table 1: Overview of Invoice Processing Before and After DL Freight

	Number of Process Steps	Percentage of Invoices Disputed	Time Needed to Agree Upon an Invoice	Business Outcomes
Process Before DL Freight	11 steps	Up to 70%	Day, weeks, months after delivery	• High cost of reconciliations for all parties • Late payments to freight carriers • Poor carrier relationships
Process After DL Freight	Five steps	Less than 2%	Within 24 hours of final delivery	• Transparency among authorized parties about shipping events and costs • Near real-time invoicing and processing • Total cost savings delivered to Walmart Canada • Cash flows improved for freight carriers • Relationships improved • Opportunities for revenue generation by offering discounts for early payments • Opportunities for additional supply chain improvements through better business intelligence

Invoicing and payment problems are not unique to Walmart Canada and its freight carriers. Across the U.S. transportation industry, an average of $140 billion worth of invoices are in dispute on any given day while partners attempt to reconcile disparate accounting records across firm boundaries.[19] Up to 38% of invoices are overpaid because it's sometimes cheaper for enterprises to simply pay the invoices than to investigate unexpected charges.[20]

The DL Freight Adoption Journey

For Walmart Canada and its freight carriers, the processing of freight invoices for load shipments reached a breaking point in 2018. The fragmented and complex process was not working well for anyone in the supply chain. A single invoice can have up to 200 data elements from various partners in the supply chain. With up to 70% of those invoices being disputed, the effort and time required to investigate was considerable. Walmart Canada used both internal

resources and a business process outsourcing (BPO) firm to work on reconciliations. Payment terms—such as paying the invoice within 30 days—could not be triggered until agreement was reached, which led to slow payments to freight carriers. One of Walmart Canada's largest carriers was threatening to sever its relationship because it took weeks, and sometimes months, to get paid. Sergei Beliaev, who was Walmart Canada's CIO, explained:

> *For each invoice that was in dispute, a small army of people on both sides chased down facts. Payments were outstanding, which was a significant strain on the financial stability within the carrier community. Relationships were strained, as well. It involved a back and forth on who's right, who's wrong. It was taking too much of management's time to resolve.*

In summer 2018, Walmart Canada's supply chain and logistics team asked the technology organization to assess whether IT could help improve freight invoicing. This team created a business case for the project. Francis Lalonde, VP of Transportation for Walmart Canada, explained that the firm set three objectives: 1) resolve carrier payment issues, 2) improve the efficiency

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19   "DLT Labs™ & Walmart Canada Transform Freight Invoice Management with Hyperledger Fabric," Hyperledger, 2020, available at https://www.hyperledger.org/wp-content/uploads/2020/10/HyperledgerCaseStudy_DLTLabsWalmart.pdf.
20   Ibid.

of how Walmart works with freight carriers, and 3) create visibility to establish trust with carriers.[21] The business case estimated a one-year financial return on investment.[22]

The initial thought was to improve freight invoicing, but John Bayliss, Walmart Canada's senior VP of Logistics Supply Chain (currently executive VP, chief transformation officer) asked the CIO this provocative question: Instead of reducing reconciliations, can we remove them altogether? This idea came from the business team, which realized that Walmart Canada was overpaying the BPO provider for a service that didn't meet the transportation team's requirements.

The CIO and his technology team thought that blockchain technology could possibly eliminate the need for reconciliations. A blockchain solution would establish a near real-time, single shared version of an invoice. The technology team considered blockchain technologies to have advantages over traditional solutions. Compared to conventional applications, blockchain applications: 1) provide a real-time, single version of the truth to eliminate (or significantly reduce) disputes, 2) create a tamper-resistant, traceable history of events to simplify workflow and compliance, and 3) automate execution with tamper-resistant smart contracts to accelerate business processes. A blockchain solution could work if it could be integrated with all of the partners' existing technologies. The solution would need to allow each carrier to continue using its own internal systems yet share reliable, standardized information with Walmart Canada.[23]

Choosing a Configurable Solution over a Custom-Built Application

Walmart Canada decided to seek out a technology partner specializing in blockchain-enabled solutions so it could focus on its core business capabilities. The firm wanted a technology partner that could deploy a solution quickly, knowing that business associates and partners—not only within Walmart Canada, but also those of freight carriers—have limited time, limited funds, and many competing priorities.

Most potential technology providers pitched to build a customized solution from scratch in about 18 months. However, DLT Labs, a rapidly growing boutique technology platform developer, suggested using a configurable platform that could deploy a solution more quickly than a custom-built application. The platform configuration would need to be validated, but validation would be faster than coding and testing a new application. The modules of DLT Lab's platform are built on Hyperledger Fabric, an open sourced permissioned blockchain codebase.[24] Walmart Canada selected DLT Labs as its technology partner.

Developing a Production Pilot with a Major Freight Carrier

While deployments of a new technology often begin with a proof of concept to test the technology's efficacy in a sandbox environment, Walmart Canada made the crucial decision to proceed directly to a production pilot of DL Freight. The firm already knew that blockchain technologies worked; in the U.S., Walmart was using the IBM Food Trust to trace leafy greens and in China had tested a blockchain platform built by PwC and VeChain to trace food from farm to store. Moreover, DLT Labs had successfully implemented other blockchain solutions.

