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Selecting Implementation Criteria in the Age of GeoBlockchain

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Abstract

Today, the growing use of public blockchain, private blockchain, and hybrid blockchain advances in geospatial technology. Geography is a significant factor in identifying locations and spatial trends related to blockchain activities through distributed and immutable networks. Besides that, as the understanding that blockchain and location intelligence has value for many organizations. Our study examined the merge of the two technologies and identified the implementation criteria in the age of GeoBlockchchain. Moreover, it will examine the rules and roles of participants within GeoBlockchain by using Q Methodology and Q set. The ICT artifact for a supply chain use case is the result of a solution proof of concept.

Keywords

Geospatial, geoblockchain, blockchain, q-methodology, supply chain.

Introduction

Blockchain is one of the most potent promising technologies that could provide trust, immutability, and transparency to any organization's systems of systems. Cryptocurrency is the first use case for blockchain technology as a proof of concept. However, the cryptocurrency use case was developed and implemented for public blockchains such as Ethereum and Bitcoin (Yuan and Wang, 2016). On the other hand, we see a considerable demand for enterprise technologies that could use private blockchains. Besides that, we are starting to see new use cases for blockchain in the private and public sectors and accurately through the geographic information systems and supply chain field.

Geographic Information System (GIS) technology, an inherently location-based technology, can help answer the question of where a blockchain transaction has occurred (Wingreen et al., 2019). The combination of blockchain with GIS underlie the concept of GeoBlockchain. This new tool could be used to support the analysis of spatial-temporal trends of blockchain transactions via a geospatially-enabled blockchain. The result of this research was the design, development, and implementation of a prototype land ownership GeoBlockchain solution.

This paper will conduct a Q Methodology on blockchain and geospatial technology. The first objective is to generate a list of valid attributes for the integration and implementation between a private blockchain and geographic information systems. For the second objective, we will design, develop, and implement an ICT artifact using the Hyperledger Fabric and as blockchain platform and ArcGIS Enterprise as a geospatial technology platform. Finally, the third objective will evaluate the ICT artifact with our findings.

Literature Review

There are mixed views and attitudes from users due to the complexity of blockchain technology, its maturity level, and unconventional usage that does not highlight the real value of blockchain. The first implementations of blockchain were Ethereum and Bitcoin as a cryptocurrency use case (Yuan and Wang, 2016). While unusual, these use cases proved that blockchain technology could orchestrate valid transactions across a distributed network and store those transactions in unalterable ledgers across multiple nodes (Sharma et al., 2019). Each transaction becomes a new block; blocks are organized chronologically to form a blockchain. The main advantages of blockchain are the speed of transactions, data accessibility, and data accuracy (Yuan and Wang, 2016). The value of its use is the increase in transparency between participants and organizations (Croxson et al., 2019).

Private and public sectors might use a distributed ledger for a supply use case to record and track the geolocation of goods. This phenomenon could answer questions such as why, where, and how. For example, how a container with different products changes ownership during its travel to the consumer? That brings us to the idea of a "trust-free. How is that different from a typical supply management system, and how Blockchain and Geospatial technologies work together to answer the where and why (Wingreen et al., 2019)? By incorporating rules and roles into the blockchain, you can give a trust context based on location to tabular transactions to answer and explore the "trust" of a transaction.

Research Question

Q1: What are the generic attributes used for a private GeoBlockchain?
Q2: What are the custom attributes used for a GeoBlockchain?
Q3: What is the importance of roles and rules, in order to build trust among participants?

First Objective - Analysis Using Q-Methodology

The main principle of Q methodology is enabling researchers to discover and learn about the assortment of human subjectivity (Dennis, 1986). In a Q study, each factor demonstrates a key perspective that exists within the group of study participants. Q methodology enables the analysis of these viewpoints holistically, employing a deep quantitative and qualitative investigation (Brown, 1980; Watts & Stenner, 2005).

Q-methodology method was used for this research to evaluate the industry's implementation and integration perspectives. Since Q-method is a technique that is specialized for the analysis of peoples' subjective beliefs (Andrew Croxson, Ravi Sharma & Stephen Wingreen; 2019), this study used Q-methodology and Q-Set for ranking and sorting specific statements, to identify the attributes and criteria for a GeoBlockchain supply chain use case.

