A Use Case for Blockchain Technology:

Supply Chain Response to Humanitarian Assistance / Disaster Relief

Defense Logistics Agency, Troop Support

15 Jan 2019

Executive Summary

This paper presents a 'use case' to explore the potential for blockchain technology to increase supply chain effectiveness and efficiency in a complex scenario. Specifically, the use case traces the requirements and movement of over 62 million power grid items to the island of Puerto Rico for relief and recovery from 2017's Hurricane Maria. The end-to-end review of the supply chain covers from acquisition request to customer delivery on the island, and reveals multiple friction points. The paper explores the potential for future investments in blockchain technology to improve communication, tracking, and information availability by increasing trust and reducing costs measured in time, money, duplicated effort, and other efficiencies. A blockchain distributed ledger of information and singular version of information can support future emergency responses in complex Humanitarian Assistance/Disaster Relief events and remote environments. Federal agencies may help inform industry development of blockchain technology for future federal or military applications, and DLA Troop Support recommends exploring additional possibilities with more real world scenarios.

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15 JAN 2019

MEMORANDUM FOR: DLA TROOP SUPPORT & PARTNERS

SUBJECT: EXPLORING BLOCKCHAIN TECHNOLOGY FOR SUPPLY CHAIN TRANSFORMATION

In 2017, the United States experienced unprecedented destruction brought on by multiple natural disasters. As part of our Whole of Government mission, DLA Troop Support was called upon to support Humanitarian Assistance and Disaster Relief (HA/DR) efforts in response to wildfires and three hurricanes. Although significantly demanding, these events reaffirmed the highest degree of commitment from our employees and partners to meet customer needs in an unparalleled emergency. Today, as technologies are developing and advancing at the fastest rate in human history, DLA is leveraging scenarios such as the 2017 Atlantic Hurricane Season to examine use cases in supply chain adaptation and innovation.

DLA Troop Support has conducted in depth research into blockchain technology seeking innovative solutions with potential to improve and transform supply chain management. There is growing interest for both the private and public sectors on this topic, and this report details our initial findings through a use case on electrical materials delivered to Puerto Rico in the wake of Hurricane Maria.

This research paper first describes the technology at a high level, investigates our scenario, and then explores the technology potential to affect supply chain management and other customer needs. By using our real world, data-rich vignette, we can test blockchain technology in a theoretical environment to see how (or if) it may improve end-to-end delivery of materiel in ambiguous emergency scenarios.

The use case identifies significant potential for gains in security, transparency, accountability, scheduling, auditability, and chain of custody through the application of micro services and artificial intelligence that access and use the distributed single version of the data on the blockchain.

After reviewing this research, I approve recommendations to continue exploration of future implementation for blockchain technology within one or more of my supply chains on a test pilot basis. By publishing this use case, I anticipate further inquiry from different supply chain stakeholders and look forward to discussion and ideas for applications in the Department of Defense and across the United States Government.

MARK T. SIMERLY
Brigadier General
Commander

Acknowledgements

Brigadier General Mark T. Simerly proposed this DLA Troop Support innovative research on blockchain technology to complement his Campaign of Learning, an initiative that actively targets communication and discussion on the future of supply chain sustainment.

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An Introduction to Blockchain

Blockchain & Cryptocurrency

In 2008, a whitepaper explaining peer-to-peer electronic cash transfers introduced a concept of electronically signed and time stamped blocks of data that would evolve to become blockchain, or distributed ledger technology. In this paper, Satoshi Nakamoto proposed the concept to enable immutable trust for currency movement over every transaction that occurs. Essentially, by distributing the data chain or blockchain of currency ownership to multiple locations at the same time, the technology created the ability for different user nodes to confirm data authenticity without a third party review such as a bank or external auditor (Nakamoto, 2008). When leveraging blockchain, there is only one version of the data and everyone has the same copy.

Bridging the "Trust Gap"

Trusted transactions that occur today largely rely on third party intermediaries to facilitate and/or verify information for both buyers and sellers. Blockchain technology is valued for the increased trust in data shared in near real time across a widespread digital environment. This has significant implications for multiple industries that rely on data in a knowledge-based economy. According to IBM, blockchain has specific attributes through which it builds trust in a way that is absent from our current transactional systems (Gupta, 2018).

1. **Decentralized / Distributed Ledger**
   There is no central administrator (i.e. a bank or lending house) or centralized data storage (i.e. current enterprise resource planning (ERP) systems). A distributed ledger shares data and information across a network of multiple nodes (users, sites, institutions, etc.). All participants within a network have their own identical copy of the ledger, reflecting any changes made in all copies in near real time (Shankar, 2017).

2. **Secure, Validated & Immutable Records**
   Permissions and cryptography prevent unauthorized access to a network and ensure that participants are who they claim to be. As transactions between users occur, all relevant

network participants must agree that a transaction is valid. Pertinent transaction information stores in "blocks" that link to form a "chain." These blocks contain cryptographically stored information and are then tamper-resistant. Once stored, correcting any errors requires inputting new, verified transactions (Gupta, 2018).

3. **Auditability**
Because participants in a transaction have access to the same records, they can validate transactions and verify identities or ownership without the need for third-party intermediaries. Transactions are time-stamped, ordered, and verified in near real time (Gupta, 2018).

Smart Contracts

Building upon the existing benefits of a blockchain is a tool known as a smart contract. Smart contracts are the agreed upon terms between a buyer and seller (i.e. the contract) that are directly written into lines of code. Smart contracts then become self-executing when terms are met through information transmitted via blockchain. These tools digitally facilitate, verify, and enforce the negotiation or performance of the contract, they are trackable, and they are essentially irreversible once distributed across the network. Smart contracts further dispel the need for third party intermediaries, improving efficiency and lowering the cost of transactions.