The DL Freight production pilot included the full set of internal business, compliance and technology that stakeholders needed for live deployment. Walmart Canada invited one of its major freight carriers, Bison Transport, to participate in the production pilot to ensure that the solution worked for freight carriers as well as for Walmart Canada.

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21 "Walmart and DLT Labs Disrupt Freight Invoicing with 97% Reduction in Disputes," DLT Labs, August 18, 2020, available at https://www.youtube.com/watch?v=trwQOeZLpkw.

22 Hyperledger, op. cit., 2020.

23 "Walmart Canada and DLT Labs Recognized for Supply Chain Innovation," Walmart press release, September 1, 2020, available at https://www.walmartcanada.ca/newsroom/2020/09/01/walmart-cana-da-and-dlt-labs-recognized-for-supply-chain-innovation.

24 Hyperledger Fabric is one of the projects sponsored by the Hyperledger Project, a nonprofit organization launched by the Linux Foundation in December 2015 to advance the application of enterprise-grade blockchains across industries. Hyperledger Fabric's ledger is structured as a chain of blocks and has two subsystems: "the world state" and the "transaction log" of all the transactions that led up to the current world state. Hyperledger Fabric uses the concept of channels within the blockchain network so that all information remains private. Only authorized individuals within authorized channels have read and write access to the data. It also has a smart contracting feature called Chaincode, which is used to automate transactions and to connect outside applications to the world state ledger. For more information, see https://www.hyperledger.org/use/fabric.

The configuration, testing and compliance cycle for the production pilot took only eight months from conception to live deployment. The first two months were spent specifying requirements. Walmart Canada then spent a further two months configuring and testing DLT Labs' platform to ensure it could meet the requirement, and rigorously reviewed DLT Labs and its platform. As Loudon Owen, CEO of DLT Labs, stated: "Walmart is renowned for its rigorous security and compliance reviews. We went through and passed nine extensive security audits by Walmart Canada and its parent company, Walmart, Inc., to be confirmed in this role, and are subject to ongoing periodic reviews."

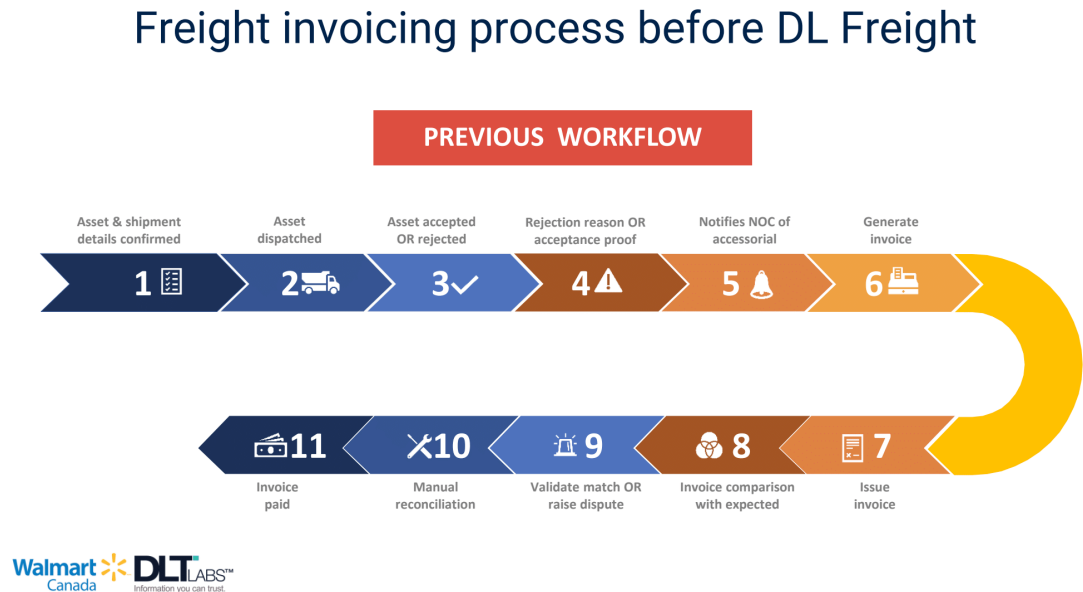### Reengineering Invoice Processing

The production pilot involved significant business process redesign. Before DL Freight, freight carriers generated an invoice after the final delivery of a shipment, which is when Walmart Canada saw the invoice for the first time. Walmart had to investigate all of the unexpected "accessorial" charges (i.e., fees added to a freight bill for additional services provided by the carrier) that appeared on an invoice.

As shown in Figure 1, the freight invoice process prior to the adoption of DL Freight required 11 steps. The value-adding steps are the ones that process data about the shipment, including confirming shipment details (Step 1), dispatching (Step 2) accepting or rejecting delivery (Step 3), issuing a correct invoice (Step 7) and paying the invoice (Step 11). All the other steps involved reviewing data and reconciling any discrepancies within the freight carrier's data.

