

GEOBLOCKCHAIN FOR TRUSTED AND AUTHENTICATED GEOSPATIAL SYSTEMS

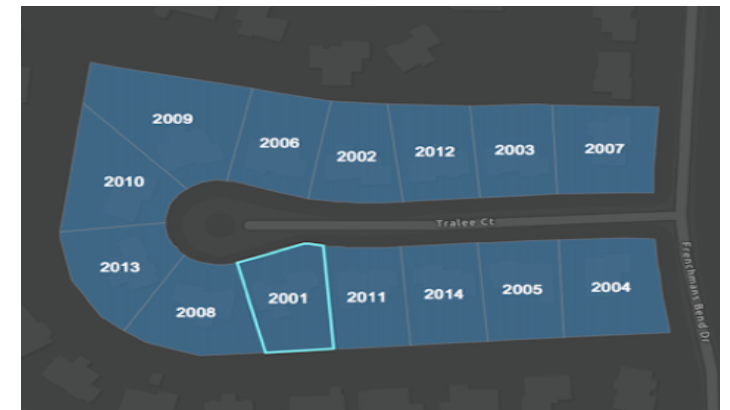
Constantinos Papantoniou, Ph.D., MBA, GISP
Founder of GeoBlockchain Framework

Agenda

- Introduction
- Blockchain and GIS
- Land Ownership and Supply Chain
- Motivation: Business and Research Questions
- Blockchain, GIS, Use Cases, and Regions
- Fundamentals
- Public vs Private Blockchains
- Blockchain Examples
- Blockchain and IoT
- Blockchain and GIS
- GeoBlockchain Foundation
- GeoBlockchain – Examples
- GeoBlockchain – Framework
- Questions and Answers

Introduction

- Land ownership and supply chain use cases are an enormous business challenges for both the public and private sectors
- Every organization has different needs and wants, and industry leaders are researching and exploring ways to improve and impact their business transaction processes
- Blockchain and Geospatial technologies are two tools that could help an organization add value in this manner
- The combination of blockchain and geospatial technologies would result in the new concept of GeoBlockchain



Blockchain and GIS

- *Blockchain:*
 - a way to build trusted data in a distributed, unalterable ledger that records the history of immutable transactions
 - transparency and visibility among participants are valuable benefits while the risk of non-accurate data and the overall cost of legal procedures to validate the information could be minimized
 - new method to share and collaborate using trusted data across distributed ledgers and computers
- *Geographic Information Systems (GIS):*
 - for collecting, storing, analyzing, and visualizing spatial data
 - analyze and incorporate a variety of datasets in infinite ways
 - advantageous for every industry from agriculture, utilities, real estate, land ownership and supply chain to implement spatial information systems

Land Ownership and Supply Chain

- *Land Ownership:*
 - most countries use outdated cadastral management systems to manage their land ownership
 - it is important now more than ever to invest in improving these systems of land ownership to be able to fully trust, manage, and exchange the information regarding land ownership among participants such as owners and legal authorities
- *Supply Chain:*
 - related to supply chain technology, little is understood regarding the disruption blockchain adoption has had on transport and logistics
 - blockchain has the potential to be interlinked with a variety of transportation, logistics, and supply chain activities and methods that rely on organizational and process information

Motivation: Business and Research Questions

- ***Why do we need to integrate geospatial technology with blockchain technology?***

It has been suggested, that when designing a blockchain for real estate, it should provide a protocol that allows for a complete real estate transaction, which can offer at least the same guarantees for both the signatories and for third parties as current procedures

- ***As such, the GeoBlockchain can answer questions such as where, why, and how; for example, how might a land transaction or a shipping container take place as a trust-trade exchange between different owners and how might that be verified by legal and private authorities?***

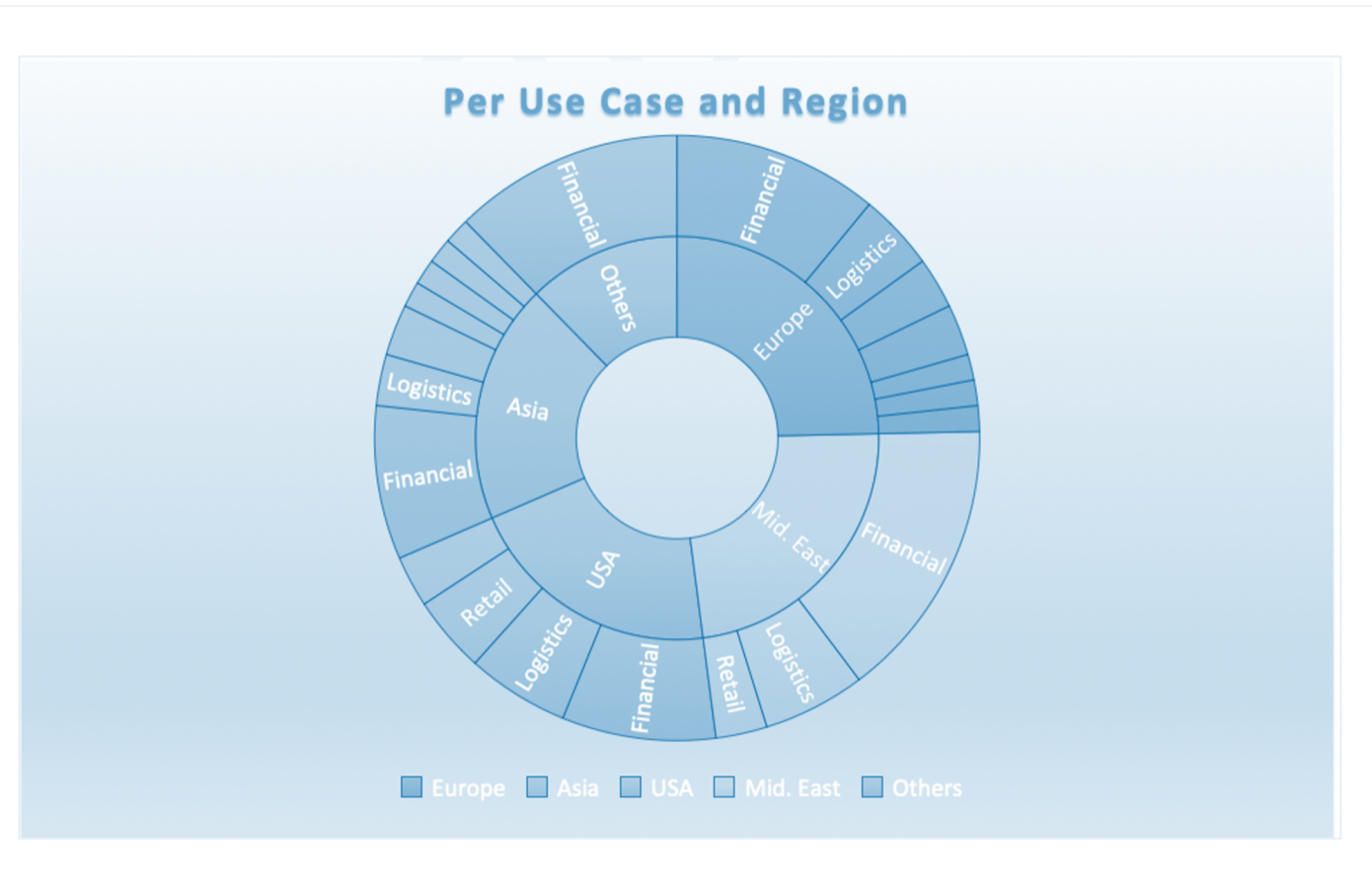
That brings us to the idea of “trust-free”, the same approach as cryptocurrency’s legal regulations

- ***How is that different from a typical traditional land ownership and supply chain transaction systems, and how might blockchain and geospatial technologies work together to answer the where and why?***

By incorporating rules and roles into the blockchain, you can provide a trust context based on location to the tabular transaction to answer and explore the “trust” of a transaction

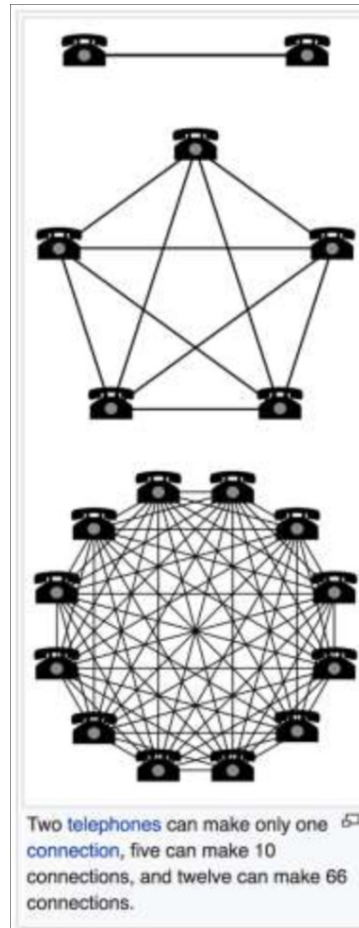
Blockchain, GIS, Use Cases and Regions

- *Blockchain is primarily known for cryptocurrencies and smart contracts*
- *Bitcoin, the main, and most demanding cryptocurrency have helped and hurt blockchain technology*
- *Blockchain is a decentralized ledger that removes the middleman from the equation*
- *Public, Private, and Hybrid Blockchain Frameworks*
- *Spatial information systems (GIS) are digital systems for collecting, storing, analyzing, and visualizing spatial data*



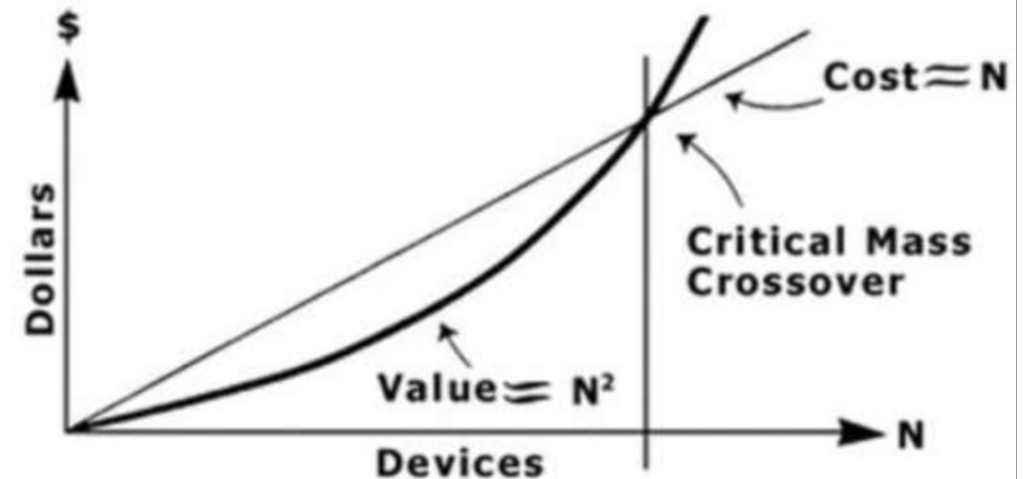
Fundamentals

- Metcalfe's Law states that the value of a network is proportional to the square of the number of participating nodes.
- Blockchain cryptocurrency use-case is based on Metcalfe's Law. Due to Bitcoin's peer-to-peer (P2P) nature, Metcalfe's Law fit like a glove and investors quickly noticed a parallel between the rate of adoption of Bitcoin and the value of the cryptocurrency.



$$V = A * N^2$$

The Systemic Value of Compatibly Communicating Devices Grows as the Square of Their Number:



Public vs Private Blockchains

Public	Private
Permission-less. Anyone can join the network and read, write, or participate within the blockchain.	Permissioned blockchain. Private blockchains work based on access controls which restrict the people who can participate in the network
Decentralized and does not have a single entity which controls the network.	Centralized: There are one or more entities which control the network, and this leads to reliance on third-parties to transact.
Data: on a public blockchain are secure as it is not possible to modify or alter data once they have been validated on the blockchain.	Data: in a private blockchain, only the entities participating in a transaction will have knowledge about it, whereas the others will not be able to access it.
Bitcoin and Ethereum	Hyperledger-Fabric and Ripple

Differences between Public and Private Blockchains

- Consensus algorithms such as Proof of Elapsed Time (PoET), Raft, and Istanbul BFT can be used only in the case of private blockchains. Transactions per second are lesser in a public blockchain when compared to private blockchains. As the number of authorized participants is less in a private blockchain, it can process hundreds or even thousands of transactions per second.
- A public blockchain cannot compete with a private blockchain in terms of scalability issues as it is slow and hence can process transactions only at a slow pace. In a private blockchain, only a few nodes must manage data. Transactions can be supported and processed at a much higher pace.
- Public blockchains are trustless, and participants must not trust one another in a private blockchain setup. In a private blockchain, the validity of records cannot be independently verified as the integrity of a private network relies on the credibility of the authorized nodes.

