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BaaS is the future

Enhancing traceability and transparency of
supply chains using Blockchain as a service

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Abstract

Blockchain is one of the most sought-after and emerging technology right now. Blockchain as a technology uses cryptography to secure data over a network and provides transparency across different nodes of the network. The supply chain consists of a broad range of activities from the inception of any goods until it reaches the consumer. So, transparency, traceability of the information along the chain and quality, quantity, and the optimized management of the passing information is a very tough challenge in any complex supply chain. Blockchain has the potential to address this issue and by its natural decentralization, it provides a more transparent way to manage data transmission across any supply chain. This Paper discusses different case studies focussed mainly on food industries, where it shows how Blockchain can enable customers or consumers to know the origin of the packaged food. It also highlights how Blockchain is being used as a service by different tech leaders of this world to track the provenance of the finished goods and how it adds value to the service dedicated to the customers. It shows how a network of a Blockchain can be created, the information passing mechanism in an established blockchain-based network, and what are the different steps involved for a full-scale rollout of a Blockchain project. The paper also discusses the limitation of the blockchain in form of immutability and scalability and how industries – these days –are overcoming these challenges and implementing Blockchain to improve security, transparency, and traceability across different supply chains.

Keywords: Blockchain, Supply chain, Transparency, Traceability, Scalability, Supply chain Management.

I. Introduction

Supply Chain is the combination of all the steps involved in getting products from Raw material to the customer. So, every Supply Chain of this world focuses on how to fulfil demand efficiently, drive customer value, improve responsiveness, and contribute as much as possible to the financial success of the business. In today's world, different supply chains are facing few key challenges like the Involvement of multiple layers in a distribution chain creates lack of transparency, discrepancies in records, limited cross-process visibility, globalization of Supply Chain operations, maintaining high performance, etc. One another key problem that is giving the modern supply chains quite a pain, is the circulation of counterfeit products. A recent study revealed that almost $1.2 trillion has been lost in the worldwide supply chain due to counterfeiting in the year 2017 [1]. Blockchain is a decentralized perpetually increasing electronic ledger that keeps an immutable record of all the transactions that have taken place, in a cryptographically assure, sequential, and irremovable way. Thus, Blockchain can help to tackle all the above-mentioned challenges of a supply chain and it is emerging as a technical solution to these troubles. Since supply chains involved in a wide range of activities in the flow of goods and products from their origination till those get consumed, thus Blockchain can
i) ensure provenance tracking and how the goods or products can be traced along the value chain, ii) improve its access and the accuracy and standard of the information in every stride of the entire supply chain, iii) render a more pellucid way to present information at a specific juncture under consideration.

In this paper, I will try to discuss and review few related case studies where the implementation of technology like Blockchain in different supply chains helped to overcome major disadvantages, added value to the customer demand fulfilment owing to the requirement, and increased the overall responsiveness of the supply chain. Along with this, I shall also take a deep look into how Blockchain help to reduce frauds, errors, and increase data transparency and privacy in a supply chain.

II.   Features of a Blockchain

One of the most important features that Blockchain as technology provides is its ability to exchange and make use of information and systems, which is leveraged for passing and transmitting information through different nodes of a supply chain like suppliers, vendors, and customers. In a distributed Blockchain having more than one identical copy of data blocks distributed across multiple nodes, keeping track of the entire data flow is much easier and each of these blocks is connected using a cryptographic hash. This cryptographic hash acts as a digital fingerprint for a certain amount of data. This data transparency will make to avoid illicit product distribution. Distributed Blockchain technology helps all the stakeholders of the supply chain to access data from any corner of the entire supply chain.

Blockchain as a technology shows immutability in nature, hence not any distinct stakeholder in an entire network can tweak data without the needed permission and visibility of other nodes or stakeholders present in the network, this mechanism ensures that no data breach can happen without the perceived knowledge of all the stakeholders of the supply chains. So, the coalescence of transparency, traceability, and immutability helps to reduce fraud,

cheating, and ever-increasing counterfeiting as well as to increase the rectitude amongst the several participants of any business network. In a shared Blockchain system, the silos of information in supply chains - from raw material to customer as a finished good – get permission, cryptographically secured, and shared equally. The way to do that is by tracking individual assets with the token associated with the moving products as they make their way through each step of the supply chain. At its most basic level, the core logic of Blockchain means that no piece of inventory can exist in the same place twice [2].