Technology Potential

Adopting blockchain technology to improve transactional trust has the potential to realize efficiencies in information accuracy, accountability, auditability, communicability, transfer, transparency and more. Effective solutions will result that make data timely, accurate, and actionable. Models for descriptive, predictive, and prescriptive data use will mature through computer learning or artificial intelligence (AI), making blockchain an attractive investment for research and development. Specific examples of real world scenarios offer a more complete picture of how the theoretical use of blockchain may help to solve large and small problems faced in the day-to-day transactions of goods or materiel movement through a supply chain.

Use Case Scenario

Overview

The scope of this use case is to evaluate blockchain technology against a real world, data-rich vignette. The chosen scenario is the DLA Troop Support Construction and Equipment (C&E) supply chain and the electrical Bill of Materials (BoM) items used to restore permanent power to Puerto Rico following Hurricane Maria. This assessment includes an end-to-end process analysis from the time C&E receives a request for goods/services through final delivery, which, in this vignette, went far beyond the initially contracted ports on the shores of the continental United States (CONUS). The process analysis includes interactions with partner agencies, prime vendors, and other key stakeholders. Merging an understanding of this event with knowledge of blockchain enables DLA Troop Support to evaluate blockchain technology and propose how its application could have changed the response. Prior to delving into the details, it is important to understand the role of DLA Troop Support in HA/DR missions as well as the events leading up to the response in Puerto Rico.

DLA Troop Support – Whole of Government Line of Effort

DLA's global supply chain network and expertise in supply chain management supports Warfighters around the globe as well as other agencies in a line of effort (LOE) identified as Whole of Government. As part of the DLA Whole of Government LOE, DLA Troop Support develops strong partnerships with other government agencies to support the Nation in disaster relief including hurricanes, typhoons, earthquakes, wildfires, and more. DLA Troop Support provides emergency responders with medical supplies, firefighting equipment, law enforcement needs, food programs, construction materials, uniform items, tents, and military materiel sales, among other items. During disaster relief efforts, DLA Troop Support mutually supports swift

interagency response by engaging federal, state, and local organizations. DLA leverages its extensive supply chain partnerships to develop processes, actions, and policies that enable agile, rapid responses while demanding accuracy, transparency, and accountability of federal resources.

Whole of Government LOE – HA/DR

DLA's Whole of Government LOE was in full effect during the 2017 Atlantic Hurricane Season, with multiple HA/DR missions to address. As one of the most active hurricane seasons in U.S. history (there were 17 named storms, 10 of which became hurricanes), major devastation resulted from three successive major hurricanes making landfall between 25 August and 20 September 2017. These three storms caused a combined $265 billion in damage and resulted in widespread displacement of survivors. Devastating wildfires in California further complicated HA/DR support. Collectively, the hurricanes and wildfires affected more than 47 million people – nearly 15% of the Nation's population (FEMA, 2018).

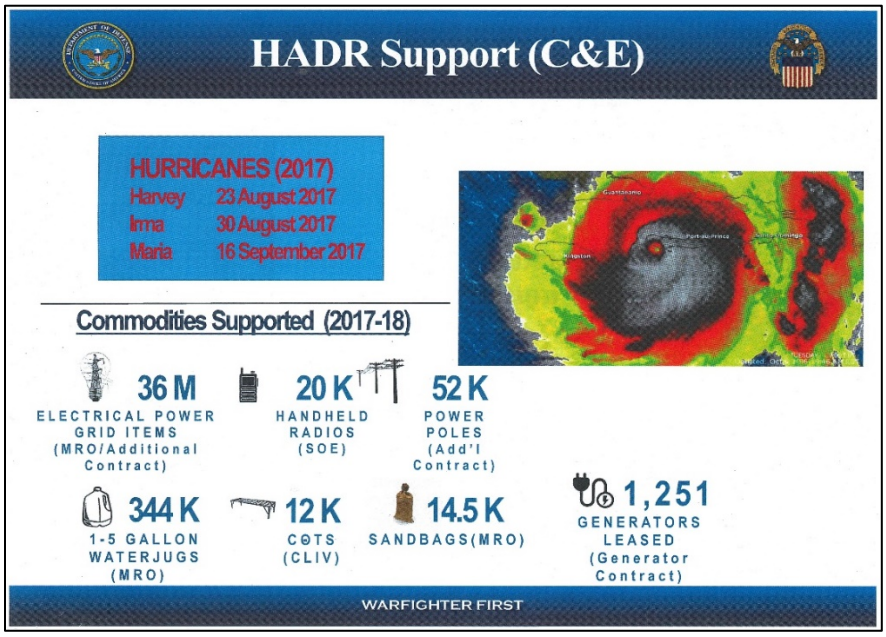

Figure 1 - Infographic of DLA Troop Support's C&E Supply Chain HA/DR support during the 2017 Atlantic Hurricane Season.

While the magnitude of the 2017 Atlantic Hurricane Season and corresponding disaster relief efforts are crucial to this use case, the focus will turn to the DLA Troop Support response efforts for Puerto Rico following the third of the three major hurricanes: Hurricane Maria. More specifically, we will look at the efforts of the C&E supply chain and the goal to restore power to the island.

DLA Troop Support – C&E Supply Chain

'From light bulbs to bulldozers,' is the motto of the C&E supply chain at DLA Troop Support. C&E provides a diverse set of solutions for the military and other federal customers. The C&E support of programs includes equipment to mitigate fire emergencies and force protection, communication and tactical equipment, and materiel needed to keep critical weapon systems operational. C&E additionally provides worldwide customers with construction and facility maintenance materials. Some other support efforts also go beyond land operations with marine life saving and diving equipment. C&E leverages contractual agreements with commercial suppliers to ensure availability and rapid shipment of goods, and offers additional tailored work to support unique customer needs. The Secretary of Defense designated DLA as the Defense Department Executive Agent for construction and barriers, providing C&E the distinction of being the single DoD point of contact for construction and barrier support.