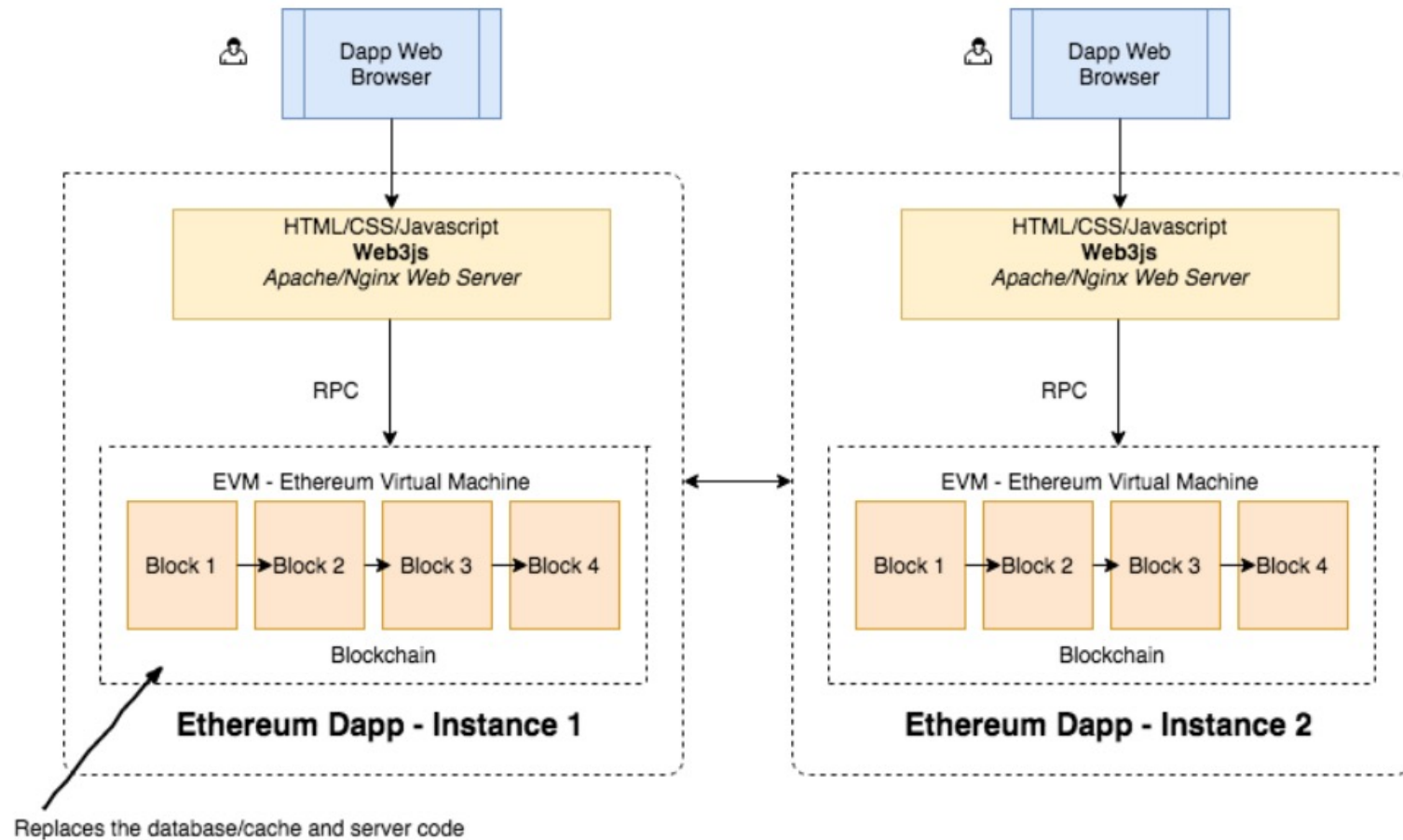
Differences between Public and Private Blockchains

- A public network is more secure due to decentralization and active participation. Due to the higher number of nodes in the network, it is nearly impossible for 'bad actors' to attack the system and gain control over the consensus network. A private blockchain is more prone to hacks, risks, and data breaches/ manipulation. It is easy for bad actors to endanger the entire network.
- A public blockchain consumes more energy than a private blockchain as it requires a significant amount of electrical resources to function and achieve network consensus. Private blockchains consume a lot less energy and power.
- In a public blockchain, it is necessary to grant access to a centralized authority to oversee the entire network, thus making it a private blockchain at this point. In a private blockchain, anyone who is overseeing the network can alter or modify any transactions according to their needs.
- In a private blockchain, there is no chance of minor collision. Each validator is known, and they have the suitable credentials to be a part of the network. But in a public blockchain, no one knows who each validator and this increases the risk of potential collusion or a 51% attack (a group of miners that control more than 50% of the network's computing power).

Similarities between Public and Private Blockchains

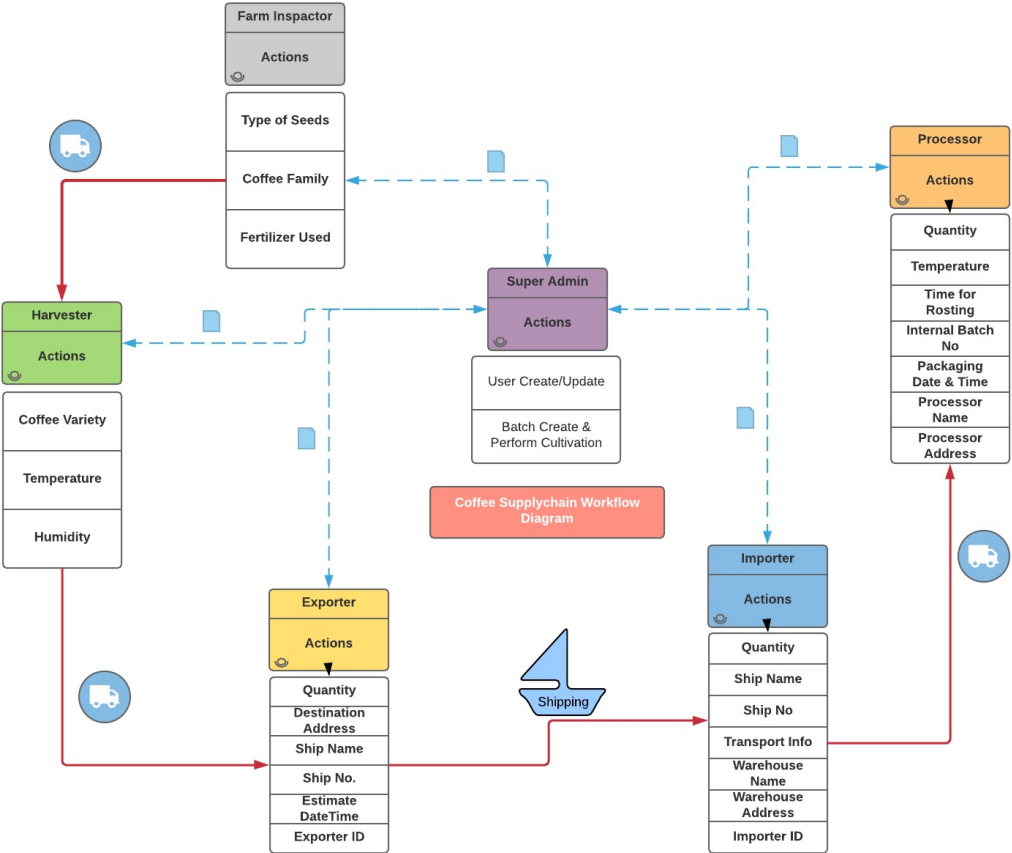
- Both function as append-only ledgers where the records can be added but cannot be altered or deleted. Hence, these are called immutable records.
- Each network node in both of these blockchains has a complete replica of the ledger. Both are decentralized and distributed over a peer-to-peer network of computers.
- In both, the validity of a record is verified, thus providing a considerable level of immutability, until the majority of the participants agree that it is a valid record and reach a consensus. This helps prevent tampering with the records.
- Both blockchains rely on numerous users to authenticate edits to the distributed ledger thus helping in the creation of a new master copy that can be accessed by everyone at all times.

Ethereum Public Blockchain



Ethereum Public Blockchain

COFFEE SUPPLYCHAIN



Ethereum Public Blockchain


The screenshot displays a web application interface for 'IMPERIAL SOFTECH'. At the top, there is a header with the company logo and name. Below this is a purple banner featuring a 'Supply Chain' logo and the user's name 'Swapnali Dive' along with their contact number '0x9f386ccd8a8e704'. The main content area shows three fields: 'Contact No' with the value '9876543210', 'Role' with the value 'FARM_INSPECTION', and 'Settings' with an 'Edit' button. Below this is a section titled 'BATCHES OVERVIEW' containing a table with columns for 'Batch ID', 'Farm Inspector', 'Harvester', 'Exporter', 'Importer', 'Processor', and 'View'. The table lists four batches with their respective statuses in colored buttons.


Batch ID	Farm Inspector	Harvester	Exporter	Importer	Processor	View
0x2d67d05f937896dc96821B86fe24C56800B67236	Completed	Completed	Completed	Completed	Completed	👁
0x4DFFE2e04CBeB7a2782bD4FBdEA840FE102f9B99	Update	Not Available	Not Available	Not Available	Not Available	👁
0xE90DFF881265248332c592892A6B9B8f6a10fA39	Completed	Completed	Completed	Completed	Processing	👁
0x41a6a570f85eaFD6e64c04B6fbEE3eCD92B21A12	Completed	Completed	Completed	Completed	Completed	👁