After DL Freight was implemented, the invoice was jointly built in near real time with data from Walmart Canada and the freight carrier. The "happy path" of the reengineered freight invoice process requires just five steps—i.e., the flow that triggers no exceptions or error conditions (see Figure 2).
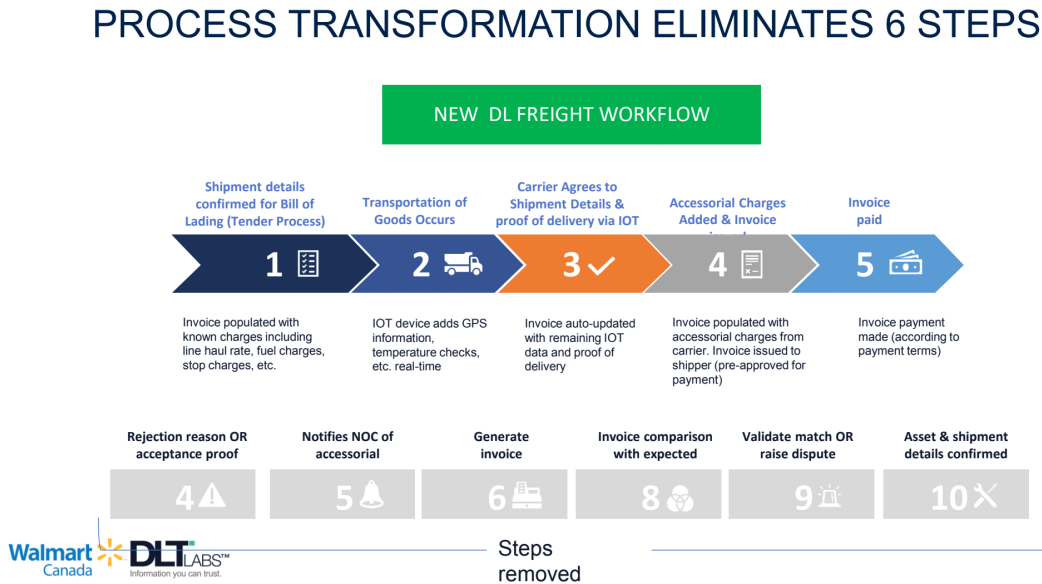
In Step 1 of the revised process, Walmart Canada's transportation management system (TMS) serves as the source of truth for the tender and contracting data. The TMS uploads the shipment tender (using the EDI 204 data standard) to the DL Freight platform to initially populate the invoice with shipment details, load details and delivery instructions. Known charges are added to the invoice, including fuel, planned stops and hazardous materials handling charges.

Figure 1: Freight Invoice Process Before the DL Freight Solution

Source: reproduced with permission from Walmart Canada and DLT Labs

Figure 2: Freight Invoice Process After Implementing the DL Freight Solution

PROCESS TRANSFORMATION ELIMINATES 6 STEPS

Source: reproduced with permission from Walmart Canada and DLT Labs

Carriers interact with DL Freight—either directly through APIs or through a portal—for tender approvals. DL Freight sends a tender-acceptance notification to the TMS (using the EDI 990 data standard). The connections between freight carriers' systems and DL Freight are depicted in Figure 3.

During Step 2, IoT devices that track temperatures, GPS locations and times are read and posted in near real time to DL Freight as the shipment moves along the transportation route. The automatic uploads are done via FourKites, a system that collects and consolidates data from the IoT devices. Some smaller carriers without sophisticated IoT device systems enter their data manually. IoT data triggers variable accessorial charges that are added to the invoice along the way, such as charges for wait times and layovers. Most transaction approvals are automated using smart contracts.

In Step 3, Walmart Canada's distribution centers connect to DL Freight to verify receipt of goods via proof of delivery. GPS reads confirm delivery to the final destination.

During Step 4, the freight carrier validates the shipment details and proof of delivery and completes the invoice by adding any

final accessorial charges. Since payments are preapproved, the invoice is issued to Walmart Canada and is paid according to payment terms recorded in the smart contract. The countdown clock for payment terms, such as "pay the invoice in net 35 days," does not start until the parties have agreed upon the final invoice. With DL Freight, invoices are validated soon after final delivery, ensuring that carriers get paid the right amount within the predetermined timeframe. In short, carriers have certainty about the amount they will be paid and receive the payments faster.[25]

Launching DL Freight as an SaaS Application

DL Freight went live with the production-level pilot on January 1, 2019, with Walmart Canada and Bison Transport on the platform. Next, Walmart Canada had to convince other freight carriers to join DL Freight. Some were understandably suspicious at first—wondering if the solution would benefit Walmart Canada

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25   Hamilton, S. "MOBI Community Innovation Lecture: The partnership between DLT Labs and Walmart Canada," MOBI, September 24, 2020, available at https://dlt.mobi/mobi-community-innovation-lecture-the-partnership-between-dlt-labs-and-walmart-canada/.

to their detriment. To alleviate their concerns, Walmart Canada met with the carriers to explain the business value to them. According to Alexey Shlykov:

> *Some of the carriers were hesitant, and our conversations were never in a form of an ultimatum. It was always in the form, 'Let's talk to help you understand why this is a better solution.' Walmart Canada's IoT team helped with those conversations because, as subject matter experts, they were able to spell it out to carriers.*

DLT Labs also talked with freight carriers.