2017 Atlantic Hurricane Season

In 2017, three strong hurricanes landed on American shores in rapid succession recording one of the busiest and most destructive hurricane seasons on record. Hurricanes Harvey, Irma, and Maria broke a 12-year American hiatus from major hurricanes leaving Texas, Florida, and Puerto Rico, with over $250 billion in damages (Belles, 2017). GAO noted these hurricanes, combined with the California wildfires, created an unprecedented demand for federal disaster

response and recovery resources that required the deployment of 14,000 federal employees in October 2017, and as of June 2018, over $120 billion in supplemental Congressional appropriations (United States Government Accountability Office, 2018).

HA/DR Initiative for Puerto Rico

Hurricane Maria devastated the island of Puerto Rico leaving 90% of power availability disabled and less than 8% of roads as trafficable (Belles, 2017). On September 18, 2017, the President of the United States (POTUS) declared an emergency in the Commonwealth of Puerto Rico and ordered federal assistance to supplement commonwealth and local response efforts for the emergency conditions resulting from Hurricane Maria. The POTUS action authorized the Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA), to coordinate all disaster relief efforts as the lead agency for emergency response (The White House, 2017). FEMA worked "hand in glove" with the U.S. Army North (Fifth Army) as the land component of U.S. Northern Command. The combined three storms were the largest domestic incident response in the history of the agency. LTG Jeff Buchanan, Commander of the Fifth Army stated the response was "larger than Katrina in 2005 ... and from the total response of the government aspect, it was much larger" (Garamone, 2017).

On the ground in Puerto Rico, LTG Buchanan saw the island was "overwhelmed because it had weak infrastructure, it was vulnerable." The joint response by the military of the National Guard, Sailors, Marines and Coast Guardsmen provided search and rescue operations, reopened airports and seaports, and pushed out lifesaving aid via ground and air assets (Garamone, 2017). Under the National Response Framework, the U.S. Army Corps of Engineers (USACE) went into action as the primary agency for emergency support to public works and engineering and accepted a supporting role for search and rescue (National Response Framework, 2018).

In their after action review, FEMA assessed the response to Hurricane Maria as "unprecedented." This was the largest and longest federal responses to a domestic disaster in the history of the United States (Department of Homeland Security, 2018). Specific operation records include:

- The longest sustained domestic air mission of food and water response in U.S. history;
- the largest disaster commodity distribution mission in U.S. history;
- the largest sea-bridge operation of federal disaster aid in U.S. history;
- the largest disaster generator installation mission in the united states, with generators still installed at critical facilities today;
- one of the largest disaster medical response missions in U.S. history; and
- one of largest disaster housing missions in U.S. history.

C&E HA/DR Process Analysis: Overview

Narrowing the focus for this paper, the materiel acquisition process starts with FEMA assigning USACE the mission to restore power to Puerto Rico, then USACE contacting C&E to supply materials for restoring both temporary and permanent power to the island. On an interim basis, C&E provided over 1,200 generators and support material to establish initial power capabilities. C&E also served as the primary materiel provider for rebuilding the power grid and power distribution system.

DLA Troop Support's global supply chain network and expertise in supply chain management optimally positioned it to support the federal HA/DR operation. Hurricane Maria's extensive damage was not limited to ravaging Puerto Rico's antiquated electrical power grid, as only 5% of the island's cell towers were serviceable and significant damage to seaports, airports, and roads hampered or completely halted transportation (FEMA, 2018). C&E processed over $230 million in obligations to help USACE restore electrical power in Puerto Rico, and the C&E Maintenance, Repair, and Operations (MRO) ordered over 36 million electrical power grid items and 52,000 power poles to support the power recovery. (C&E Supply Chain, 2018).

C&E HA/DR Process Analysis: Detail

C&E achieved significant success and remained resilient throughout the variable requests and chaotic schedules. The team went into action for a relief effort following one of the most devastating hurricane seasons in recorded history, all while competing priorities demanded resources to support other disaster responses in areas around the country.

Although the National Response Framework details procedures leading up to formal disaster declarations, the process analysis supporting this use case only briefly discusses that and instead focuses specifically on requirement determinations, materiel acquisition, and delivery.

Disaster Declaration

When the Governor of Puerto Rico requested federal assistance, POTUS signed a federal emergency disaster declaration that activated FEMA, the primary emergency response agency. The declaration also authorized FEMA special funding and approval authorities with responsibility to report directly to POTUS, and not through the DHS chain of command (Strausbaugh, 2018).

Phase 1: Damage Assessment & Requirements Determination

FEMA tasked USACE to restore power to the island of Puerto Rico. USACE conducted the damage assessment in partnership with the Puerto Rico Electric Power Authority (PREPA). The damage assessment enabled USACE and PREPA to determine initial requirements, and communicate them to the DLA Troop Support C&E supply chain for acquisition processing. This was an iterative process, with new and/or changing requirements hitting C&E hourly. Initially, a language barrier presented problems for translation as some requirements received by C&E were in Spanish. Once C&E received clear and complete requirements, it engaged the three prime vendors it uses as part of its MRO program: Noble Supply, Science Applications

International Corporation (SAIC), and Supply Core.