Ethereum Public Blockchain

IMPERIAL SOFTECH
















Dashboard

USERS
 **3**

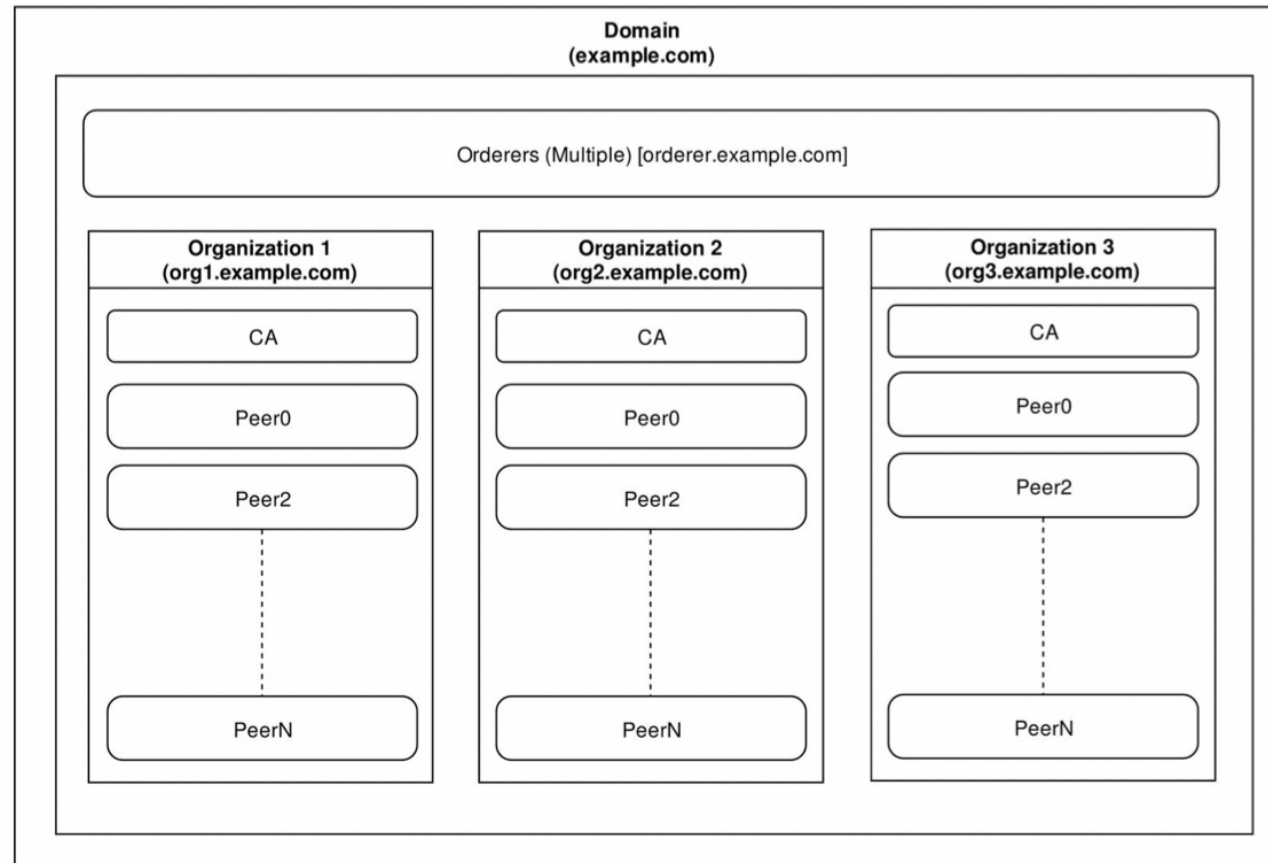
TOTAL ROLES
 **5**

TOTAL BATCHES
 **6**

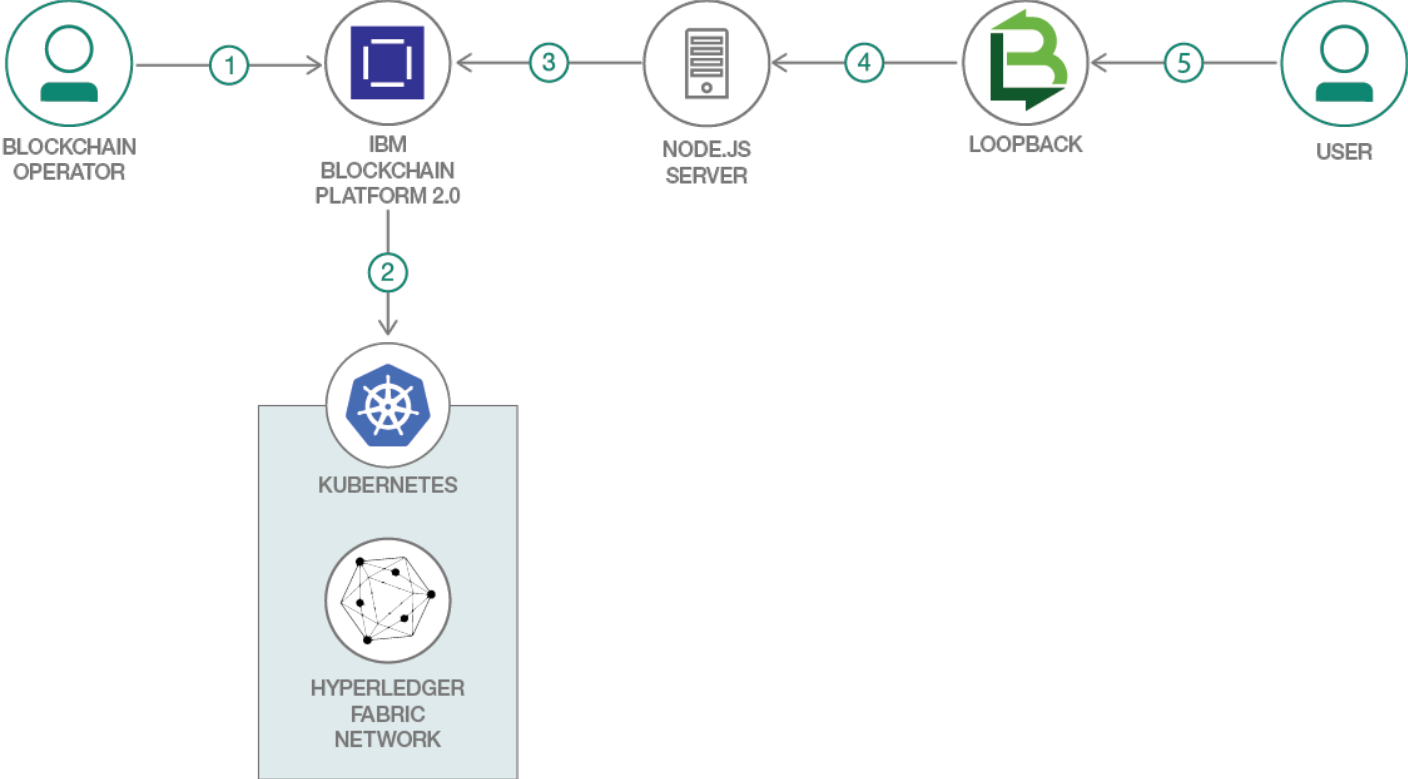
BATCHES OVERVIEW Create Batch

Batch ID	QR-Code	Farm Inspector	Harvester	Exporter	Importer	Processor	Actions
0x2d67d05f937896dc96821B86fe24C56800B67236 		Completed	Completed	Completed	Completed	Completed	
0xE90DFF881265248332c592892A6B9B8f6a10fA39 		Completed	Completed	Completed	Completed	Processing	
0x41a6a570f85eaFD6e64c04B6fbEE3eCD92B21A12 		Completed	Completed	Completed	Completed	Completed	
0x48Fb3E1081D62546c332512717F69175395A6aeA 		Completed	Completed	Completed	Completed	Processing	
0xCB9eE8d83b54AD34C7c590be91e81a8a152b0268 		Completed	Processing	Not Available	Not Available	Not Available	

Hyperledger Private Blockchain



Hyperledger Private Blockchain



Hyperledger - IBM Cloud Dashboard

The screenshot shows the IBM Cloud Dashboard interface. At the top, there is a navigation bar with the IBM Cloud logo, a search bar, and links for Catalog, Docs, Support, and Manage. The user's account information, '2017416 - Constant...', is also visible. Below the navigation bar, the main content area is divided into two columns. The left column, titled 'Resource summary', contains a table with two rows: 'Clusters' with a green checkmark and the number '1', and 'Services' with the number '1'. A 'View resources' link is located at the top right of this section, and an 'Add more resources' link with a plus icon is at the bottom right. The right column, titled 'Classic infrastructure', lists several options: 'Device list', 'Support cases', 'User list', 'Subnets', 'Network monitoring', 'Block Storage', 'Compliance reports', and 'Learn about the transition to IBM Cloud'. A 'Create resource' button is located at the top right of the dashboard. A vertical 'FEEDBACK' button is positioned on the far right edge of the dashboard area.

cloud.ibm.com

IBM Cloud Search resources and offerings... Catalog Docs Support Manage 2017416 - Constant...

Dashboard Customize

Create resource

Resource summary		View resources
Clusters	✓ 1	
Services	1	

Add more resources +

Classic infrastructure

- Device list
- Support cases
- User list
- Subnets
- Network monitoring
- Block Storage
- Compliance reports
- Learn about the transition to IBM Cloud

FEEDBACK

Hyperledger - IBM Cloud Dashboard

The screenshot shows the IBM Blockchain Platform dashboard for the 'Nodes' section. The browser address bar displays the URL: `2e7b5a391587409e9b6ac95985a5e539-optools.uss02.blockchain.cloud.ibm.com/nodes`. The dashboard header includes 'IBM Blockchain Platform' and a 'Get started' link. A left sidebar contains navigation icons for Nodes, Peers, Certificate Authorities, and other system components. The main content area is divided into two sections: 'Peers' and 'Certificate Authorities'. The 'Peers' section shows one peer, 'Peer Org1', with details 'Peer' and 'org1msp'. A blue 'Add peer' button is visible. The 'Certificate Authorities' section shows two CAs: 'Orderer CA' and 'Org1 CA Admin', both identified as 'Certificate Authority' and 'IBM Cloud'. A blue 'Add Certificate Authority' button is also present. The interface uses a dark theme with blue and green accents.

Hyperledger - IBM Cloud Dashboard

Nodes / Org1 CA Admin

Re-enroll identity + Register user +

Certificate Authority (CA) ⚙️ ⬇️ 🗑️

Node location
IBM Cloud

Fabric version
1.4.3-0

Database
SQLite

Org1 CA Admin →
Associated identity for root CA

Enroll ID	Type	Affiliation
admin	client	⋮
app-admin	client	⋮
org1admin	client	⋮
peer1	peer	⋮
user1	client	org1.department1 ⋮
user2	client	org1.department1 ⋮
user4	client	org1.department1 ⋮

Nodes / Orderer CA

Re-enroll identity + Register user +

Certificate Authority (CA) ⚙️ ⬇️ 🗑️

Node location
IBM Cloud

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Orderer CA →
Associated identity for root CA

Enroll ID	Type	Affiliation
admin	client	⋮
orderer1	peer	⋮
ordereradmin	client	⋮

Hyperledger - IBM Cloud Dashboard

The screenshot displays the IBM Blockchain Platform dashboard. The top navigation bar includes the text "IBM Blockchain Platform" and "Get started", along with help, notification, and user profile icons. The left sidebar contains a menu with icons for home, channel, application, ordering, channel, and settings.

The main content area is divided into two sections:

- Channel:** A settings panel for the "Channel" with a gear icon. It lists the following details:
 - Ordering service: Orderer
 - Application capability version: V1.3
 - Ordering service capability version: V1.4.2
 - Channel capability version: V1.4.3
- Block history:** A table showing the sequence of blocks. The table has four columns: ID, Created, Transactions, and Block hash.

Below the block history table, there is a pagination control showing "1 - 10 of 29 Items" and a page indicator "1 / 3" with navigation arrows.