Before going live on DL Freight, a carrier reviews all its business rules and master data governing the relationship with Walmart Canada. All decisions about transaction workflows involve multiple approval steps on both sides. There is also a dispute mechanism for escalating any issues concerning assessorial charges or deliveries.

Walmart Canada and DLT Labs configured DL Freight to minimize the changes carriers would have to make to join the platform. Carriers are also given support to change their existing systems so they can interact with DL Freight. Large carriers connect their existing systems using API calls, a process that typically takes four to five weeks. Smaller organizations with little to no technology infrastructure—for example, a carrier that operates a few special-delivery trucks—access DL Freight through a portal. Setting up access via the portal takes about 72 hours. Alexey Shlykov summed up the process of joining the platform as follows:

> *Change management was reduced because it was driven by the business and because DLT Labs was pretty good in working with both the business and carriers. The speed was very crucial. The business didn't lose patience. The carriers saw it can be adopted quickly, and the whole thing just came together very nicely.*

DLT Labs charges freight carriers a monthly fee for access to the platform, using a SaaS model.[26] The price depends on the volume of transactions, the complexity of integration and the number of players. In the first six months of 2019, 17 of Walmart Canada's national carriers, both large and small, signed up for DL Freight (a total of 18 including Bison Transport), and by Summer 2020 all its 70 freight carriers were on the platform.

There were, of course, some initial hiccups. DLT Labs noticed a nightly increase in network congestion during deployment caused by the extensive volume of concurrent reporting by freight carriers. This congestion was creating lengthy delays in generating the required reports, which frustrated users. DLT Labs solved the issue by releasing a set of scalable services and algorithms deployed as part of the platform. This dramatically reduced the time to generate reports—in general, from eight hours to 30 minutes.

Within a few months, over 98% of invoices were following the "happy path." For the remaining 2%, Walmart Canada and the freight carriers must still investigate exceptions or errors and reconcile any differences. However, discrepancies are now resolved when they happen, rather than (as previously) having to wait weeks or months from when they appeared on an invoice. For example, if a driver takes a detour that was not preauthorized, an exception is triggered, and all parties can investigate immediately. As Sergei Beliaev stated: "The beauty of resolving disputes right away is that the information is fresh; everybody has full context of what's taking place right now or what has just taken place, so fact-finding is quite easy."
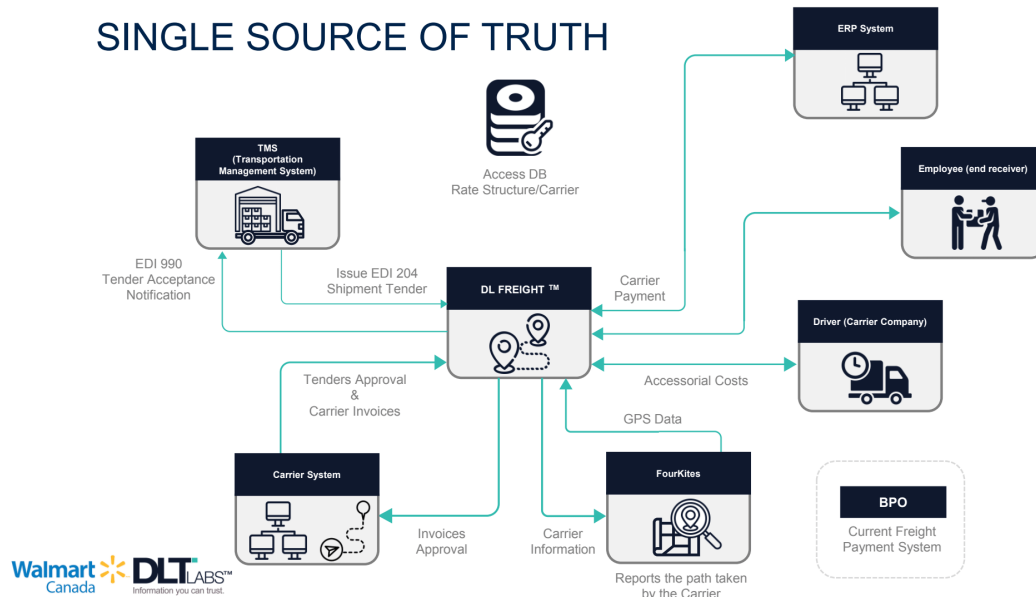
DL Freight Governance Issues

Walmart Canada and DLT Labs carefully thought through governance issues for DL Freight. Governance defines the decision-making rights for a blockchain-enabled solution.[27] The

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26   Walmart Canada has a separate agreement with DLT Labs because it uses DLT Labs' managed services to operate the DL Freight platform.

27   Governance is a major challenge for blockchain-enabled digital ecosystems. For more on governance challenges and solutions, see: 1) Lacity, M. C. "Addressing Key Challenges to Making Enterprise Blockchain Applications a Reality," *MIS Quarterly Executive* (17:3), September 2018, pp. 201-222; and 2) Zavolokina, L., Ziolkowski, R., Bauer, I. and Schwabe, G. "Management, Governance, and Value Creation in a Blockchain Consortium," *MIS Quarterly Executive* (19:1), March 2020, pp. 1-17.