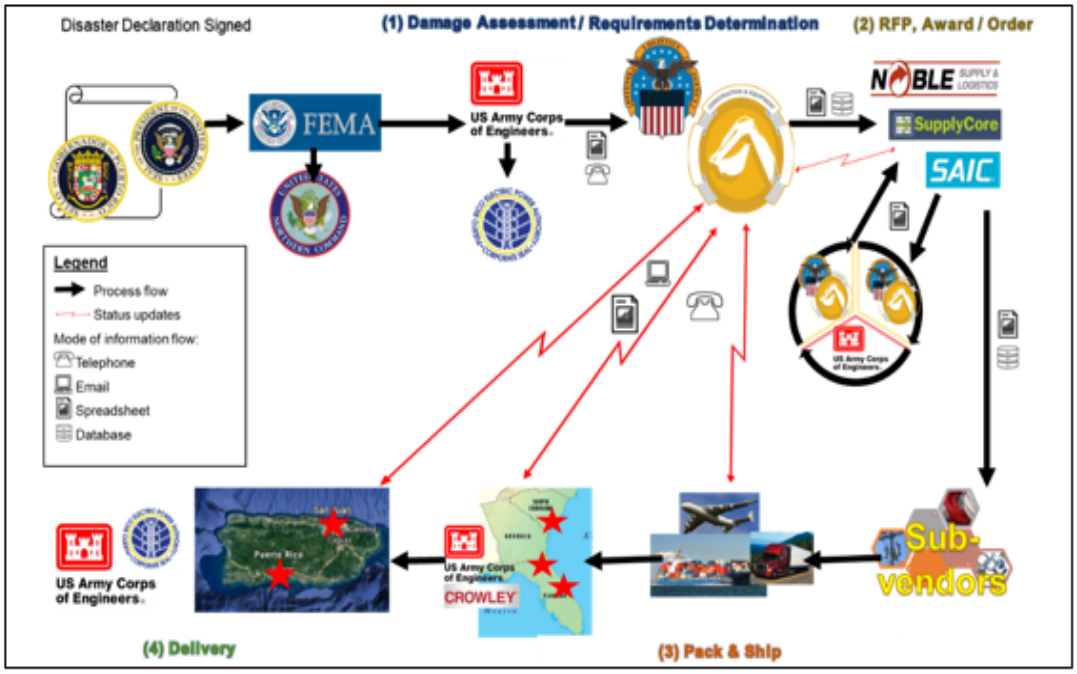

Figure 2 - High-level process map of C&E HA/DR support to USACE. Notice the linear process flow as well as the variety of communication modes among stakeholders.

Phase 2: Request for Proposals, Awards & Orders

C&E put out a Request for Proposal (RFP) to its prime vendors. This process was an interaction between the three prime vendors and their sub-vendors, who provided information on the request such as material availability, estimated delivery dates, price, and technical specifications. Due to the urgent nature of the request, C&E asked its prime vendors for a quick turnaround time on the RFPs, two days or less, with a one-week extension for extenuating circumstances (MacMurray, 2018).

Once C&E received the RFPs back, it shared them with USACE for decision-making. USACE reviewed the details of the RFPs in their entirety. After verifying the solicitation of correct BoM items, the primary factor for choosing a provider was the best delivery date. The nation-wide demand for disaster relief continually stressed a supply chain that was experiencing capacity limitations and low inventory levels. For all members of the network, strained resources

and staffing levels were the norm. While C&E made sourcing recommendations to prime vendors, the vendors themselves had a repository of trusted suppliers. In parallel as stock levels decreased and lead times became longer, the pressure continued to build for USACE to provide timely support at the disaster site. As a result, USACE sought to identify independently the direct sourcing recommendations. Although USACE was well intentioned, their receipt and review of bids was susceptible to fraudulent company promises of on-time deliveries. With an inability to confirm supplier identity amid an increasingly chaotic environment, the challenges continued to mount.

Similar tensions surfaced as USACE modified requirements and C&E processed purchase requests. Varied use between electronic databases and a manual contracting process for purchases added to processing times and management challenges for C&E. Additional time passed as prime vendors, and in turn their suppliers, needed to solidify transportation after C&E awarded the purchase requests. Compounding the difficulties, priority shipments across the country were at a premium as the rapidly approaching holiday season began to inundate transportation companies.

Phases 3 and 4: Pack & Ship and Delivery

The next phases of the process include packing, shipping, and final delivery. The transportation companies faced excessive priority requests while there was a limited number of ports and locations that could effectively transport goods from the United States to Puerto Rico. The ports in Charleston, the Jacksonville Port Authority, and Port Canaveral were the main ports of embarkation, with Jacksonville eventually becoming the focal point for the C&E electrical BoM shipments. Complexities continued at the ports due to volume constraints and miscommunication with delivery drivers who could not meet or identify customers to sign for

their goods. As USACE was actively engaged on the island, there were limited numbers of contracted barges and ships to move equipment. According to FEMAs after-action reporting, damage to the island's seaports, airports, and roads increased transit times and limited the territory's capacity to receive commodity shipments (FEMA, 2018). The flow of ships to and from Puerto Rico was difficult to estimate as the delivery ports in Ponce and San Juan first had to re-establish operating capability, and then work through capacity challenges, as well as maintain safe and debris-free waterways (Miller, 2018). C&E worked far beyond its contracted delivery points to get its materials on the island to support USACE in the forward mission.

At both the CONUS & Puerto Rican ports, inventory tracking and material visibility challenges proved, at times, to be overwhelming. The primary tool used was a computer software spreadsheet maintained by C&E and regularly updated to inform USACE and other agency partners. Each day, the C&E team manually updated the spreadsheet with information acquired through constant communication from vendors and transportation providers. Manually tracking shipments in this manner was extremely laborious, and despite best efforts, with limited staffing levels, some shipments were inevitably lost or misplaced. A lack of systematic in-transit visibility resulted in a barrage of phone calls, emails, and meetings to provide the best status possible for each operational update. Notwithstanding the obstacles, C&E employees worked nights, weekends, and holidays to ensure the orders continued to be shipped. Their efforts accumulated 200+ hours of overtime per month and 190 uninterrupted days of coordinated support to achieve success.

Proposed Future State - Incorporating Blockchain Technology

This HA/DR process analysis brought many themes and "friction points" to light, and suggests areas where blockchain technology may improve end-to-end supply chain management

and logistics operations. Improved communications, reduced duplication, contraction of transaction time, as well as auditability, increased security, and overall timesaving for manual processes are a few notable areas.