ID	Created	Transactions	Block hash
28	12/1/2019, 9:19:52 PM	1	3b+BWuQZvSnHH4GwJO5buNsv6XImOYRTFZy2olpU+WI=
27	12/1/2019, 9:19:19 PM	1	LOQR5YTn0+CURB1s6cVBoIw/az1QwsXJ+BIfoBe8rI=
26	12/1/2019, 9:18:14 PM	1	MDR36IPyAoDAdcaxBYqLdcN0Hje9TpCKfACZSWcc5w0=
25	12/1/2019, 9:16:48 PM	1	cARNe1XuilHiRbqXh1FHFdUgEhbfVywavV5A75VIDe0=
24	12/1/2019, 9:16:03 PM	1	BPij64fLgpg0LvTpjSpJFMnBrFQwHt4gAFNLcXGe4gs=
23	12/1/2019, 9:13:05 PM	1	dm9cdWyTOV614QVArjzU1mUMTJ6TwF5xP7nJ0TTeaTk=
22	12/1/2019, 9:11:53 PM	1	9J7Tn0+bwXOzughCpxEQ4cELA8EDw+0uNxR7KU8IgAY=
21	12/1/2019, 9:10:01 PM	1	7EI9WHLcgUCfBp3mboqBNlv56ZPNILQnLo+xZNQdGxM=
20	12/1/2019, 9:08:01 PM	1	i8w06XqUqJvetRXbo9vIUpsk+zXD67KNZckCLxr/UQ8=
19	12/1/2019, 9:03:52 PM	1	q0eUbQeRP9mfh2wIr6ScLkDjt226xiJc8QQGPKo6i/8=

Hyperledger - IBM Cloud Dashboard

Transaction

2cabb25d788daadde40ef8fcaa8
fc5985564cebeca1e2d47e8246
ee8fe4f0d68

Smart contract ID

blockchainbean2 0.0.1

Input

```
["addMember","Grower-0201","Claremont Graduate University","150  
E 10th St Claremont 91711 USA","grower"]
```

Output

```
WRITE Grower-0201 = {"id":"Grower-0201","organization":"Clarem  
ont Graduate University","address":"150 E 10th St Claremont 91711  
USA","memberType":"grower"}
```

Hyperledger - IBM Cloud Dashboard

LoopBack API Explorer

127.0.0.1:8080/explorer/

Servers

http://127.0.0.1:8080

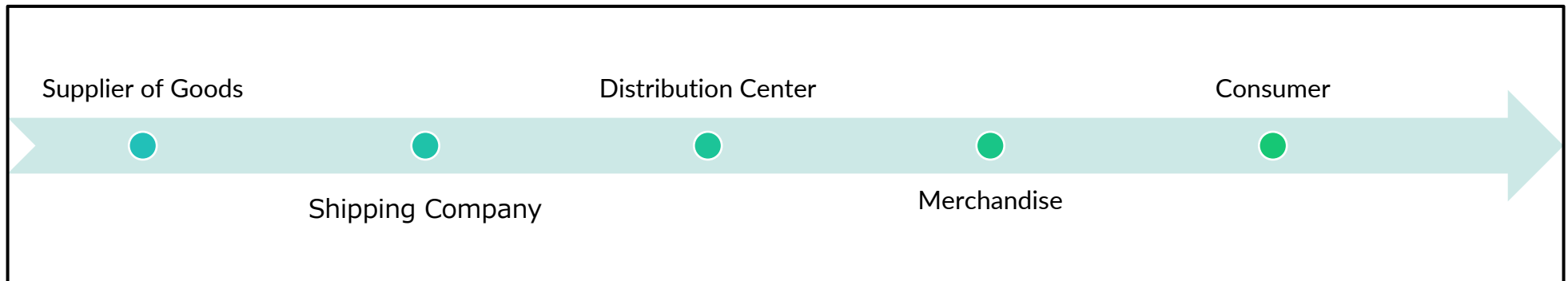
Filter by tag

- GrowerController** ▼
 - POST /Grower
- RegulatorController** ▼
 - POST /Regulator
- RetailerController** ▼
 - POST /Retailer
- ShipperController** ▼
 - POST /Shipper
- TraderController** ▼
 - POST /Trader

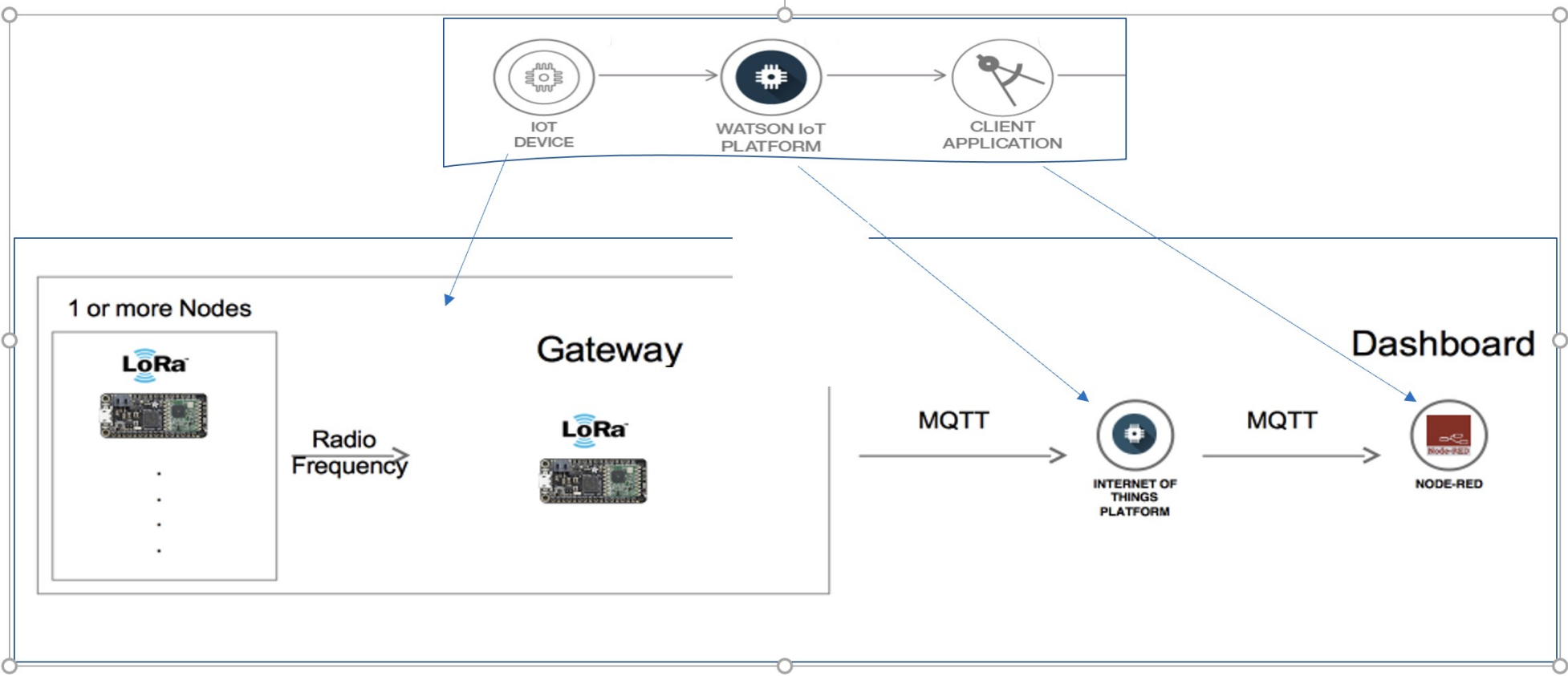
- AddCoffeeController** ▼
 - POST /addCoffee
- PourCupController** ▼
 - POST /pourCup
- SubmitCuppingController** ▼
 - POST /submitCupping
- SubmitFairTradeDataController** ▼
 - POST /submitFairTradeData
- SubmitInboundWeightTallyController** ▼
 - POST /submitInboundWeightTally
- SubmitPackingListController** ▼
 - POST /submitPackingList

Blockchain and IoT

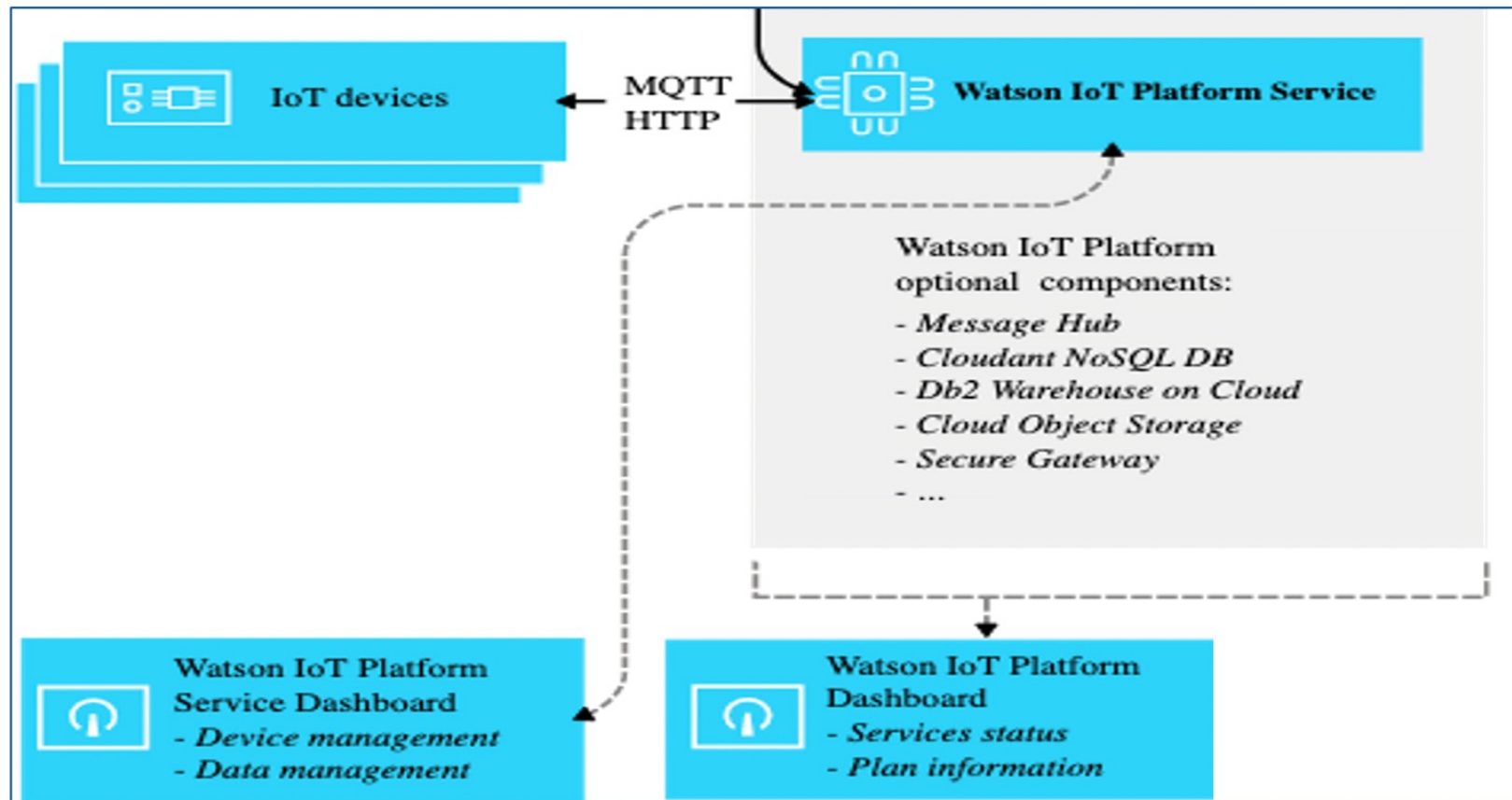
- With IoT asset tracking and blockchain, we capture multiple data points on each shipping container. By capturing the location, temperature, and humidity we will be able to provide an analysis of different measures that can be used to track historic events. In addition to a device that can capture and transmit data over many networks, we will be adding various multimedia components and can make viewing data clear and simple
- Could be used in: Supply chain, Asset monitoring, Transportation, Security, Marketing, Emergency response, Health
 - Example: Supplier of Goods, Shipping Company, Distribution Center, Merchandise, Consumer