Figure 3: Connecting Freight Carriers' Systems to DL Freight

Source: reproduced with permission from Walmart Canada and DLT Labs

scope of blockchain decision-making rights is complex, spanning participation rights and validation rights, as well as decisions about platform oversight, software update control, data policies, override rights, compliance assurance and ownership of software intellectual property.

Participation Rights

A blockchain solution must specify who is allowed to carry out transactions over the network. DL Freight is a private blockchain—an invitation-based system requiring approval from platform administrators. Since freight carriers used by Walmart Canada are expected to join the DL Freight platform, approval to participate is inherent in becoming a Walmart Canada carrier.

Validation Rights

A blockchain solution must specify who is allowed to operate a validation node in the network. DLT Labs is the network operator for DL Freight and is thus responsible for the validation (endorsing peer and ordering) nodes. DLT Labs deliberately dispersed the geographic location of the nodes to prevent an electricity outage in a single region from making the blockchain

network unavailable. As mentioned earlier, DLT Labs went through nine extensive security assessments by Walmart Canada and its parent company, Walmart, Inc., in order to be confirmed in the role of network operator, and is subject to ongoing periodic reviews. As part of its role as network operator, DLT Labs runs and manages nodes on behalf of the platform participants.

Platform Oversight

Walmart Canada controls most decisions regarding upgrades and modifications to DL Freight's core system. However, it has collaborative relationships with the freight carriers and has regular dialogues with them about improvements.

Software Update Control

With a blockchain solution, software changes must be coordinated across a distributed network of nodes. Whether it's an emergency patch for a newly discovered software vulnerability or a planned software release, the majority of validator nodes must choose to update the software for it to take effect. For example, any update to DL Freight's software can only be

successfully deployed when it has been approved by enough participants to satisfy the platform's lifecycle endorsement policy (a majority, by default). Thus, software cannot be rolled out without having the consensus of the majority. Once the update is approved, it is pushed to all participants in the network.

Data Policies

A blockchain solution must have a data policy that defines who owns the data on a shared ledger and how data is to be uploaded, used and retired. DL Freight uses a distributed ledger, meaning that the data is shared between authorized participants in the network and each of them "accesses" the same data. By using channels,[28] DL Freight ensures that there is no intentional or accidental leakage of data across participants (i.e., a carrier seeing the information of another carrier). In DL Freight, data is never actually retired because the blockchain is immutable, but any updates of the data elements can be stopped by deactivating the workflow ID associated with those elements. Freight carriers can extract data shared between themselves and Walmart by using authenticated and authorized API calls.

Override Rights

Override rights define who is authorized to roll back the blockchain ledger in the event of egregious errors such as a hack. The only way to roll back a ledger is to create a "hard fork," a permanent, divergent path of a blockchain. A hard fork is a highly contentious issue because a blockchain ledger loses its immutability property.[29] Hard forks are not allowed on the DL Freight platform. The record is immutable. If there is an egregious error, correction entries are pushed in the form of transactions, which bring the system information to a corrected state, maintaining the record of both the error and its

correction. This allows for complete transparency for audit and compliance purposes.

Compliance Assurance

Every blockchain solution must answer two compliance questions: 1) Who is in charge of ensuring regulatory compliance? 2) Who is liable if a law is violated or a regulation is not followed? With DL Freight, the business participants (Walmart and the freight carriers) are accountable for ensuring relevant regulatory compliance. As Sergei Beliaev explained:

> *"From a system perspective, this is one of the key benefits of using blockchain technology. The inherent immutability and transparency of all data guarantee the integrity of the business information and a permanent digital footprint of all changes for compliance reporting."*

Ownership of Software IP

The intellectual property for DL Freight is owned by DLT Labs. It provides data stewardship but Walmart Canada owns the data and the specific implementation. Licenses are managed using an SaaS model.

Positive DL Freight Business Outcomes for Walmart Canada and Freight Carriers

As of Summer 2021, DL Freight had processed 340,000 invoices. Preparing these invoices involved 57.1 million IoT messages and 2.6 million temperature updates. As described below, DL Freight provided positive business outcomes and benefits, not only to Walmart Canada but also to its carriers.

Data Transparency

All relevant data is now transparent to all authorized participants in the DL Freight platform. Not only can they view direct information about shipments but, for the first time, can now see reference data such as rate cards. One of Walmart Canada's smaller freight carriers noted: "For the first time, I can see the rate that Walmart is going to apply to their own calculations."

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28   See Footnote 24 above

29   For example, Ethereum split into Ethereum and Ethereum Classic in 2016, when the community disagreed about remediating the hack of the decentralized autonomous organization (DAO) set up on Ethereum. The decision was made to let miners vote, weighing their votes by their hashing power. The miners voted for a hard fork, a permanent divergence in the Ethereum blockchain. The blocks were rolled back, and the stolen ether was returned. Those miners who refused to follow the fork continued to mine with the original code, leaving Ethereum (fork followers) and Ethereum Classic (non-fork followers), where the thief can still cash in.