Friction Point	*Definition*	*Specific Examples*	*Blockchain Potential*
Requirements Determination	New & changing requirements daily	Quantities, delivery requirement dates, shipping dates, modes of transportation, and requested materials fluctuate during crisis response	Smart contracts enable efficient, verifiable exchange of information
	Timelines	Vendor identification and constraints impact delivery	
	Technical specifications of items require USACE verification	Delayed USACE approval of technical items slowed delivery	
Movement Flexibility	Optimal logistics support solutions	Multiple suppliers, modes of transportation, constantly changing storage and climate conditions contribute to chaos of determining optimal solutions	Enable data analytics to evaluate alternative transportation solutions in real time; considers multiple sources of input simultaneously including international support
Port Overload	Inability to manage mass of physical inventory Negative impact to delivery time	Trucks full of ordered materials were turned away from ports when warehouses were full, returning materials to origin instead of alternate locations nearby	Synchronize delivery to capacity; Identify solutions in real time to changing conditions; Enable on the spot problem solving by appropriate authority; Reduce material losses and increase accountability
Inconsistent regulatory application at ports	Lack of information or understanding of regulations or agreements Confusion about roles, responsibilities, and end to end processes	Compliance with Berry Amendment, Memorandums of Agreement, trade regulations, etc. Port Authority processes and regulations unavailable to response team	Smart contracts enable efficient, verifiable exchanges of information
Delivery location changes	DLA contractual locations can be different than customer's expectation Locations can change because of changing event requirements.	Multiple organizations resulted in a lack of visibility for contractual requirements; e.g. delivery point, quantity, date of shipment and expected arrival dates	Provide real time, agile response to changing conditions
3rd party management	Vendor Managed Inventory puts the burden of recognizing stock shortages on the vendor	Depleted inventory stores from earlier disasters resulted in lower than usual surge item availability	Allows immediate visibility of needs as storms are forming, allowing proactive action ahead of impact

Table 1 - Friction points identified through process analysis that may be opportunities for improvement via blockchain application.

C&E Future State Process Analysis: Blockchain Applications

Disaster Declaration

Upon notification of the disaster declaration, a blockchain application could streamline the approval process to exist on a shared ledger with smart contracts designed to execute and distribute funds as certain criteria are met. This solution could shorten lead-times from 2-4 days down to minutes (Strausbaugh, 2018). Financial transactions and the military interdepartmental purchase request (MIPR) process could be improved via a blockchain application that streamlines the grant awarding process for local departments and emergency responders to confirm specific needs and to gain approvals in near real time.

Phase 1: Damage Assessment & Requirements Determination

The damage assessment and requirements determination process was iterative, with new and/or changing requirements hitting C&E hourly. These requirements were captured through emails and phone calls in an excel spreadsheet by members of C&E and stored in a central location. This spreadsheet evolved into multiple spreadsheets and became the "database of record" for tracking requirements. Manual updates continued after the exchange of more emails and phone calls occurred. For improvement, the concept of a decentralized ledger could capture all transactions from requirement acceptance through delivery to reduce, or in some cases eliminate, the need for daily meetings, phone calls, or duplicative emails to communicate new requirements, changing requirements, and inventory tracking updates. DLA Troop Support Continuous Process Improvement team estimates that alleviating the inefficient processes and procedures used for requirement acceptance and inventory tracking would reduce financial burden by an estimated $250,000 in salaried hours over the course of this HA/DR scenario.

Phase 2: Request for Proposals, Awards & Orders

A verification "loop" required USACE to review RFPs in their entirety after C&E received information from its vendors. This manual process could be simplified by transmitting RFPs through a blockchain, where accurate information is shared securely and can be automated to execute smart contracts. Blockchain does not eliminate the need to verify the information initially, but it does eliminate a second validation, and could further automate the process, improving process lead-times and reducing accumulated project hours.

Government entities and private small businesses are currently collaborating to explore the potential for blockchain technology to enhance the effectiveness and efficiency of government acquisition processes (Trujillo, Lawson, & Foley, 2019). The collaboration offers a blockchain prototype that targets specific tasks accomplished by acquisition specialists and improves the quality and timeliness of solicitation reviews for large contracts containing a variety of regulatory clauses.

Blockchain and smart contracts can also help acquisition processes complete a variety of standard forms such as the Acquisition Plan, Justification and Approval, and the DD250 form used for invoicing (Zelenovic, 2019). Potential also exists for automated completion of other repetitive fields throughout contract processing including completion of the SF 26 used to award a contract, the SF 30 used to modify contracts, Contract Data Requirement Lists, delinquency letters to vendors, and other applications. The potential of a single distributed version of data is magnified when combined with other emerging technologies such as AI and machine learning.

Other specific opportunities for blockchain to improve this phase of the HA/DR process include addressing the concerns of suppliers and their capacity constraints as well as entry of new suppliers and the ability to verify their authenticity. Permission based blockchains can

selectively allow access to verified entities, which reduces multiple verification steps and greatly improves trust among all parties. Blockchain cannot automatically improve inventory levels of suppliers who have nearly depleted their stock of finished goods or raw materials, however, it can affect improved sharing of information (inventory levels, lead times, etc.), and help planning along the supply chain. The more transparent this information becomes among trusted partners, the easier it would be to coordinate activities among stakeholders.

Phases 3 and 4: Pack & Ship and Delivery

Blockchain has the potential to increase data security, enable greater automation, and significantly reduce human error in preparing packing and shipping documents used to communicate among various entities in the transportation process. Fewer discrepancies in shared documentation means fewer post award contracting requirements and reduced or eliminated unliquidated obligations, delinquencies, or backorders that are currently managed manually. The potential impact across the number of forms used by DLA contracting would be significant.

Another exciting and impactful opportunity is in-transit visibility of materials. Blockchain could enable all members in a process to view the status of material deliveries from point of sale through final delivery destinations or beyond. Feedback loops on the product could also be incorporated. This would help all stakeholders (from suppliers to ports and customers) to make more informed decisions in near real time, optimizing outcomes in a variety of ways. For the HA/DR Puerto Rico response, in transit visibility means the port manager knows exactly what shipments will arrive and how much space would be required well in advance. This also could reduce or help avoid material loss and delivery delays.