Blockchain provides another major solution regarding the verification and accuracy check of the product as it moves through the supply chain. Blockchain has three general types of oracles as in Hardware oracle, triggered by a sensor (e.g., RFID, IOT Sensor, Barcode Scanner, etc.), Software oracle, i.e., information available online (e.g., market data, data triggers) and Human oracles, to verify and research events (Quality control, Special Knowledge, etc.). These Blockchain oracles are often third-Party agent which seeks and verifies information and occurrences in the real world outside the Blockchain, to be used by smart contracts [3].

III. Motivation behind using of Blockchain

We all like to know the source of the food we consume every day, isn't it? When we buy something from supermarkets or order package food items from online groceries or from local retailers, we all want to track the provenance of the item as it not only assures us the safety of the product but also it intrigues us to trust the "Manufactured by" part written on the packaging. Say, for example, if I buy a packet of Karachi Bakery biscuit from a supermarket in Kolkata, obviously I would like to know whether they are really from Karachi Bakery of Hyderabad, India or not? **Below figure also explains how traceability delivers value on multiple fronts:**

Sourcing:
- Where does the product originate?
- Was it farmed morally?
- Pesticides were deployed?

Packaging:
- The amount of recycled material used in the product packaging is what percentage?
- Does the packaging have a BPA certification?

Consumption:
- Who consumed the product?
- They liked it or not?

Circularity:
- How can I recycle items after using them?
- Does circularity result in fresh business prospects?

Processing:
- What facility processed the product?
- Chemicals were used?
- If the factory is affected, are there any alternatives?

Distribution:
- How was the product delivered to the client?

Disposal:
- How was the packing disposed of by the consumer?
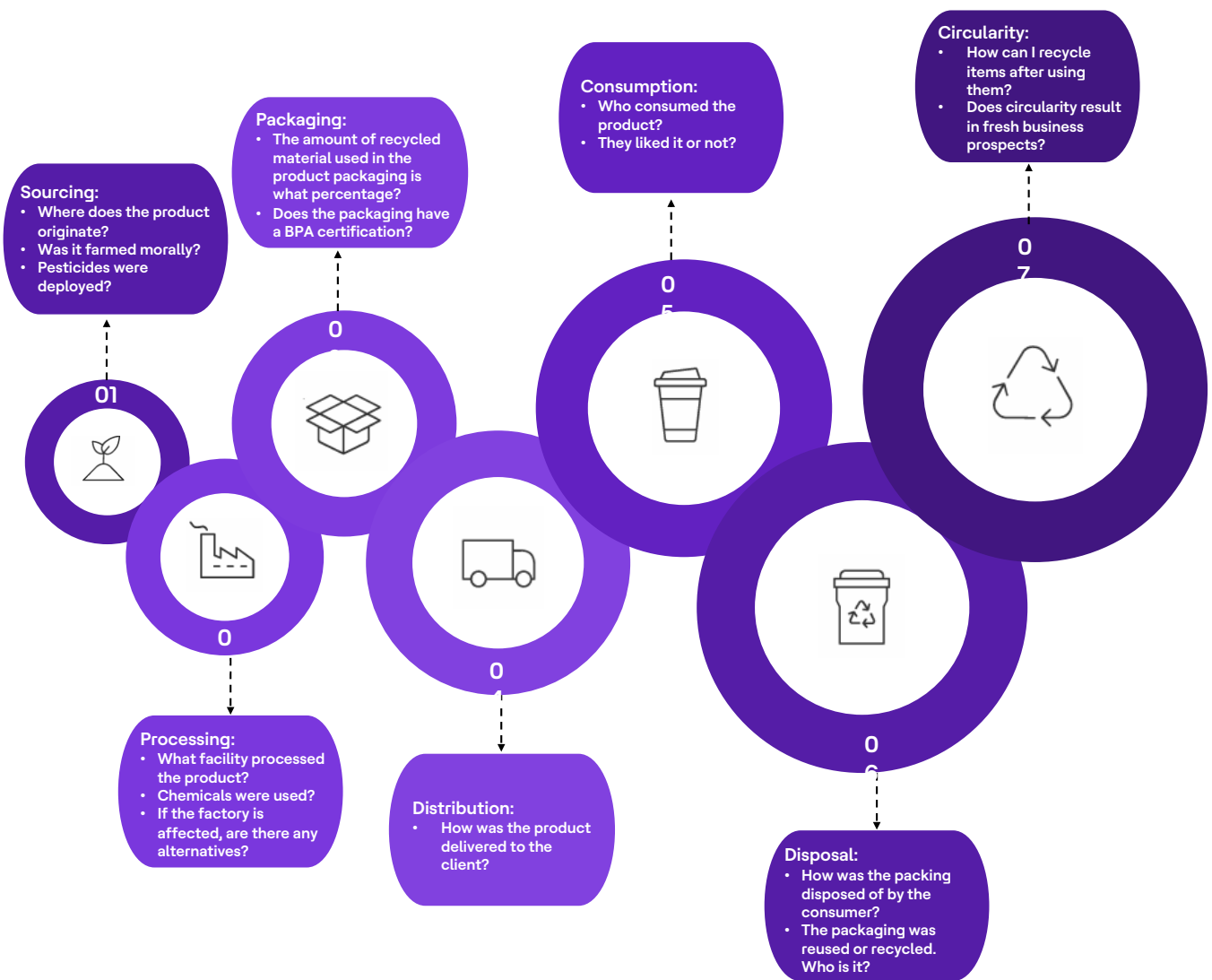- The packaging was reused or recycled. Who is it?