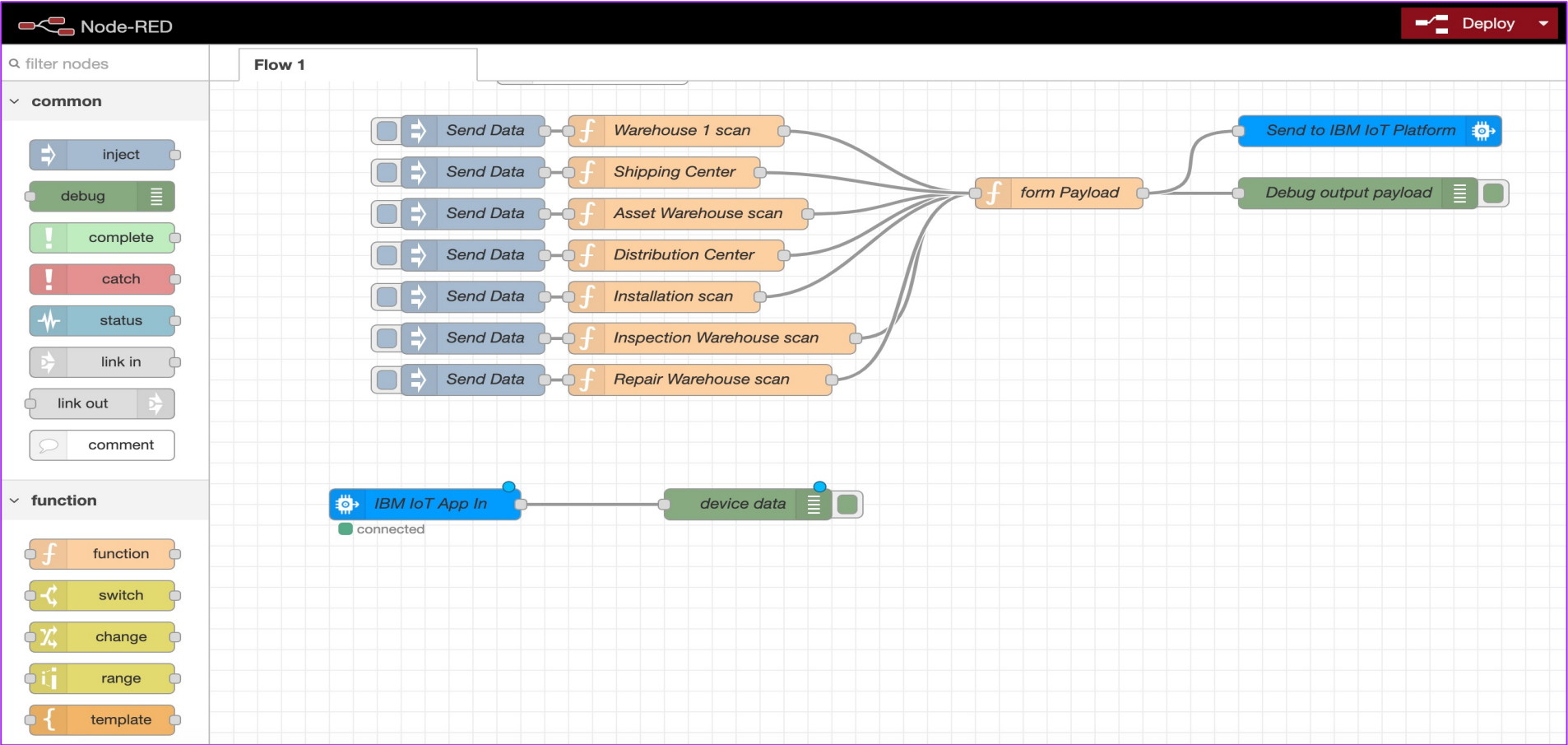
Blockchain and IoT



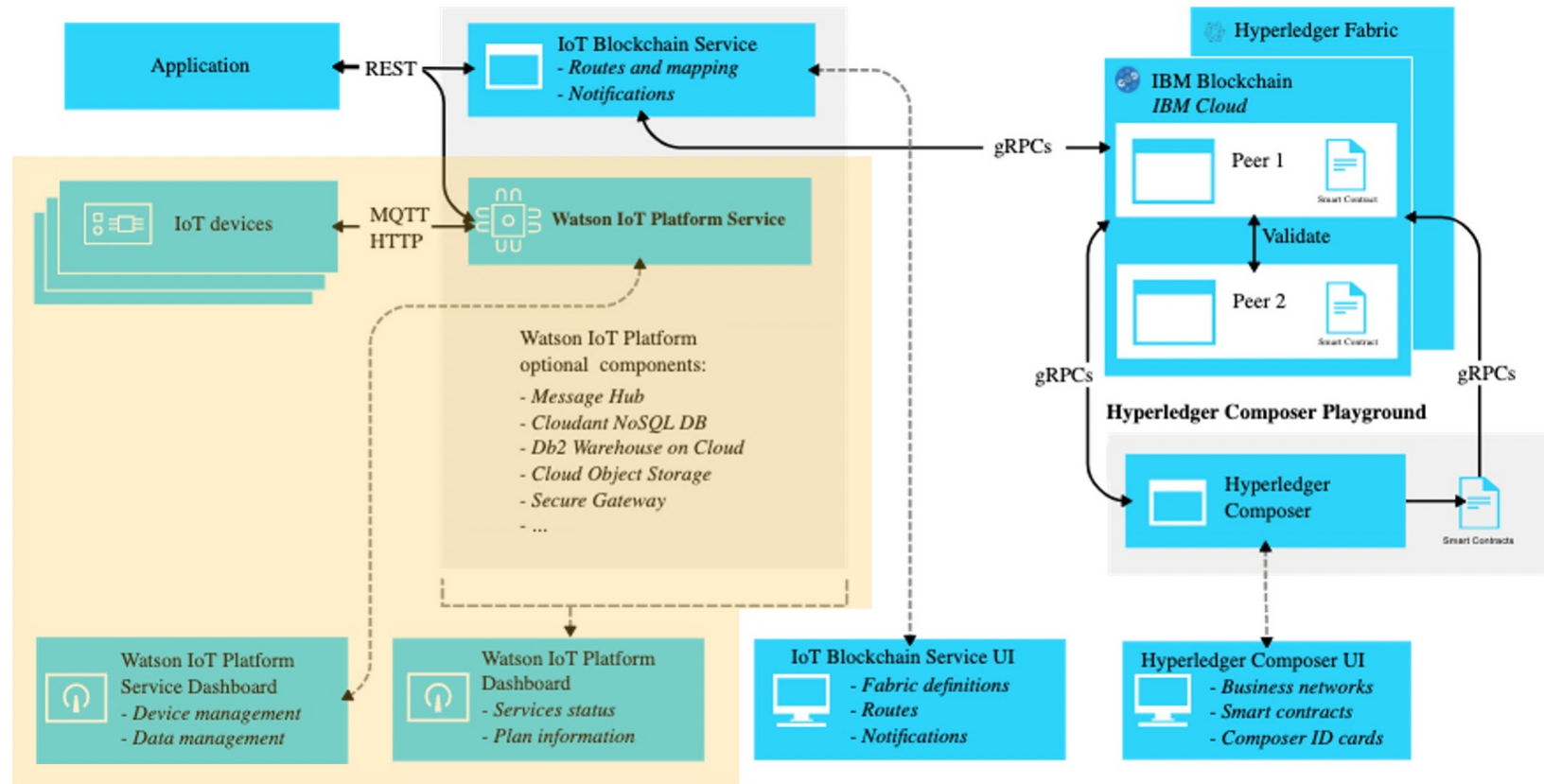
Blockchain and IoT



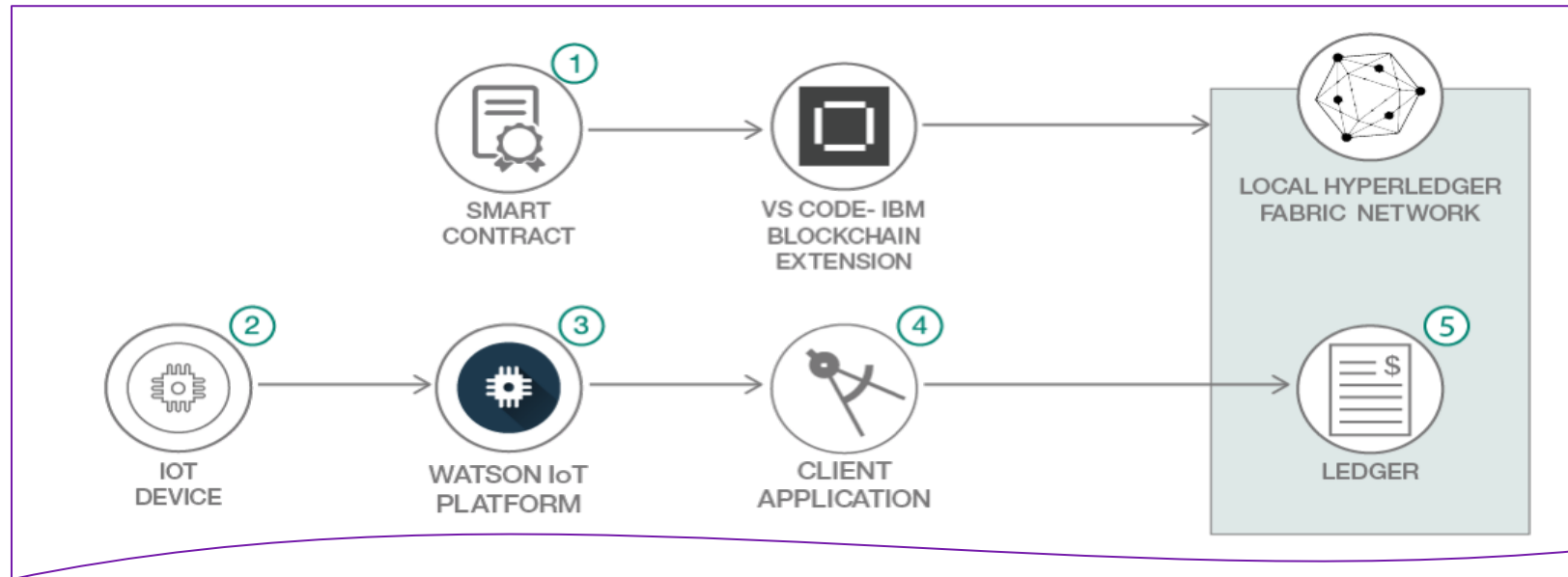
Blockchain and IoT



Blockchain and IoT

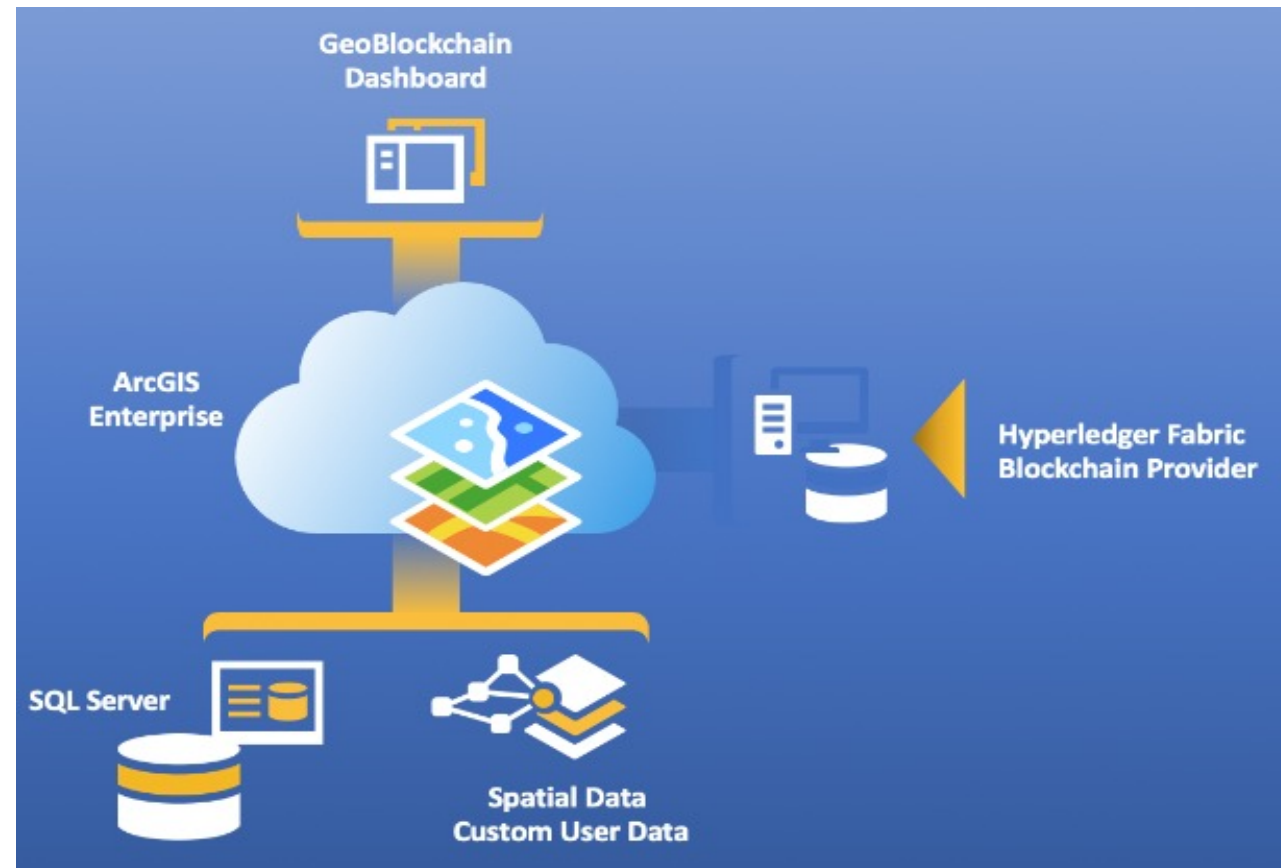
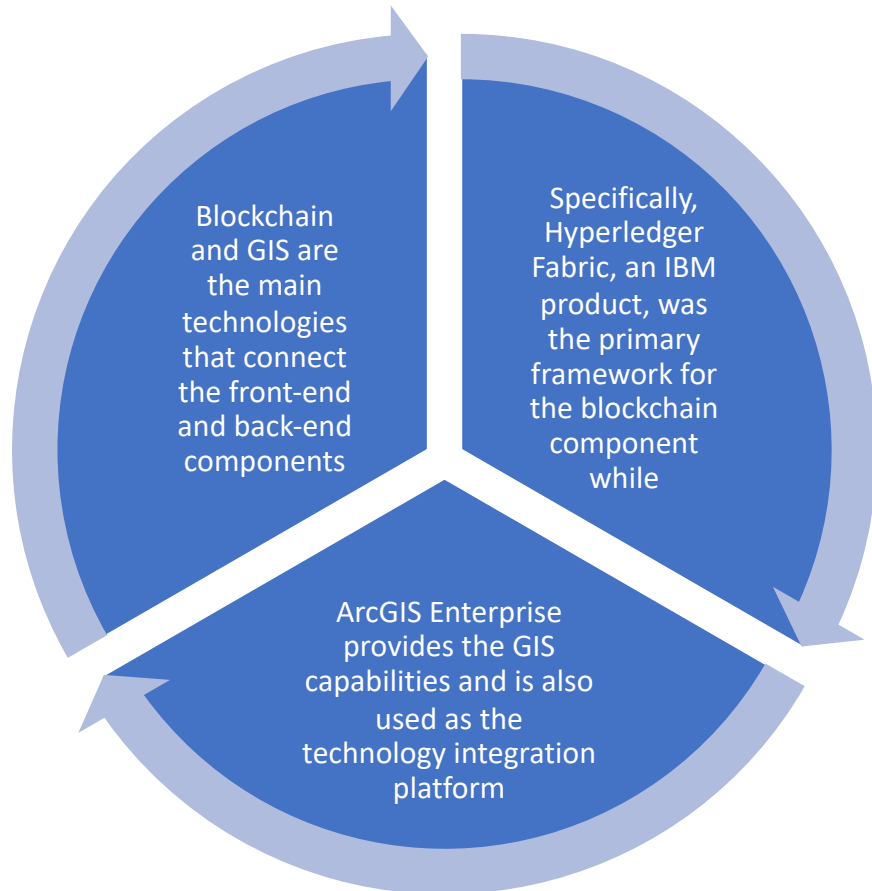


Blockchain and IoT



- 1) The smart contract is deployed to a local Hyperledger Fabric network via the IBM Blockchain Platform extension for VS Code
- 2) As the asset is moved from place to place by an IoT device
- 3) The IoT device publishes an event notification to the IBM Watson IoT Platform, which then notifies all listening applications
- 4) An application listening to the IBM Watson IoT Platform for looking for events then invokes a transfer transaction
- 5) The location of the asset is updated in the ledger automatically

Blockchain and GIS



GeoBlockchain Foundation

- **Blockchain**

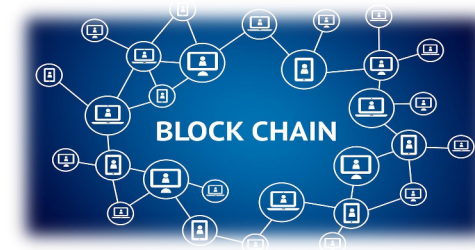
- Trust; Immutability; Transparency