In summary, looking at the C&E HA/DR process through the lens of proposed blockchain application, the process flow remains mostly linear. The main difference is information can flow much more openly across the distributed ledger network, and communication is rapidly shared among the trusted parties. Employing the use of smart contracts for portions of the acquisition process could further reduce processing times. For this use case, the DLA Troop Support Continuous Process Improvement team estimates added efficiencies may improve internal lead times by up to 70%.

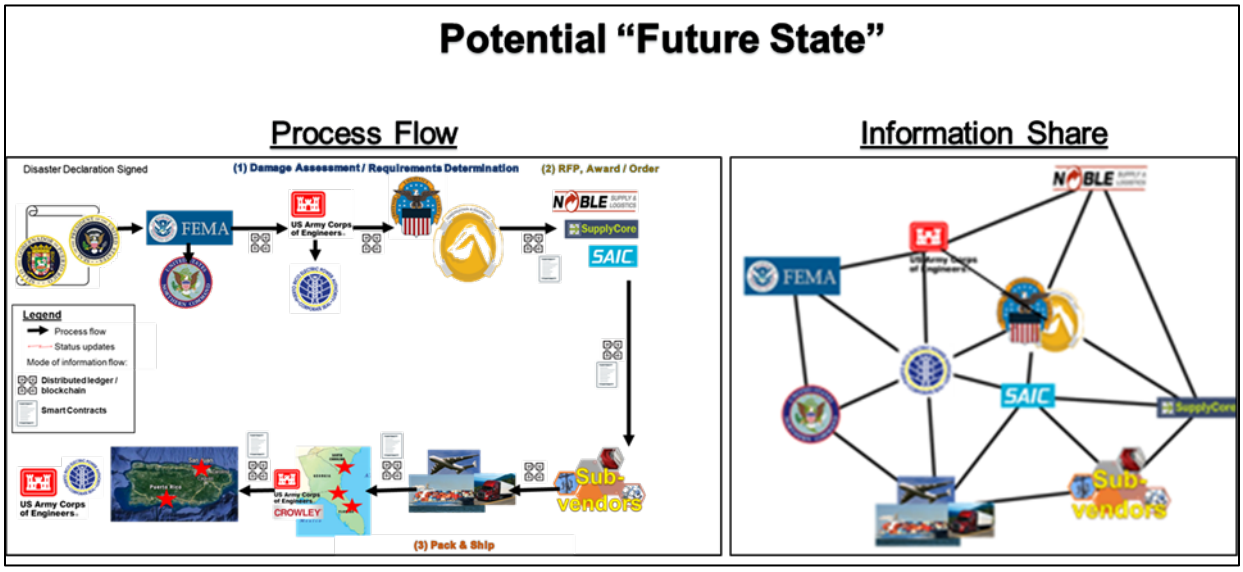

Figure 3 - Although "the process flow remains mostly linear…information can flow much more openly across the distributed ledger network, and communication is rapidly shared among the trusted parties."

By developing this use case, DLA Troop Support has a better understanding of blockchain as a technology that can complement or enhance existing practices and will continue to seek partners to explore and integrate opportunities for DoD.

Counter Narrative

If industry can develop, implement, and deliver the technology to achieve the vision of timely, accurate, and immutable data, blockchain has significant potential. While consultants continue to solicit high dollar projects with different firms and agencies, many have not yet demonstrated sufficient results for widespread adoption. Forrester released a study of 43

initiatives that proposed blockchain as revolutionary, however no projects reviewed have achieved their full implementation objectives and the report forecasts a blockchain winter may begin in 2019. In an article that summarizes the recent cryptocurrency devaluation and failed or fraudulent rounds of initial coin offerings, Bernard Marr, a government technology advisor, asked *Is This The End Of Blockchain?* His question sees the term blockchain as blemished, and he suggests while some firms move to use the term distributed ledger technology (DLT), criticism also continues in other areas due to high power generation requirements to sustain cryptography on public blockchains and the environmental costs of power production (Marr, 2018).

The attention and excitement for blockchain may be approaching a difficult 'trough of disillusionment,' or period of doubt, found along the Gartner technology adoption cycle. In a presentation by Tyson Foods, their Director of IT Applications, Food Safety, and Quality Assurance suggested blockchain might be approaching a peak of inflated expectations (Kelley, 2018).

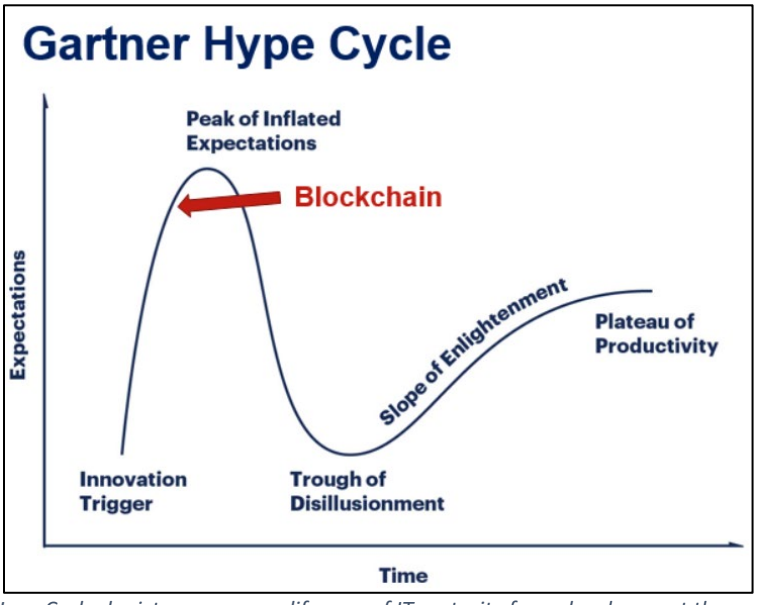

Figure 4 - The Gartner Hype Cycle depicts an average lifespan of IT maturity from development through adoption/application. The red arrow indicates the area IT experts from Tyson Foods believe blockchain technology may currently be.