Fig: Traceability delivers value on multiple fronts (Source: Bain & Company)

A persistent keenness to know the reason behind this made me explore Blockchain as a technology, and how it is giving a solution to this all-important provenance tracking for customers and adding value to their demand. Research on this domain of Blockchain and the use of this technology in the various domain to enhance traceability and transparency of these supply chains is growing rapidly.

IV. Leading companies are ripping benefits using Blockchain

A very distinct purpose of all supply chain management is to take the edge off the risk associated with the supply chain. These risks cover the chance of fraud, chance of other stakeholders to get involved in opportunistic behaviour like swindling, counterfeiting, manipulating information in the wrong way, etc. Here in this section, we will see how several companies around the Globe are using Blockchain as technology in several supply chains to track evidence and origin for providing better transparency to their customer.

In the United States, during thanksgiving, a special feature was introduced by a global food corporation. Their packaged turkey was made available in the market with the tagline "meet your farmer". Now the concept behind this was the farm to table traceability of the turkey. Their world-known product Honeysuckle white turkey was packaged with a code on the wrap and when customers go to Honeysucklewhite.com, enters the "meet your farmer" code then they can check the history and ownership of the farm, map location, photos, and message from the farm.

Every turkey packaged is assigned to a unique individual key, and Blockchain as a technology is used to track the provenance. From regular surveys much more complete consumer experience is being created. This pilot project was launched in 2017 in Texas for 60,000 Honeysuckle white turkeys and expanded to 200,000 turkeys from 70 farms, one-third of the turkeys sold for that brand. 350 retail stores across the United States during the 2018 thanksgiving season [5]. A Uganda based café chain where they are using Blockchain traceability of coffee across the supply chain. The first shipment of multiple tons of 'Bugisu Blue' coffee in December 2018. This Blockchain-based traceability of coffee puts in value to the customers' demand and thus helps farmers to charge more. Farmers can digitally integrate an immutable certification, including a QR Code. This allows farmers and companies to add value and charge more.

A famous jewellery company leverage Blockchain to track the historical ledger of the movements of diamonds with real-time data. This data includes diamond origin, cutting, polishing, master artisan's work, and certification. On the website for tracking diamonds, customers will be able to view a consolidated grading report where they can track provenance to check the originality of the diamond as well as to connect with the makers of the jewellery. It gives a complete enhanced customer experience which in turn adds value to their requirements and eventually, the company can charge more on that.

When it comes to any packaged food, consumer's most sought-after information normally is the provenance of the food. In 2016, a world known retailer first tests its Blockchain-based tracking of the food supply chain and in the first go, it reduced the time to track produce from an average 6 days to under 3 seconds. It increased efficiency and improved supply chain transparency rapidly. Later, all suppliers were mandated to adopt the solution and there is a plan to extend to other fresh fruits and vegetable suppliers to use this Blockchain ecosystem over the next year.

How it can be done and what all is recorded in blockchain: As mentioned above pork experiment start with first step of slaughterhouse capturing that is manufacturing process using RFID and cameras -> Beef is ready to ship, then loaded onto shipment trucks equipped with GPS as well as sensors for humidity and temperature -> Now meat landed in distribution hubs -> Purchasing manager has all the tracking data. In blockchain, the chain recorded start with farm origin, followed by the batch number, factory data and processing data. Information like expiration data, temperatures, and shipping data. All these information go into the blockchain.