Real-Time Invoicing and Processing

Before DL Freight, it could take weeks, even months, to approve freight carrier invoices. Walmart Canada's finance department first had to review and approve each invoice, especially any accessorial charges in excess of a threshold amount, and then work with a third-party BPO reconciliation provider to investigate any disputes. After the implementation of DL Freight, invoicing and approvals were automated in real time. John Bayliss explained:

> The biggest change for Walmart Canada since using DL Freight is the reduction in manual work to resolve disputes. The cost and the waste associated with chasing dispute resolution has come down dramatically from over 70% disputes of our invoices at peak times to under 2% … We are seeing the proof of the waste that can be wrung out of the system from this additive technology.[30]

Financial Benefits

The ROI from DL Freight took less time than the expected one year. Walmart Canada achieved cost savings because it no longer needed the services of the BPO provider to investigate disputes. Savings also resulted from more accurate calculation of accessorial payments, improved compliance and reduced audits. According to John Bayliss: "DL Freight has gotten us over this bottleneck so we can pay our carriers on time. The cost and the waste associated with disputes has come down dramatically." Walmart Canada redeployed the personnel freed up by implementing DL Freight to more value-adding tasks.[31] Financial benefits for carriers came in the form of better cash flows. For example, one carrier noted that it no longer had millions of dollars tied up in disputes, thus reducing its accounts receivable.

Improved Relationships with Carriers

The carriers are happy because they get paid more quickly. As John Bayliss confirmed: "We've had phenomenal reviews from all of our carriers."[32] For example, as Rod Hendrickson, VP of Finance and Administration for Bison Transport stated:

> Before DL Freight, we had a large amount of discrepancy in terms of what we billed Walmart and what Walmart was expecting to be billed by Bison Transport. That's not uncommon in this industry. Since the implementation of DL Freight, we have processed close to 15,000 invoices and have a discrepancy percentage of under 2%. We are very pleased; that is a significant reduction.[33]

Likewise, Alex Fu, CFO at Titanium Transportation (another of Walmart Canada's carriers) said: "I would love to see other companies adopt DL Freight as their standard. The reason is simple: It creates a lot of efficiencies and simplifies the billing and payment process."[34] According to Alexey Shlykov:

> The relationship between carriers and Walmart has improved dramatically. It's not just the removal of suspicion about overpayments or late payments; it's that our carriers realize that Walmart is doing something exciting to make their lives easier. They see it as a sign that Walmart is committed to a long-term partnership.

Providing Financial Incentives to Supply Chain Partners

Before adopting DL Freight, Walmart Canada did not offer finance-related incentives to its freight carriers because the lack of transparency made the financial risks too great. After adoption, Walmart Canada felt it could rely on the data and agree to discounts for early payments.

Better Business Intelligence

Walmart Canada and its carriers now have access to more information, such as the temperature and GPS data that flows in from IoT devices. Supplementing that data with other parameters like weather and road conditions

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30 Walmart press release, op. cit., September 1, 2020.
31 Hamilton, S., op. cit., September 24, 2020.

32 Walmart and DLT Labs Disrupt Freight Invoicing with 97% Reduction in Disputes," op. cit., August 18, 2020.
33 Ibid.
34 Ibid.

allows Walmart Canada to perform better predictive analytics. According to John Bayliss:

We can understand patterns around stores and depots that are not turning quickly and roads that are not as efficient as both parties would like them to be. The technology brings all this together into one ledger that originally was a payment platform, but we are using it much more as an information platform to give us insight on how we run our business.

The data from DL Freight will also be funneled into Walmart Canada's Smart Transportation initiative.[35] As Alexey Shlykov stated:

We can generate quite exotic ways of reporting [from] that information and provide analytical support to both Walmart Canada and our carriers. It opens up a new field based on the information we are collecting now—for instance, adding tracking of produce provenance, freshness and transportation conditions to the platform.

Recognition as Innovation Leaders

DL Freight is generating a lot of international attention for Walmart Canada, DLT Labs and the freight carriers on the platform. For example, in 2020 DL Freight was recognized as one of the top six innovators of the year by the Council of Supply Chain Management Professionals (CSCMP)[36] and was first runner-up (Silver) for CSCMP's prestigious 2020 Supply Chain Innovation Award.[37] In 2021, DL Freight was a finalist for the Accenture Freight & Logistics Innovator Award for North America.[38]

Recommendations for Using Blockchain Technology for Interfirm Process Innovation

The lessons from the DL Freight case translate into six recommendations for reimagining

interfirm transaction processing. The first recommendation focuses on the potential business value of interfirm process innovation: are the problems worth reimagining? The other five focus on thinking through decisions about reengineering processes, whether to implement a blockchain solution or use traditional databases, whether a custom build or configured platform is more appropriate, whether to start with a proof of concept or a production pilot, and whether to operate the platform yourselves or buy it as a service.