We defined the Q-Set as the study criteria for the GeoBlockchain supply chain implementation use case.

1. Participants: Multiple organizations participated in the supply chain use case.
2. Trusted Organization: The main authority in the blockchain that controls policies, rules, and roles.
3. Centralized Operation: Every participant control and manage its own transaction information.
4. Transparency and confidentiality: All participants could share encrypted information.
5. Integrity: All transactions stay into the chain history for provenance.
6. Immutability: Blockchain data cannot be changed or deleted.
7. High Performance: System scalability and system behavior from big datasets either text or spatial.

Second Objective - GeoBlockchain ICT artifact

For the second objective, the ICT solution prototype artifact was created with the merge of Hyperledger Fabric Cloud and ArcGIS Enterprise. We identified all GeoBlockchain participant's roles in "Table 1". The finished product of this prototype is a cloud-based GeoBlockchain Web Dashboard that participants could use through the supply chain process. Different roles with specific profiles will be leveraged through this example, and all transactions (spatial and not spatial) will be recorded into the GeoBlockchain.

Participants	**Responsibilities**
GeoBlockchain-Administrator	Administrator has full privileges to Hyperledger Fabric and ArcGIS Enterprise
GeoBlockchain-Supplier	Participant that is added to GeoBlockchain with controlled roles only for "Supplier" Group

GeoBlockchain-Port	Participant that is added to GeoBlockchain with controlled roles only for "Port" Group
GeoBlockchain-Distribution Center	Participant that is added to GeoBlockchain with controlled roles only for "Distribution Center" Group
GeoBlockchain-Shipping	Participant that is added to GeoBlockchain with controlled roles only for "Ship" Group
GeoBlockchain-Trucking	User that is added to Blockchain with controlled roles only for "Trucking" Group

Table 1. GeoBlockchain Participants

Results and Outcome (ICT-Artifact)

The result of this study is a GeoBlockchain-supply chain dashboard web application "Figure 1". This research indicates that blockchain technology can be integrated with geospatial technology, resulting in the GeoBlockchain.