Fig: Structure of a food traceability system (Source: ResearchGate)

An international accredited registrar and classification society launched a mobile-based application to scan QR code to enable "Grape-to-Bottle" visibility for the wine consumers. This QR code scanning enables a Blockchain-based technology to be able to provide information about the full history of the wine from vineyard's grape to bottle including quality, authenticity, origin, and ingredients. It gives the consolidated report with finer details like water and energy consumption too.

One of the leading lending companies use to lend cash through blockchain. Customers lending's platform borrow amount against any type of bitcoin or blockchain asset as collateral. Another quality is that Loan is approved based on borrower's credit score but on the value possess by collateral. To be on this platform a user needs to buy cryptocurrency.
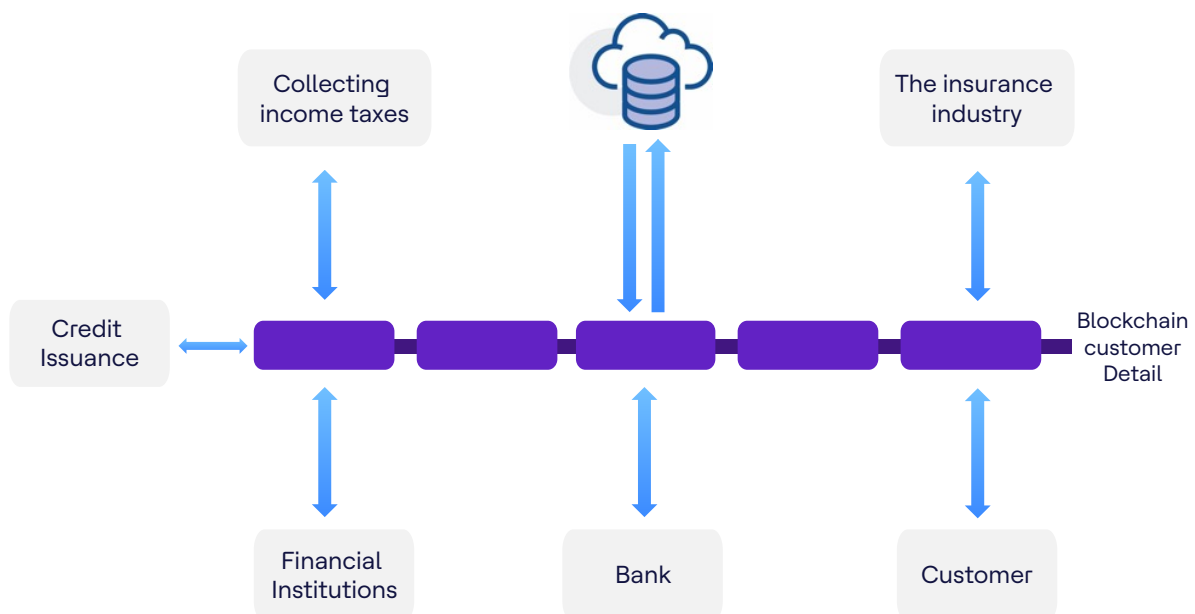