- Public: Cryptocurrency
- Private: Enterprise World

- **Geographic Information Systems**

- Location-based technology
- Spatial Analysis
- Answers the question of “*Where*”

- **GeoBlockchain Concept**

- Combination of Blockchain with GIS
- Geospatially-enabled Blockchain
- Analysis of spatial-temporal trends



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Implementation Phases

Phase I

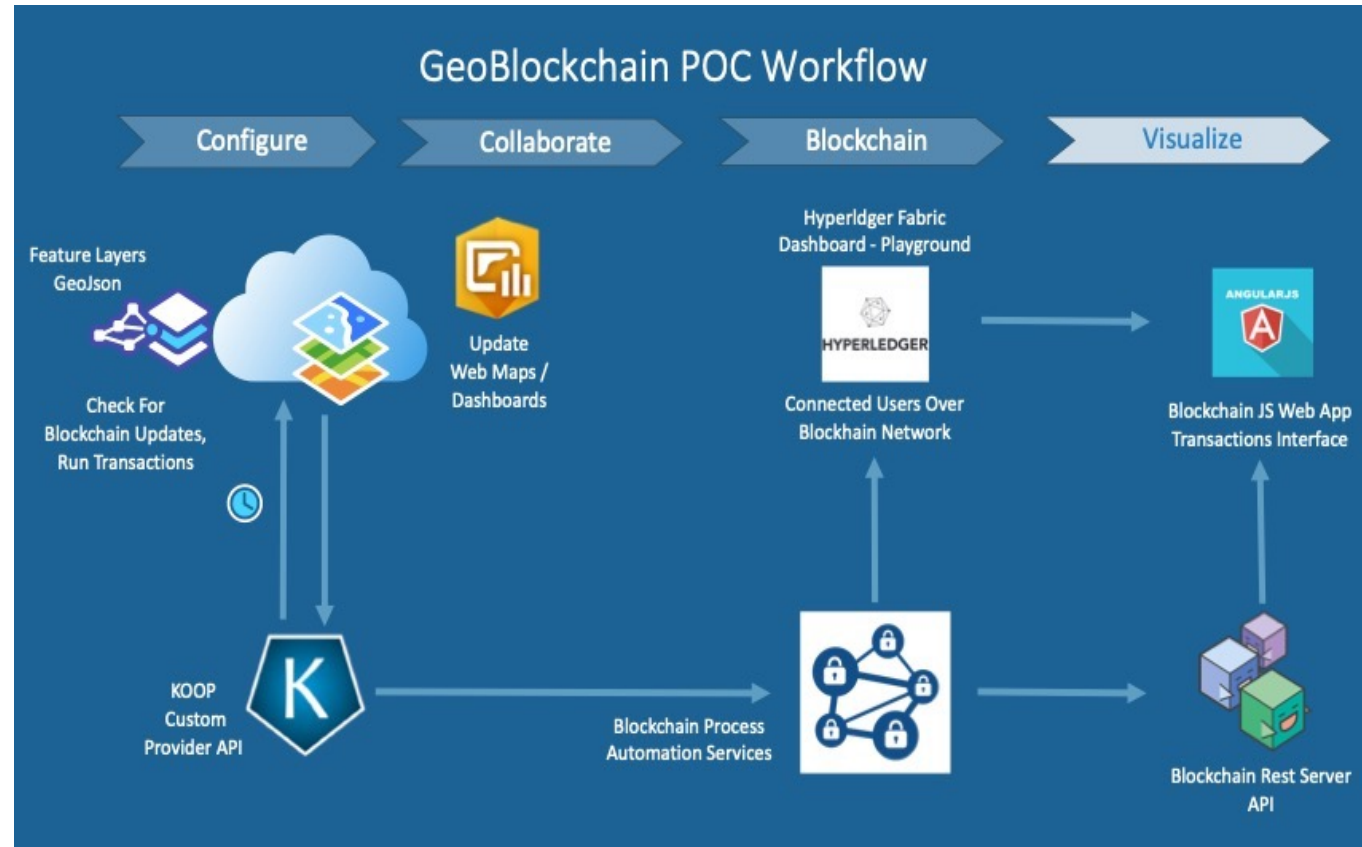
- Design and development of the back-end components
- Hyperledger Fabric blockchain API service was utilized along with the ArcGIS Enterprise API rest service

Phase II

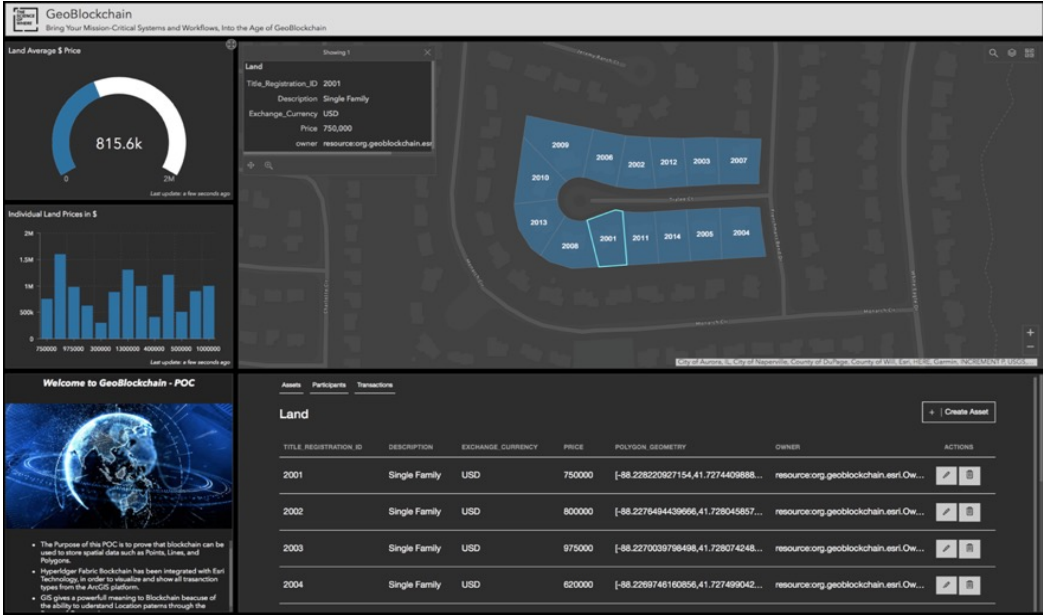
- Creation of various coding artifacts that connect the blockchain API services and geospatial API services
- Creation of the GeoBlockchain

Phase III

- Involved the creation of the front-end
- An interactive dashboard that visualizes the GeoBlockchain results in a web-based application that includes various widgets and map-based output