1. Assess the Investment Potential of Interfirm Process Innovation

The business opportunity for interfirm process innovation must be large enough to compensate for the money, time and risks involved in building and maintaining an ecosystem-level solution. If the pain points are significant for all trading partners, then a potential use case for developing a solution exists. For Walmart Canada and its freight carriers, the processing of freight invoices was broken. It cost both sides too much money and took too long to reconcile up to 70% of invoices. Freight carriers were getting paid weeks or even months after final delivery. If this had just been Walmart Canada's problem or just the freight carriers' problem, DL Freight might not have emerged as an interfirm initiative.

One key to DL Freight's success is that both Walmart Canada and the freight carriers gained significant business value from adopting the solution. The value for Walmart Canada came from real-time invoicing and payments, a drastic reduction in discrepancies and disputes, better business intelligence, improved carrier relationships and opportunities for early payment discounts. Business value for the carriers included shortening the payment delays to almost nothing, improving cash flow and receiving more information, enabling their internal analytics to make their operations more efficient. As Rod Hendrickson, VP of finance and administration for Bison Transport, commented:

I think this solution has the potential for being a game-changer for supply chains across the industry. We have hundreds of customers, and when we see the improvement to the cleanliness of the

35 Hamilton, S., op. cit., September 24, 2020.
36 Walmart press release, op. Cit., September 1, 2020.
37 "Intel takes home CSCMP Innovation Award," DCVelocity, September 23, 2020, available at https://www.dcvelocity.com/articles/47258- intel-takes-home-cscmp-innovation-award.
38 "DLT Labs is Finalist for Accenture Award," DLT Labs, May 13, 2021, available at https://www.dltlabs.com/news/dlt-labs-is-finalist-for-accenture-award-967437.

accounts and the timeliness of payments, I think if I had all of my accounts in such good shape, I would be very happy.[39]

2. Determine the Root Causes of Ecosystem Pain Points and Consider Reengineering Them

Interfirm processes are often expensive and slow because they are still paper based or use legacy technologies such as batch processing of EDI transactions. Transaction records about events often lag behind the actual events, causing both operational and financial pain points. In the Walmart Canada case, the two root causes of invoice disputes were mismatched records that needed reconciling and the fact that an invoice was only created and shared with Walmart after final delivery. During the pilot, Walmart Canada, DLT Labs and Bison Transport redesigned the invoicing process to eliminate the root causes.

The redesigned DL Freight invoicing and payment process removes steps no longer needed to validate information. So far, about 98% of invoices follow the "happy path," which requires just five steps, compared to 11 steps previously. DL Freight synchronizes digital records of events in near real time with actual shipments, and these digital records are shared—there is one version of the invoice shared between Walmart Canada and a given freight carrier. According to Sergei Beliaev: "If you are into Six Sigma, this is a huge opportunity to take the waste out of the business process. This is business process reengineering at its best."[40]

3. Create a Shared Version of the Truth and Consider Whether Blockchains Might Apply

Trading partners must create transaction records that all parties agree is a true record of what happened. However, a shared vision of the truth does not necessarily indicate that a

blockchain solution is appropriate.[41] If only one party needs to write the transaction, it will be easier to use a traditional database and grant read access to the other parties. If transactions require multiple parties to update the data, then a blockchain should be considered. Just as ERP aimed to create a single version of the truth within a firm's boundary, blockchain applications provide a single version of the truth across firm boundaries. Specifically, a distributed ledger creates a time-stamped, permanent record of all valid transactions that have occurred within the blockchain application. Trading partners encode smart contracts defining when and how to automatically update the distributed ledger.

Walmart Canada's objectives were well-suited for a blockchain-enabled solution. The firm set three objectives: 1) resolve carrier payment issues, 2) improve the efficiency of how Walmart works with freight carriers, and 3) create visibility to establish trust with carriers. Compared to traditional applications, the DL Freight blockchain application provides three advantages:

1. It provides a real-time, single version of the invoice, which eliminates (or significantly reduces) disputes and thus allows carriers to be paid the correct amount on time
2. It creates a tamper-resistant, traceable history of events, which simplifies workflow and compliance and automates execution with tamper-resistant smart contracts that accelerate business processes
3. It provides visibility into events and charges that authorized parties now see in near real time.

4. Consider Whether to Custom Build or Use a Configurable Platform

Trading partners need to decide whether to develop a custom solution, configure an existing platform or simply join an existing network. Although joining an existing network is the fastest, easiest and least expensive option, it offers limited scope for adapting the solution. A custom solution can provide the best fit for

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39   Walmart press release, op. cit., September 1, 2020.

40   Research consistently finds that broken processes need to be fixed before applying any automation technologies. As a corollary, trading partners also need to clean up data before automation; otherwise, trading partners only have more visibility into poor data. The maxim "garbage in, garbage out" is a perennial truth, but in the case of blockchains, this is exacerbated by the distribution of data across trading partners. For more information, see Van Hoek, R., Fugate, B., Davletshin, M. and Waller, M. *Integrating Blockchain into Supply Chain Management: A Toolkit for Practical Implementation*, Kogan Page, 2019.

41   See Pedersen, A., Risius, M. and Beck, R. "A Ten-Step Decision Path to Determine When to Use Blockchain Technologies," *MIS Quarterly Executive* (18:2), June 2019, pp. 99-115.

the founding partners, but is the most expensive option and has the longest development cycle. Moreover, the design of a custom solution should ensure that it is compelling for others to join. Scaling the solution to parties beyond the founding partners may be key to growing its value and ensuring the lasting success of the solution and achieving its full benefits.