Fig: Blockchain Framework for Credit Scoring of an Individual

V. HCLTech's proposition for Blockchain as a service (BaaS)

Blockchain as a Service (BaaS) is an offering that enables customers to be able to use cloud-based solutions of different providers to host their Blockchain applications, platforms, all their smart contracts, and all the different functions they have but not having to build their infrastructure. BaaS is very similar to Software as a Service (SaaS). Like in SaaS you don't have to buy the software, but you can use those as subscription-based services, BaaS also provides an infrastructure of Blockchain platform where you can use cloud-based platforms of different providers to access Blockchain as a service. There are different models available in market for Block chain implementation: 1> Consortium based Model e.g., R3, B3i, IBM Maersk where the platform is managed by a distinct legal entity and funded by aa consortium to accommodate competing interests. 2> Anchor based Model e.g., Walmart IBM which is funded and managed by a single entity which is common for small number entities. 3>Single Organization Model created to support a specific type of transaction (i.e., Bitcoin or Ripple) and funded by individual participants.
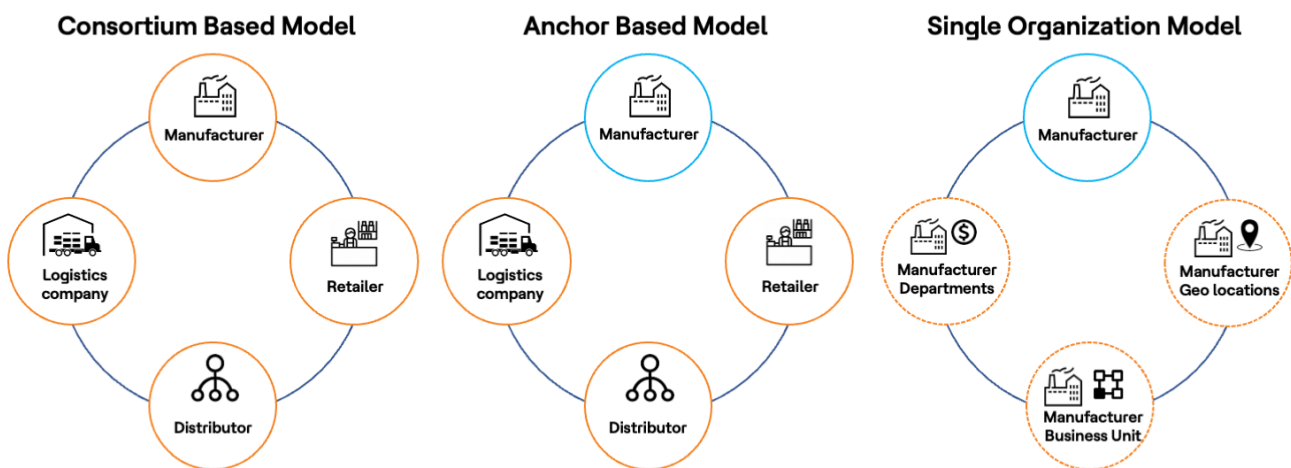

Fig: Different models of Blockchain Implementation

HCLTech's Blockchain application platform – CoTrust

A Blockchain engine is just one piece of an application: Every blockchain application will require some unique business logic to be coded, the other pieces will be similar from one application to another and you should not have to reinvent the wheel by creating these common pieces from scratch.

The CoTrust Blockchain application platformSM provides the common pieces: The CoTrustSM platform provides these and other common pieces, CoTrust supports HCLTech's mission of providing high value services, A CoTrust license is included when you engage HCLTech on a blockchain project and Paid license are available if you choose not to engage HCLTech.
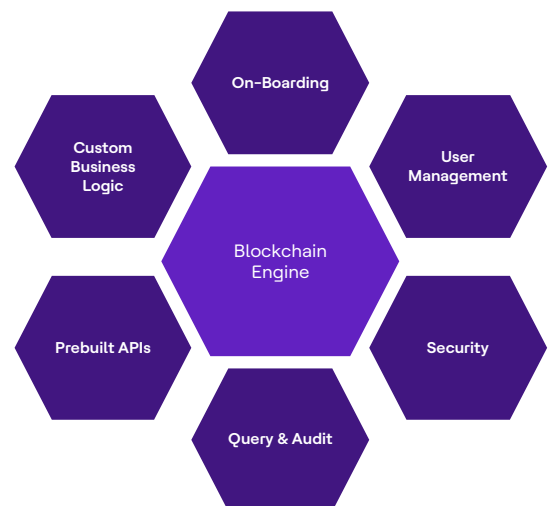