However, Gartner's own research on emerging technologies holds blockchain even further along in the development cycle at the cusp of the trough (Figure 5), though the plateau for productivity, or real adoption, still remains five to ten years out (Gartner, 2018).

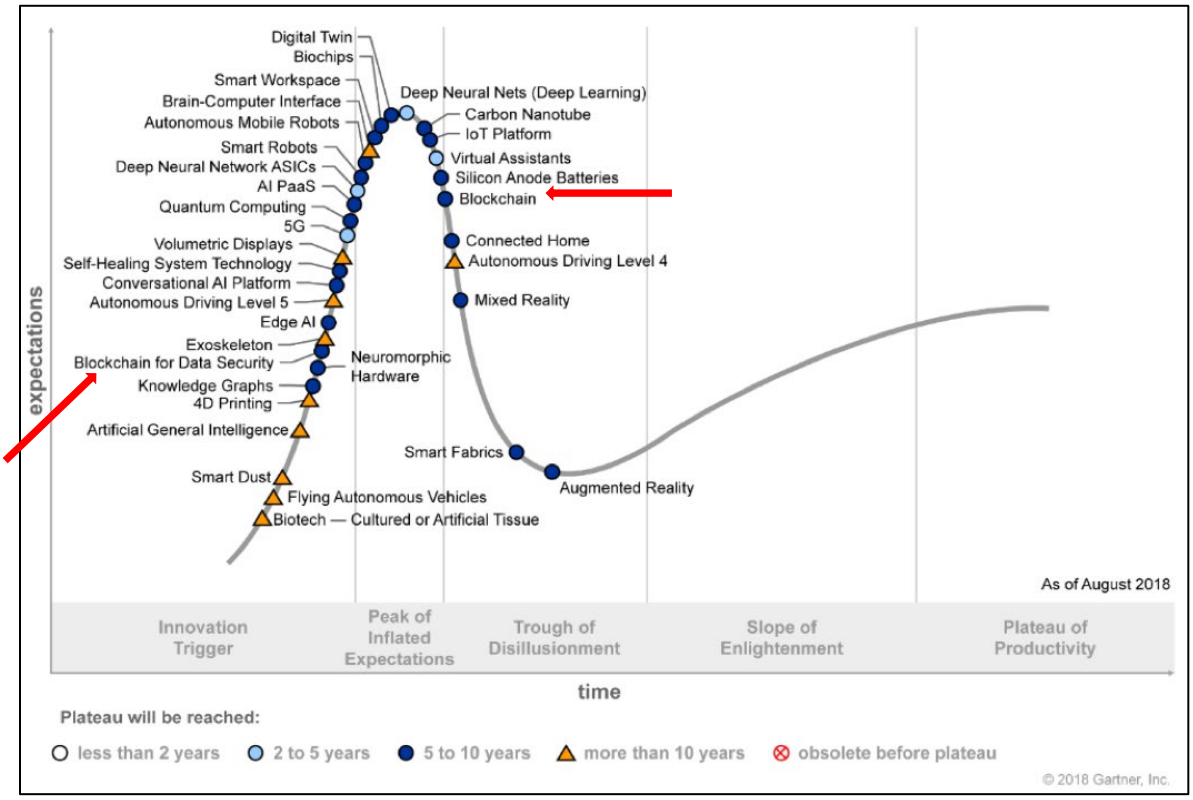

Figure 5 - Gartner's own research on emerging technologies plotted along the aforementioned Hype Cycle

Blockchain Investigations by other DoD Entities

In response to Congressional requirements of the National Defense Authorization Act (NDAA) for fiscal year 2018, the DoD Chief Information Officer presented Congress with an overview of research conducted to understand current and potential uses of blockchain technology within the DoD. The briefing included four elements: (1) a description of potential offensive and defensive cyber applications of blockchain technology and other distributed database technologies; (2) an assessment of efforts by foreign powers, extremist organizations, and criminal networks to utilize such technologies; (3) an assessment of the use or planned use of

such technologies by the Federal Government and critical infrastructure networks; and (4) an assessment of the vulnerabilities of critical infrastructure networks to cyber-attacks.

The underlying theme reiterated in the Government Accountability Office's (GAO) Strategic Plan for 2018-2023, "Trends Affecting Government and Society," includes blockchain as one of the five emerging technologies with the potential to transform society. Many institutions within our own government as well as around the world are taking notice. Security of communications can increase in networks that are open, closed, or semi- closed, and allow for protection beyond secure servers. That also offers compliance with laws and regulations such as the Health Insurance Portability and Accountability Act (HIPAA), the Gramm-Leach-Bliley Act (GLBA) also known as the Financial Modernization Act of 1999, and the Sarbanes–Oxley Act, which affects accounting (Adam Brinckman).

If adopted, blockchain may significantly affect the cyberspace domain. Retired Air Force Colonel Vincent Alcazar suggests, "blockchain might be the first technology truly worthy of the label of disruptive data technology." He identifies a crucial importance of blockchain is the ability to remove trust-management vulnerabilities for user credentialing and access in American public and military network design. The new technology and operating framework "sets aside the numerous weaknesses of the DoD's system based computing," and "greatly reduce[s] the possibility of data theft, data corruption, and sender identity compromise." Additionally, as many American weapons systems require data to function "effectively, if at all," "operational disruption and degradation resulting from an absence of authentic data," as well as "data corruption and compromise" could be taken off the table as things an enemy could do (Alcazar, 2017). This sentiment tells us that blockchain and other emerging technologies are not just behind the scenes but have tactical implications as well.

Experimentation using blockchain to secure data transmission on the battlefield may help ensure proper parts are 3D printed in real-time or even safeguard camera and sensor broadcasts from secure locations across the world (Deloitte, 2018). Other tactical applications could include clearance of targets for direct or indirect fires with transparency on the applicable laws and rules of engagement being applied in real time from an immutable single source (Arrieta, 2018).