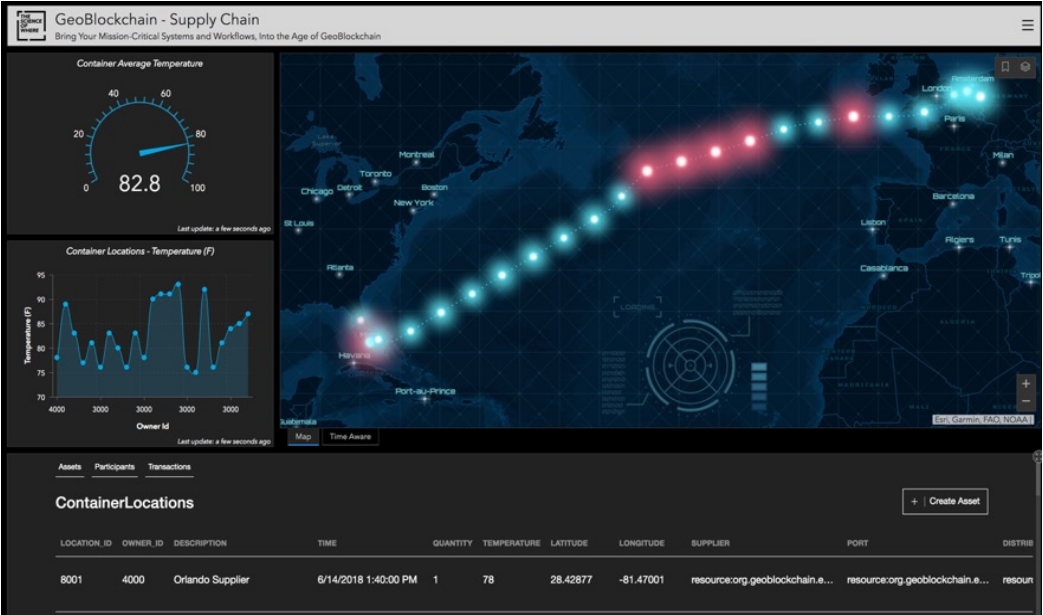


GeoBlockchain – Examples



GeoBlockchain ICT- Artifacts Outcome

*Land Ownership Dashboard
Dashboard Widgets*



GeoBlockchain ICT- Artifacts Outcome

*Supply Chain Dashboard
Dashboard Widgets*

Supply Chain - Example

Problem

- Financial losses from the shipping-food supply chain
- Could not validate cargo shipping conditions
- Liability and litigation issues
- Food spoilage, inadequate storage, inefficient routing and food waste
- Lack to authenticate environmental conditions during shipping routes

Goals

- Develop a framework for effective information-sharing
- Provide trust, authentication, and validation through the shipping routes
- Create a POC Solution to locate and fix deficiencies in the shipping-food supply chain:
 - Improve participant's ability to monitor supply chains
 - Provide the where and how the system breaks down
 - Optimized development and asset management
 - A collaborative environment that improves productivity, security, resilience, speed, and efficiency

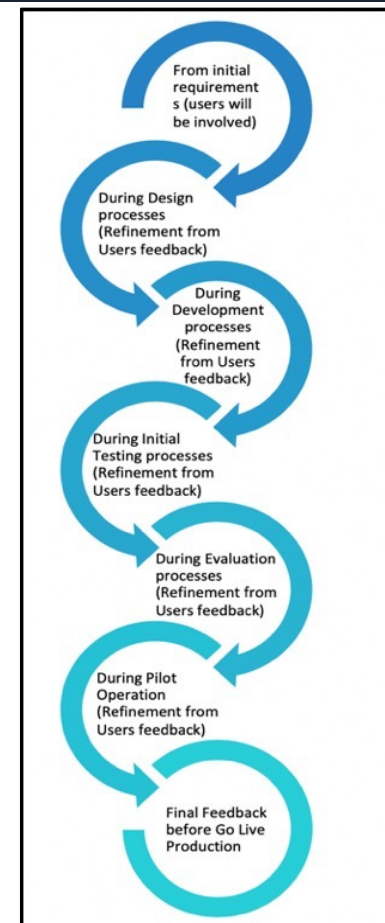
Solution Design Process

Design Thinking:

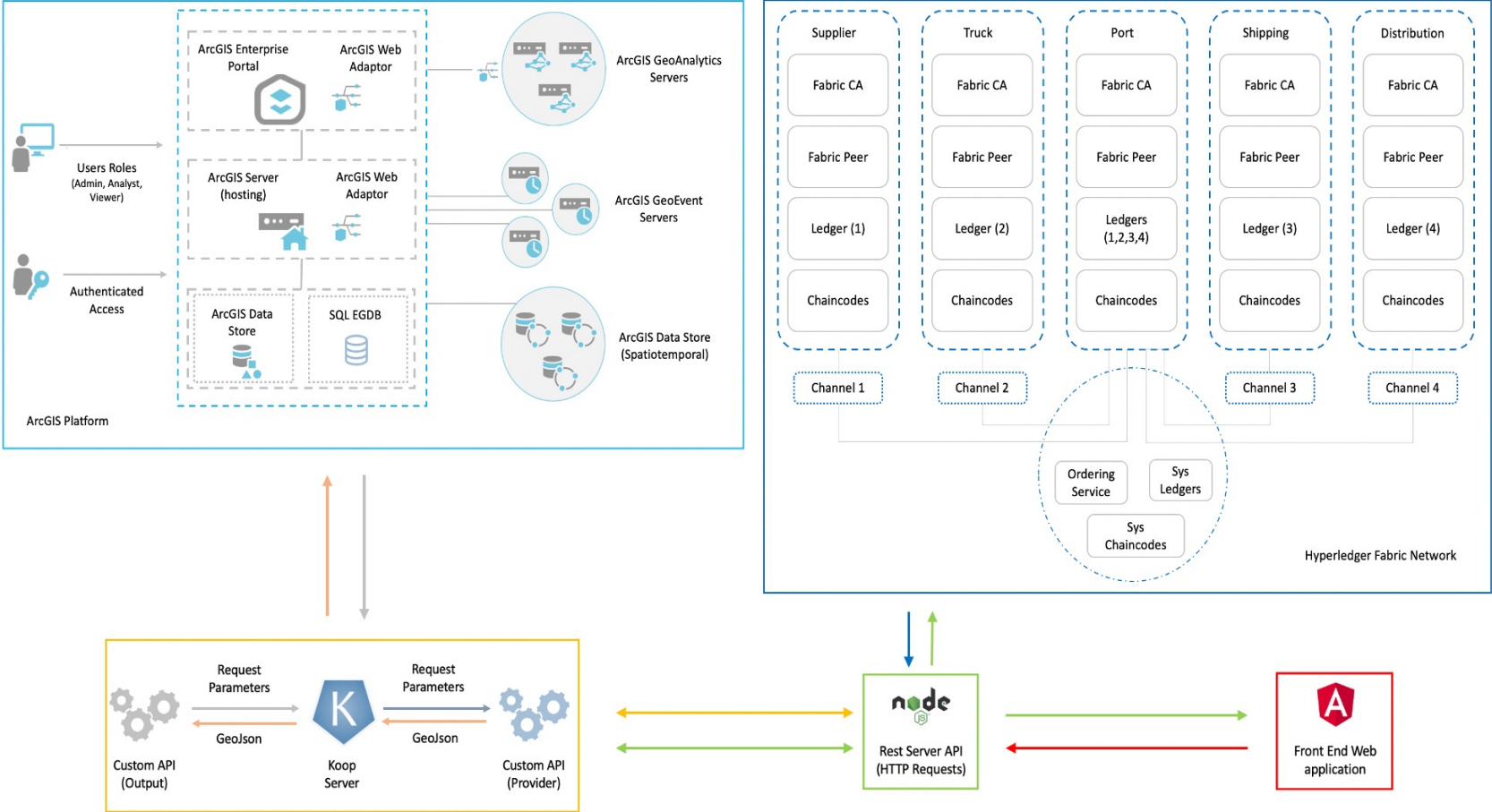
- Understand the problem
- Use 5 Whys to identify the root cause
- Gathering tech requirements
- Develop the solution
- Prototype, test and refine
- Implement
- Deliver results

Users and Stakeholders Involvement

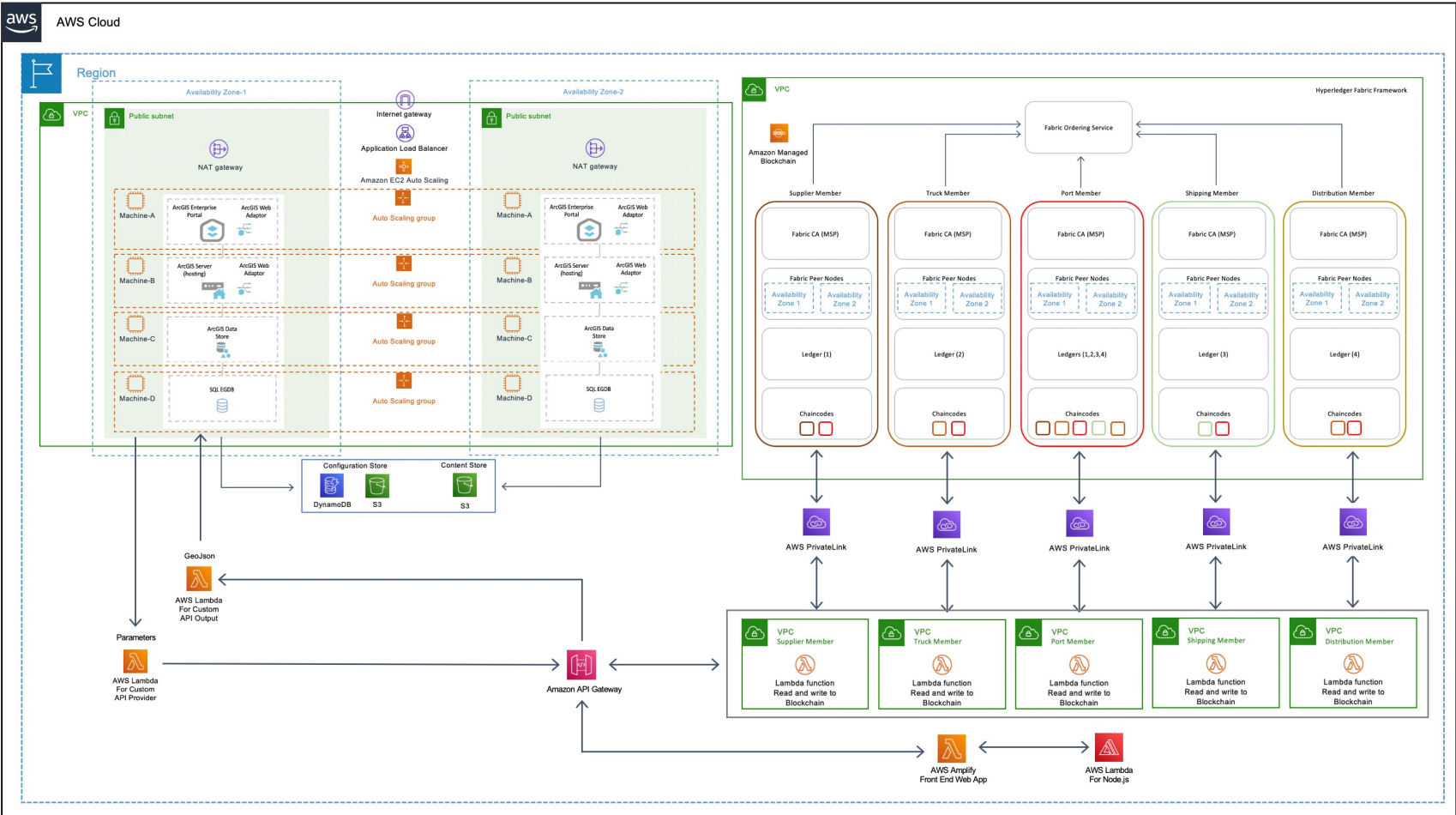
- *Incorporating usability and user engagement in this process is very important*
- *Users and stakeholders were engaged during the design, development and evaluation phases until the final production solution was achieved*