Fig: Blockchain Engine

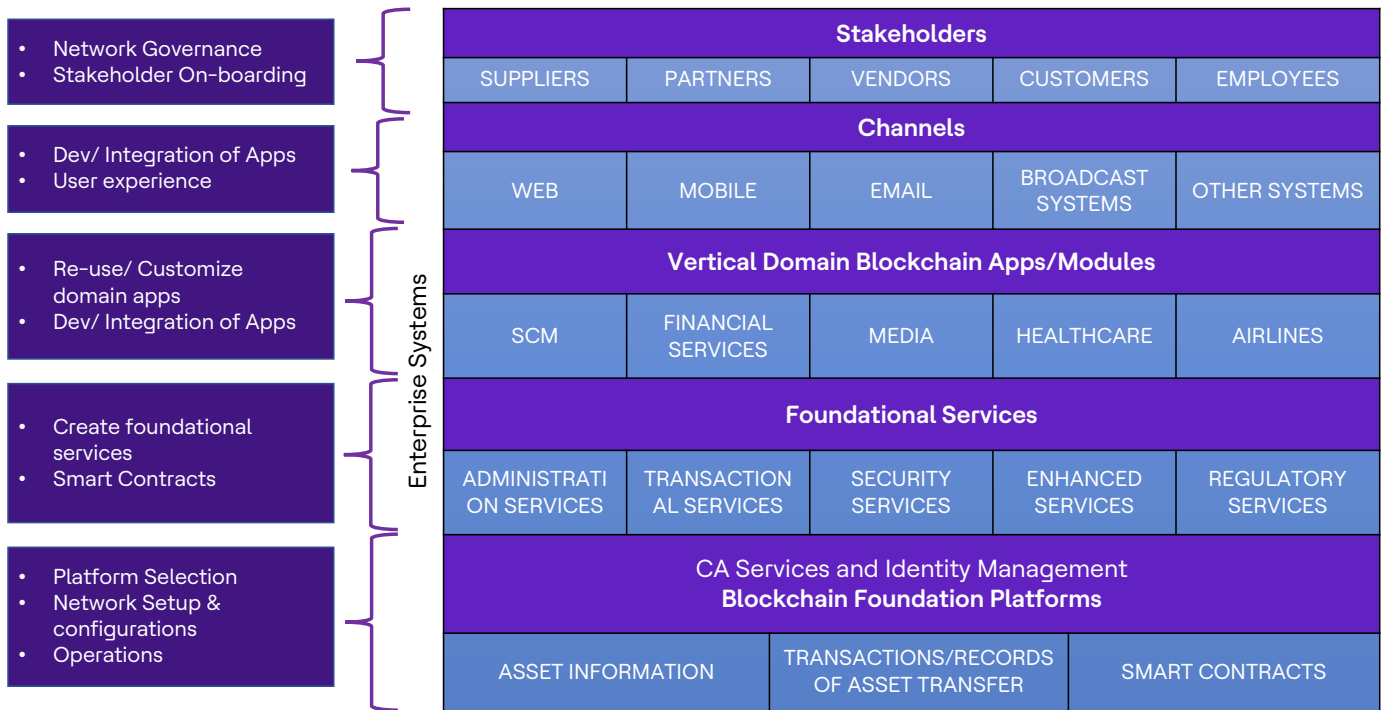# VI. Logical architecture of a Blockchain implementation & opportunity

Stakeholders				
SUPPLIERS	PARTNERS	VENDORS	CUSTOMERS	EMPLOYEES
Channels				
WEB	MOBILE	EMAIL	BROADCAST SYSTEMS	OTHER SYSTEMS
Vertical Domain Blockchain Apps/Modules				
SCM	FINANCIAL SERVICES	MEDIA	HEALTHCARE	AIRLINES
Foundational Services				
ADMINISTRATION SERVICES	TRANSACTIONAL SERVICES	SECURITY SERVICES	ENHANCED SERVICES	REGULATORY SERVICES
CA Services and Identity Management **Blockchain Foundation Platforms**				
ASSET INFORMATION		TRANSACTIONS/RECORDS OF ASSET TRANSFER	SMART CONTRACTS	

Enterprise Systems

- Network Governance
- Stakeholder On-boarding

- Dev/ Integration of Apps
- User experience

- Re-use/ Customize domain apps
- Dev/ Integration of Apps

- Create foundational services
- Smart Contracts

- Platform Selection
- Network Setup & configurations
- Operations

Fig: Logical Architecture of a Blockchain Implementation & Opportunity

VII. HCLTech's Blockchain engagements

- Engagement with America information management services company with Evidence lifecycle management, Art Tracker on Blockchain and Canada Insurance and Mortgage.
- Engagement with German software producer with its integrating supply chain control tower solution with a Blockchain. Initial use cases target to store conditions breaches based on sensor data and custodian information on Blockchain.
- Engagement with leading South African bank with Master Data Management using blockchain.
- Engagement with leading American biotechnology company with Blockchain based provider's consent management application.
- Engagement with leading American pharmaceutical company with PoC on Serialization of Medicines.
- Engagement with leading Netherland hospital and Health Care with PoC for Self-Sovereign Health Records for Hospital at Home cases.
- Engagement with leading clothing company with Retail Supply Chain.