Next Steps for Blockchain within DLA

DLA Troop Support may explore blockchain further to help our everyday mission activities ranging from traceability of contaminated foods during recalls to securing the details of manufacturing weapons repair parts. Blockchain offers transformative ways to enhance confidence in shipping and planning, foster swifter compliance with customs and trade policies, eliminate third party payment intermediaries, increase transparency for transactions and audit, and to reduce potential for human error or counterfeit items. Partnerships for improved vendor and customer communication could also explore how to collect and distribute knowledge of goods movements around the world.

Additional opportunities exist for DLA Troop Support to explore other emerging technologies as well, both individually and in conjunction with blockchain (LMI, 2018). Such examples include blockchain and AI for acquisition processes, personnel action processing, audit compliance, financial recording, or tracking military events and supply demands in near real time.

Understanding the research and development underway in commercial and public environments goes a long way toward building the right partnerships for platform expertise, interface assistance, and identifying the right supply chain professionals (Neidig, 2018). As federal agency interest in the potential of blockchain technology continues to grow, so do the

lessons learned from different use cases and pilot programs. A few reports capturing recommended starting points for emerging technology experimentation and inclusion start with narrowly scoped initiatives (Davenport & Ronanki, 2018; Trujillo, Lawson, & Foley, 2019). Prioritizing areas that are currently pain points based on impact to the organization and return on investment are the best starting points. Developing a formal Business Case Analysis (BCA) for each potential micro-service could offer a financial impact estimate and documentation of other qualitative measures for evaluation and prioritization.

Possible supply chain operations for future blockchain investigation could include the Subsistence supply chain, which provides over one million meals daily across the globe to Servicemembers; the Industrial Hardware supply chain, which provides repair parts to weapons systems, air frames, and military vehicle systems; or the significant inventory tracking, movements, and auditability of medical supplies, clothing and textiles, or construction materials.

Like other government acquisition agencies, DLA is frequently required to address updated contractual regulations and policies for the acquisition workforce, and it is necessary to implement them in a timely manner. Integrating blockchain and AI capabilities has potential to add more functionality to existing contract building software. AI could provide acquisition specialists notifications of clause changes and updates while they are working in the software, instead of manual e-mail notifications. Providing the updated information as contracts are being created, could improve compliance and reduce contractual development timelines by eliminating the need for extensive or duplicative reviews of long-term contracts (LTCs).

Acquisition specialists could also receive notifications when clause selection is inconsistent or inappropriate based on previously established contracting details. Using blockchain and AI applications in this manner could allow error detection to occur in real time,

and provide a user the opportunity to consider alternatives and/or make corrections before continuing the process. Using smart contracts and AI within a blockchain framework could eliminate existing levels of review and ensure regulatory compliance, easing audit requirements. Since DLA's long-term contract clause requirements vary based on contract type, dollar value, vendor size or economic category, commercial or non-commercial material requirements, and other considerations, there is great potential for smart contracts and AI to alleviate manual labor and reduce error.

In the subsistence supply chain, many requirements are received via e-mail from customers. This requires manual conversion into the existing systems to develop a purchase request, with 1.5 to 3 weeks for parties involved to go back and forth to capture details of the requirements. By using Blockchain and AI, customers could be guided by user-friendly pop-up questions about upcoming requirements, capturing not only subsistence information, but also for clothing, physical security, medical care, or equipment maintenance. Once this data is captured, AI could be applied to optimize logistics solution analysis, reduce customer labor requirements and avoid material delivery delays. The customer's purchase request could be automatically initiated and tailored to their location.

Similarly, for foods crossing national borders, AI could pre-populate health certificates and other forms, eliminating potential errors at the beginning of the process that currently derail timely receipt of goods at the end of the process. The data populated in the purchase request or health certificate could be provided along a blockchain to DLA acquisition specialists, selected vendors and sub-contractors, shipping entities, ports, OCONUS prime vendors and the ordering customer; all at the same time with the same version of data. In-transit visibility also means that vendors could know about produce spoiled by a delayed trucking movement and act to replace it

much sooner, perhaps avoiding contaminated food from reaching customers.

Other possibilities exist for a medical supply chain to communicate with end users, such as hospitals, so they could know the exact day the cold storage shipment of flu vaccines, or a massive MRI machine will arrive as an AI generated notification could inform them as materials neared their destination. Permitting proactive accommodation of materials in advance provides opportunity to avoid expensive material losses and rework to replace them (Olson, 2019).

In the Industrial Hardware supply chain, Blockchain and AI functionality can mean more readily understanding new mission requirements and the impact to aircraft maintenance schedules. Immediate access to the status of reordered stock materials can support more accurately material demand forecasts, and thereby improve aircraft readiness. For all of the potential areas of blockchain application, one major constant is the audit trail it provides. This could reflect records are automatically kept and verified for compliance with ready notifications for accuracy, accountably, accessibility, and reduced costs resulting in more sound financial reports and confidence in the use of public funds.

Conclusion

The DLA Troop Support C&E emergency response to Hurricane Maria explored in this paper offers a limited though complex portion of the logistical operations provided to support Puerto Rico. The U.S. Government should continue to explore blockchain technologies for potential adoption by federal agencies and our partners. The use case reviewed suggests blockchain efficiencies may increase effectiveness for communicating requirements, planning movement and flexibility, complying with regulatory applications, monitoring third party deliveries and in-transit visibility, and reducing duplication of efforts. Each of these efficiencies provides real savings in time and dollars.

DLA Troop Support should have a role to inform decision makers on what is possible to address the multiple logistical challenges in technology adoption, access to blockchain platforms, and governance development. DLA Troop Support may continue to explore further with C&E, or other supply chains, more detailed applications or iterations of blockchain and distributed ledger technologies. By choosing to work actively with leaders for the emerging technology, DLA Troop Support can build and share knowledge that will better inform understanding of what blockchain is and the potential it possesses for business transformation and warfighter support.

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