Walmart Canada selected the middle option—configuration—and chose DLT Labs as its technology partner, partly because it had a configurable platform. Other potential providers proposed developing new bespoke solutions, with the accompanying inherent uncertainties about outcomes and timing. Walmart Canada involved its production pilot partners in the configuration process and saved time by not having to develop a custom design from scratch. Once the DL Freight platform was deployed, additional freight carriers joined the network. The onboarding process for these additional carriers involved minimal investment and changes to their IT systems.

5. Decide Whether to Start with a Proof of Concept or a Production Pilot

Trading partners who want to solve a process problem in their ecosystem need to decide whether to start with a proof of concept (PoC) or proceed straight to a production pilot. The decision will be based on the trading partners' experience with the proposed technologies. PoCs are developed in a sandbox environment to assess the efficacy of a new technology. Up to 84% of PoCs never make it out of the sandbox.[42] While many PoCs do not move into production, this does not mean that partners are not learning about the technology and possible approaches to change and adoption. Moreover, solutions may not move into production because of the technology but rather because of stakeholder issues or concerns.

Walmart Canada and DLT Labs made the crucial decision to forgo the typical PoC phase and move straight to a production pilot because they knew the technology worked in other parts of Walmart. The production pilot included business leaders, as well as IT security, legal and regulatory representatives from the start so that the solution could be brought to market quickly. Bison Transport was part of the minimal viable

ecosystem (MVE)— i.e., the minimum number of ecosystem partners needed to launch a minimal viable product (MVP) successfully.

Though many enterprises run new systems as shadow systems until trading partners are convinced that the live production system works, the production pilot convinced the business side of Walmart Canada of the system's efficacy, meaning that it was not necessary to operate a shadow system after implementation. Walmart Canada's contract with the BPO provider used to investigate invoice disputes expired about the same time that DL Freight went live, and management decided not to renew it.

6. Decide Whether to Manage the Blockchain Yourselves or Buy it as a Service

Although transactions within a permissioned blockchain application are peer-to-peer, there remains a need for managed services.[43] Someone needs to operate network nodes, enforce access rules set up by members, help participants to onboard, provide training, answer questions and manage software updates. Trading partners can establish a governance structure to manage the blockchain themselves or engage a service provider.

Walmart Canada decided it was best to use a third party, DLT Labs, to operate the solution rather than manage it themselves or manage it with multiple freight carriers. Part of the reason for this decision was that Walmart Canada sees its core business competency as a retailer not an IT provider. More importantly, however, DLT Labs serves as a neutral facilitator for signing up other freight carriers to DL Freight. As Sergei Beliaev stated: "Otherwise, if it became a purely Walmart Canada-run solution, it would not be as immutable, guaranteed and trusted." Walmart, Inc. made the same decision in the U.S. when it decided that IBM should operate the Food Trust.

The potential role of intermediaries in a blockchain application shows that blockchains may not remove the role of intermediaries in transactions but rather alter their role. While traditional intermediaries such as brokers or

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42 Mondal, T., Gupta, S., Madhur, M. and Duncan, S. *HfS Top Enterprise Blockchain Services 2020*, April 2020, HFS Research.

43 Unlike permissioned blockchains which are private networks, public blockchains are governed by a community. For example, Bitcoin and Ethereum miners "vote" by either installing or failing to install changes to the source code.

clearinghouses may see their value reduced, others, such as DLT Labs and IBM, with its role in the Food Trust, may grow into a new role of enabling the network to function.

Concluding Comments

The DL Freight case study shows that interfirm processes can be significantly improved by automating and validating events in real time, rather than doing one post hoc validation at the end. With blockchain technologies, every transaction in the ledger is verified, balances are guaranteed to be correct and current, and everything is transparent to authorized parties. This case shows that using a blockchain for interfirm process innovation is not only possible technically, but that there is demonstrable business value for all parties in the ecosystem. Walmart Canada achieved success, in part, by applying the lessons from intrafirm process innovation to interfirm processes. These lessons included:

- Reengineering processes before automation
- Creating a single version of the truth
- Configuring an existing platform rather than building custom software
- For the freight carriers, buying business processes as a service to minimize IT investments costs.

We believe that blockchains can potentially be of value in any ecosystem where trading partners need to validate transactions based on agreed upon terms and conditions, which is why blockchains have been viewed as an enabling technology in sectors such as financial services, rights and royalties, real estate, healthcare, manufacturing, education, credentials, supply chains, energy and government services.

Ultimately, each enterprise must decide whether to take the lead in developing a blockchain platform, participate in the development with ecosystem partners or wait until others develop a blockchain platform and then join. Each approach has advantages and disadvantages. Those that choose to lead, and their active ecosystem participants, architect the future, become renowned visionaries and increase brand awareness. However, they bear the most risk. Followers may end up with suboptimal

choices. In the words of John Bayliss: "When you are first, you have the opportunity to set the standard."[44]

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44   Walmart press release, op. cit., September 1, 2020.