- For an American Enterprise Information Management Company HCLTech created a Blockchain based evidence tracking system to bring end to end traceability of evidence through case's lifecycle & beyond.
- For a large Insurance Customer HCLTech created a Block chain-based KYC POC which is a decentralized digital identity platform brings individual, organizations, ID providers, credit bureaus, notaries etc. on same platform and verified identity can be shared with organizations.
- For a Global money transfer company HCLTech reorganized money transfer process based on Block chain platform. A blockchain network consisting of 3 nodes were setup. The existing money transfer (MT) platform was integrated with Blockchain service. When customers submit a Money transfer transaction, the MT platform triggered transactions inside Blockchain to provide real time visibility to external partners into their respective account balances, thus eliminating error-prone settlement and reconciliations.

VIII. Greenfield Vs Brownfield Blockchain implementations

Greenfield: A fresh stack blockchain based implementation for an existing processes like clearing & settlement or a new process such as Peer-to-peer lending. Old process & technology stack are not retained. This results in outright decentralization of existing ecosystem & efficiency gains.

v/s

Brownfield: Existing application infrastructure is Blockchain enabled. Possible options of brownfield implementation are full overlap of ledgers, partial overlap of ledgers and no overlap of ledgers. Decentralization, process change, and efficiency gains would be realized gradually.

IX. Use cases

Blockchain as transaction enabler

Peer to Peer trading between prosumers: In Shared Energy Economy setting where energy comes from DERs (Distributed Energy Resources), the energy can be sold and bought among the users (such as buildings producing excess power supplying to neighbouring buildings). These transactions can be handled on blockchain using smart contracts wherein the energy exchanged between the prosumers can be tracked, billed, and settled on the go.

Blockchain for operations

Maintenance data on Blockchain: The stakeholders such as Contractors, Utility company, Hardware suppliers which are involved in a maintenance during an outage can be made a part of blockchain network and the data generated by sensors on the poles can be shared with all for a quick response.

Blockchain for data dissemination

Smart & connected streetlights data on Blockchain: Data generated by sensors on smart streetlights can be fed to the blockchain of which Avista (Power Disruption), National weather service forecast office (Weather forecast), Fire Dept. (forest fires prediction), Police Dept. (Traffic disruption) are a part of quick data dissemination on near real time basis to all these stakeholders can help in many ways.

Blockchain Based Peer to Peer Trading and Handling of DERs

Blockchain process highlights: Decentralized system (end customers, energy consumers) in which enables prosumers to not only sell surplus energy to the grid rather to other consumers directly. Automatic settlement using smart contracts. Execute energy supply transactions in a seamless manner through Blockchain providing the basis for metering, billing, and clearing processes.

X. Implementation

Identifying the right type of Blockchain:

Before implementing the Blockchain technology in any supply chain network it is of utmost importance to identify the right type of Blockchain to be used depending on the visibility and access it needed to each block of information, across the network. There are three different types of Blockchain available right now. Private Blockchain (Hyperledger Fabric, Quorum) which are closed and only allow people to view or aces the block of information based on permissions. Public Blockchain (Ethereum, Bitcoin) networks are fully open, and anyone can form part of and participate in them. And the Consortium Blockchain (R3 Corda, We-Trade) which has the properties of both the type of Blockchain and kind of a hybrid in nature. To determine which type of Blockchain one should implement in one supply chain network a set of sequential questions should be asked and depending on the answers to those questions one Blockchain can be selected. The questions