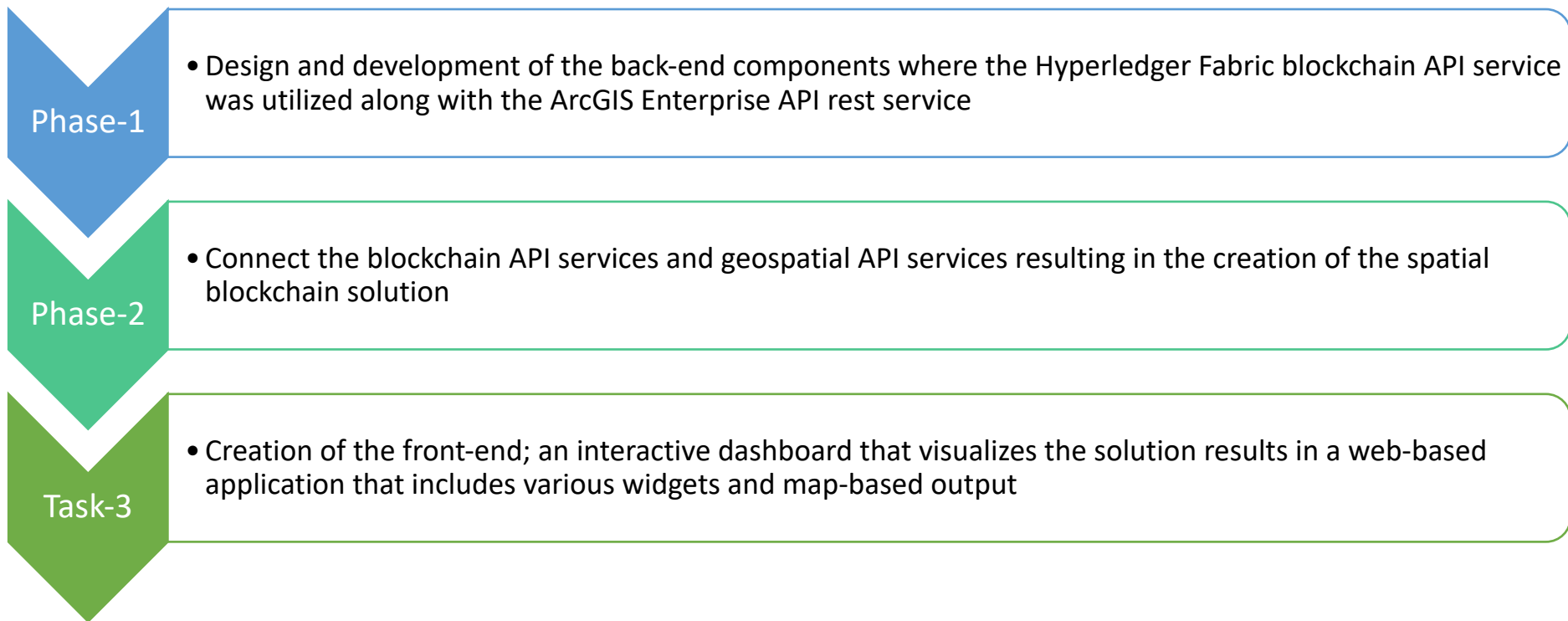
GeoBlockchain: On-premises infrastructure



GeoBlockchain: Cloud infrastructure



Implementation Phases



Challenges and Risks

Challenges:

- Select the correct type of Blockchain framework
- How spatial data could be stored on the Blockchain?
- Should the spatial data be stored on the Blockchain?
- What type of spatial datasets could we store on the Blockchain?
- How to authenticate spatial datasets?
- GIS and Blockchain integration on Premise

Risks:

- Resources and Capacity Extra Cost
- Large Volumes of Datasets could slow down the Network
- Scalability and Security
- Manage the platform for the long term

Impact and Contribution

Impact and Contribution

- Reduce losses
- Minimize liability and litigation Issues
- Monitor parameters leading to food spoilage, inadequate storage, inefficient routing, and food waste
- Validate and authenticate environmental conditions and spatial datasets during the shipping route
- Created new opportunities in other areas such as Landownership
- Scientific Research was developed

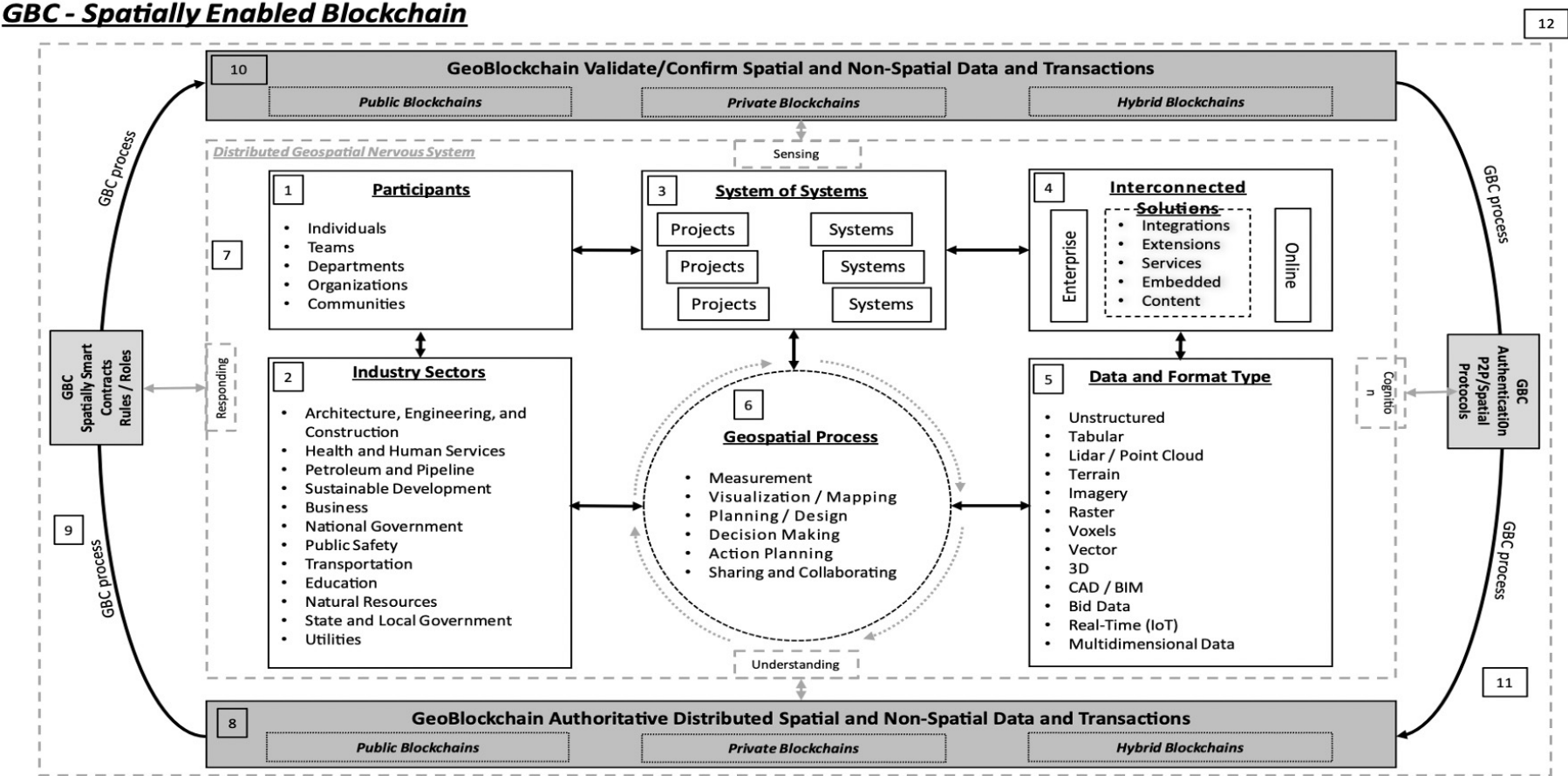
Results - Demo

The screenshot displays the 'GeoBlockchain - Supply Chain' dashboard. At the top left, the logo 'THE SCIENCE OF WHERE' is visible. The main header reads 'GeoBlockchain - Supply Chain' with the tagline 'Bring Your Mission-Critical Systems and Workflows, Into the Age of GeoBlockchain'. The dashboard is divided into several sections:

- Container Average Temperature:** A gauge showing a current temperature of 82.8. The scale ranges from 0 to 100. Below the gauge, it says 'Last update: a few seconds ago'.
- Container Locations - Temperature (F):** A line chart showing temperature fluctuations over time. The y-axis is labeled 'Temperature (F)' and ranges from 70 to 95. The x-axis is labeled 'Owner Id' and ranges from 4000 to 3000. Below the chart, it says 'Last update: a few seconds ago'.
- Map:** A dark-themed map showing a supply chain route with glowing red and blue dots. A blue box highlights a specific location. A popup window is open over this location, displaying details for 'Not Set: 671102089'.
- Popup Window:** A dark window titled 'Showing 1' with a close button. It lists the following details:
 - Class: org.geoblockchain.esri.Container
 - Location_Id: 8015
 - Owner_Id: 3000
 - Description: Express Logistics
 - Time: 6/28/2018 9:00:00 AM
 - Quantity: 1
 - Temperature: 93
 - Latitude: 47.56
 - Longitude: -26.54
 - supplier: resource:org.geoblockchain.esri.S
 - port: resource:org.geoblockchain.esri.F
 - distribution_center: resource:org.geoblockchain.esri.D
 - ship: resource:org.geoblockchain.esri.S
 - truck: resource:org.geoblockchain.esri.T

At the bottom of the dashboard, there are tabs for 'Assets', 'Participants', and 'Transactions'. Below these is a section titled 'ContainerLocations' with a '+ Create Asset' button. A table header is visible at the very bottom, listing columns: LOCATION_ID, OWNER_ID, DESCRIPTION, TIME, QUANTITY, TEMPERATURE, LATITUDE, LONGITUDE, SUPPLIER, PORT, and DISTR.

GeoBlockchain – Framework



Criteria for GeoBlockchain

N/A	Q-Set Criteria	Description
1	Participants	Multiple organizations participated in the land ownership and supply chain examples
2	Trusted Organization	The main authority in the blockchain that controls policies, rules, and roles
3	Centralized Operation	Every participant control and manages their transaction information from the GeoBlockchain
4	Transparency and confidentiality	All participants could share encrypted information through the GeoBlockchain
5	Integrity	All transactions are written into the blockchain history for provenance
6	Immutability	Data on the GeoBlockchain cannot be changed easily or deleted
7	High Performance	System scalability and system behavior from big GeoBlockchain datasets either text (blockchain) or spatial (geospatial)

Criteria for GeoBlockchain

Land Ownership Example	
Participants	Responsibilities
GeoBlockchain-Administrator	Administrator has full privileges to Hyperledger Fabric and ArcGIS Enterprise
GeoBlockchain-Seller	Participant that is added to GeoBlockchain with controlled roles only for "Seller" Group
GeoBlockchain-Legal Authority	Participant that is added to GeoBlockchain with controlled roles only for "Legal Authority" Group
GeoBlockchain-Land Owners	Participant that is added to GeoBlockchain with controlled roles only for "Land Owners" Group
GeoBlockchain-Customers	Participant that is added to GeoBlockchain with controlled roles only for "Customers" Group
GeoBlockchain-Stakeholders	User that is added to Blockchain with controlled roles only for "Stakeholders" Group

Supply Chain Example	
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

Presentation References

Scientific Publications:

- [*GeoBlockchain: The Analysis, Design, and Evaluation of a Spatially Enabled Blockchain*](#)
- [*Enterprise Solutions Criteria in the Age of GeoBlockchain: Land Ownership and Supply Chain*](#)
- [*Workflows and Spatial Analysis in the Age of GeoBlockchain: A Land Ownership Example*](#)
- [*Selecting Implementation Criteria in the Age of GeoBlockchain*](#)

Media Publications:

- [*Which Countries Use Cryptocurrency Most?*](#)
- [*Think Tank: Blockchain Evolves into Geoblockchain*](#)

Questions and Answers

Thank you!

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