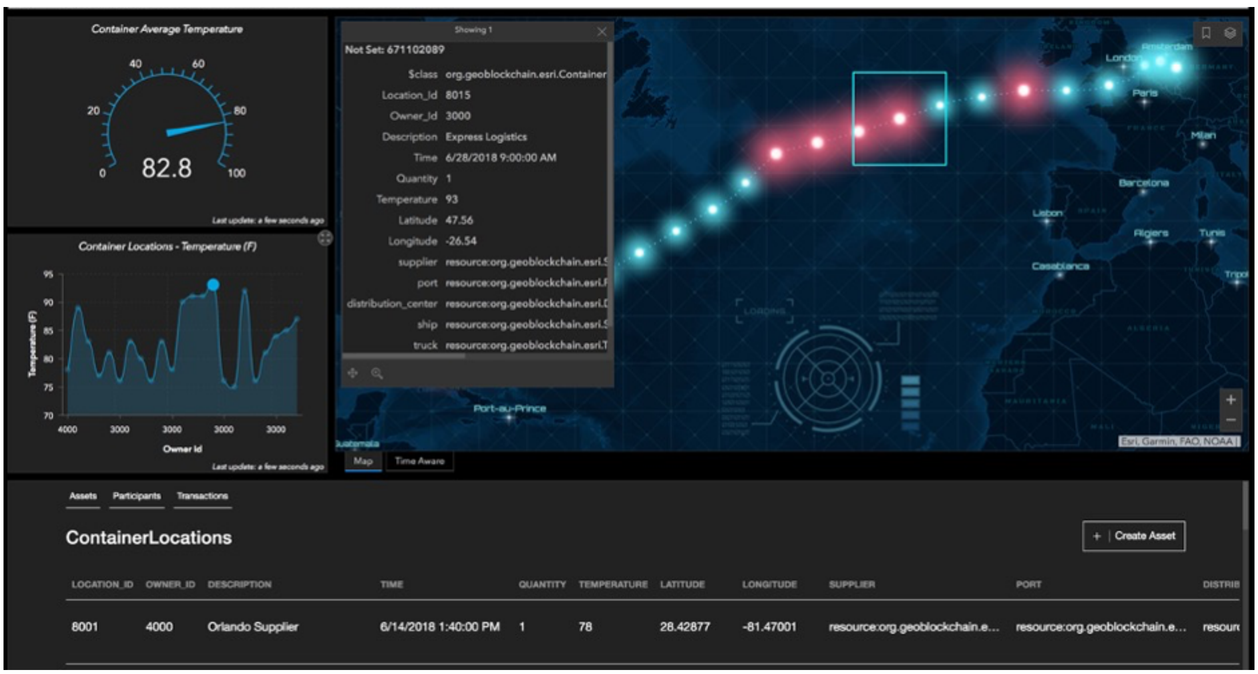

Figure 1. GeoBlockchain Dashboard

Third Objective-Findings and Evaluation

We compared the selected implementation Q-set criteria for the ICT artifact supply chain use case with our three research questions. The results are evaluated with unique measurement values such as required and not required. The evaluation methodology is motivated from recent study "Evaluating Suitability of Applying Blockchain", (Lo, et al., 2017).

Our findings, "Table 2" will support the evaluation of the criteria and the research questions. For the first research question (Q1), only the organizations participating in a transaction will have knowledge about it, whereas the others will not be able to access it; as a result, data immutability is not fully applied and is not required for the GeoBlockchain. Only participants, trusted organizations, data transparency and confidentiality, data integrity, and high-performance criteria are required for the main attributes of GeoBlockchain.

The second research question (Q2) is the only one that entirely encounters all the supply chain blockchain criteria (participants, trusted organizations, data transparency and confidentiality, data integrity, and high-performance) as GeoBlockchain attributes. However, generic attributes and custom attributes are required for Geoblockchain supply chain use case. The main reason is that every single use case is a unique study, and flexibility is needed for generalization.

Lastly, the third research question (Q3) has the minimum or less important GeoBlockchain criteria and attributes based on "Table 2". For instance, the centralized operation is required for trust between participants. However, data immutability and high performance are not obligatory either for participants' or trusted organizations.

GeoBlockchain Criteria (Q-set) Evaluation	**GeoBlockchain (Hyperledger-Fabric/ArcGIS Enterprise)**		
	Q1	**Q2**	**Q3**
Participants	Prerequisite	Prerequisite	Prerequisite
Trusted Organization	Prerequisite	Prerequisite	Prerequisite
Centralized Operation	Prerequisite	Prerequisite	Prerequisite
Transparency and Confidentiality	Prerequisite	Prerequisite	Prerequisite
Integrity	Prerequisite	Prerequisite	Prerequisite
Immutability	**Unnecessary**	Prerequisite	**Unnecessary**
High Performance	Prerequisite	Prerequisite	**Unnecessary**

Table 2. GeoBlockchain Criteria Evaluation

Limitations

The main limitations of our current research include: (1) time and data availability constraints, in the design phase and implementation phase, and the evaluation phase; (2) we need further iterations to improve the ICT artifacts (GeoBlockchain); (3) we have not tested additional criteria for the study yet; (4) fully enterprise environments are required for more real-world solution prototypes; and (5) we need to test the ICT solution prototypes with a large samples such as supply chain organizations.

Research in Progress

We will continue with the future work such as (1) completing the next generation of solution prototype artifacts; (2) multiple iterations to improve artifact GeoBlockchain design; (3) improving the suitability evaluation analysis; (4) research other types of blockchains such as hybrid blockchains to find more relevance; and (5) completing the pre-test & post-test, in order, to add value to blockchains frameworks.

Conclusion

Private blockchains such as Hyperledger-Fabric and geospatial technologies such as ArcGIS could potentially be used for any supply chain use case. Our research will continue with enhancements and refinements through the development and testing phases until it will get finalized for the next generation releases. The outcomes of this research, which is the identification and the importance of GeoBlockchain supply chain criteria, could impact participants' and main stakeholders' involvement positively and work through the supply chain. This can be achieved by leveraging existing blockchain and geospatial frameworks that use the proposed Q-set criteria from the Q-Methodology approach.

Also, future blockchain types or new blockchain project versions could make blockchain solutions more secured, more immutable, and more trusted. New technological changes such as 5G networks, quantum computing, and quantum neurons, could validate and verify our questions and answers over time. Hopefully, this will add more novelty and impact society positively.

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