are in line with who can view the information on the Blockchain and who can record information on the Blockchain. If the business where it's going to be implemented, demands only the owner or the group of the owner to view the information held in the Blockchain network then they should choose a private Blockchain which works as a permission-based shared digital edger preferably Hyperledger, Quorum, or maybe a hybrid one like R3 Corda. Now if the industry or specific supply chain needs anyone in the network to view the information inside, then it needs to find the answer to another layer of question. The second layer of the question says who can record or edit or access that information. If the answer of this part says only a select group of an owner or validated users can have access to edit then again private Blockchain with limited permission should be chosen otherwise a public Blockchain such as Ethereum, Bitcoin can be chosen which is a public or permission less shared digital ledger. The flow diagram will be looking like below:
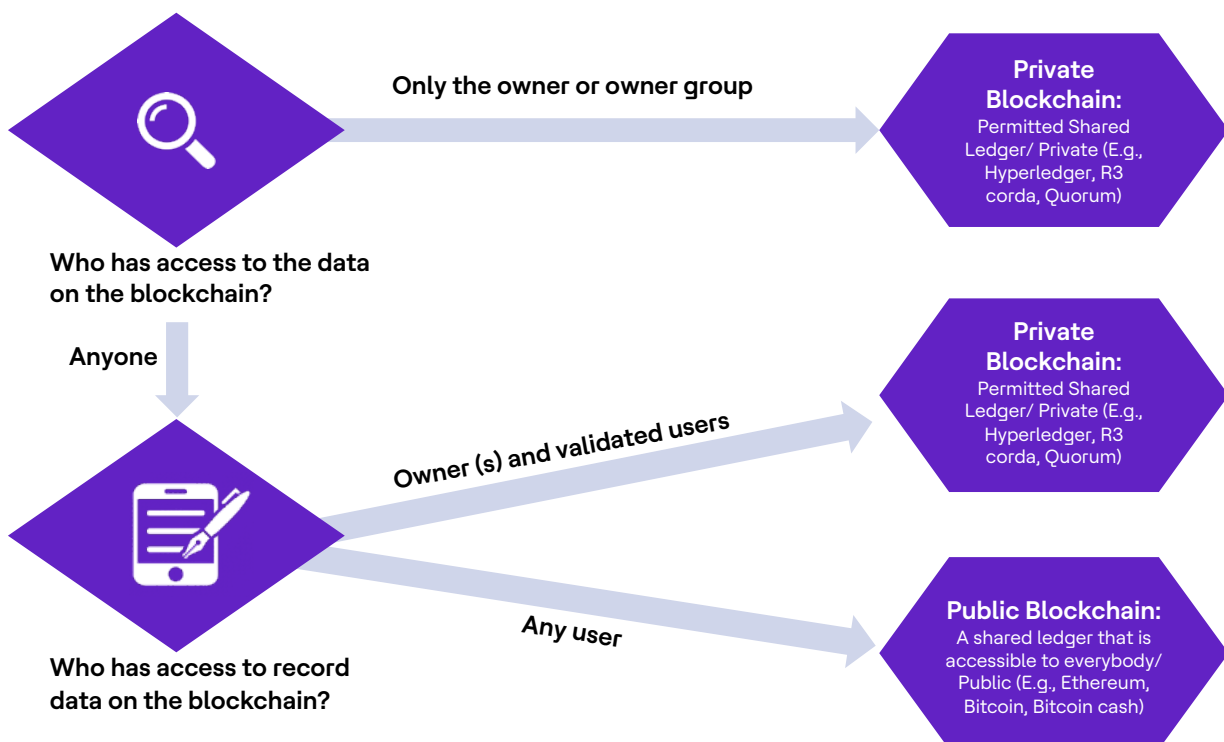

Fig: Flow diagram of the questions to determine the type of Blockchain to be implemented.
(Source: blockchaininstituteoftechnology.com)

Steps towards a successful Blockchain project implementation:

There is a possible framework that can be holistically followed to implement Blockchain as per the need of the identified supply chain. First, one needs to educate himself/herself before they initiate to implement Blockchain and transfer their knowledge to all the stakeholders so that they understand Blockchain, its benefits, and its limitations. It must be ensured that all the stakeholders know what Blockchain is, how it works, and how it will add value. Next is they need to identify whether the Blockchain solution is right for their business scenario, then comes the identification of the platform to be used, determination of the details of the implementations, and managing the framework, for that a dedicated team to be created is preferable. Then a Proof of Concept (POC) should be created where they should consider the type of Blockchain to be used and establish measurable goals so that they can measure and determine what success is. Once it is done, there should be a limited field trial of the PoC and then eventually to analyse the results of PoC to determine if a full-scale rollout is warranted. Finally, if it satisfies them, then only they should proceed with full development and full-scale rollout.

- Assess whether or not blockchain is appropriate for the situation.

Determine a blockchain use case

- Consider employing a private or permissioned blockchain for the proof-of-concept.
- Identify quantifiable objectives to measure success

Construct a Proof of Concept (PoC)

- Examine the findings of the PoC to decide whether a full deployment is necessary.

Educate Stakeholders and yourself
- Make sure that everyone involved in the project is aware of what blockchain is, how it works, and how it will provide value.
- Understand blockchain, its advantages and limits.

Create the team(s) that will develop and oversee the solution
- Decide the platform to be used
- Determine the implementation's specifics.

Create a small-scale field test of the PoC
- Define a time and geographic limit.
- Monitor and assess outcomes

If determined, carry out the entire development and deployment.
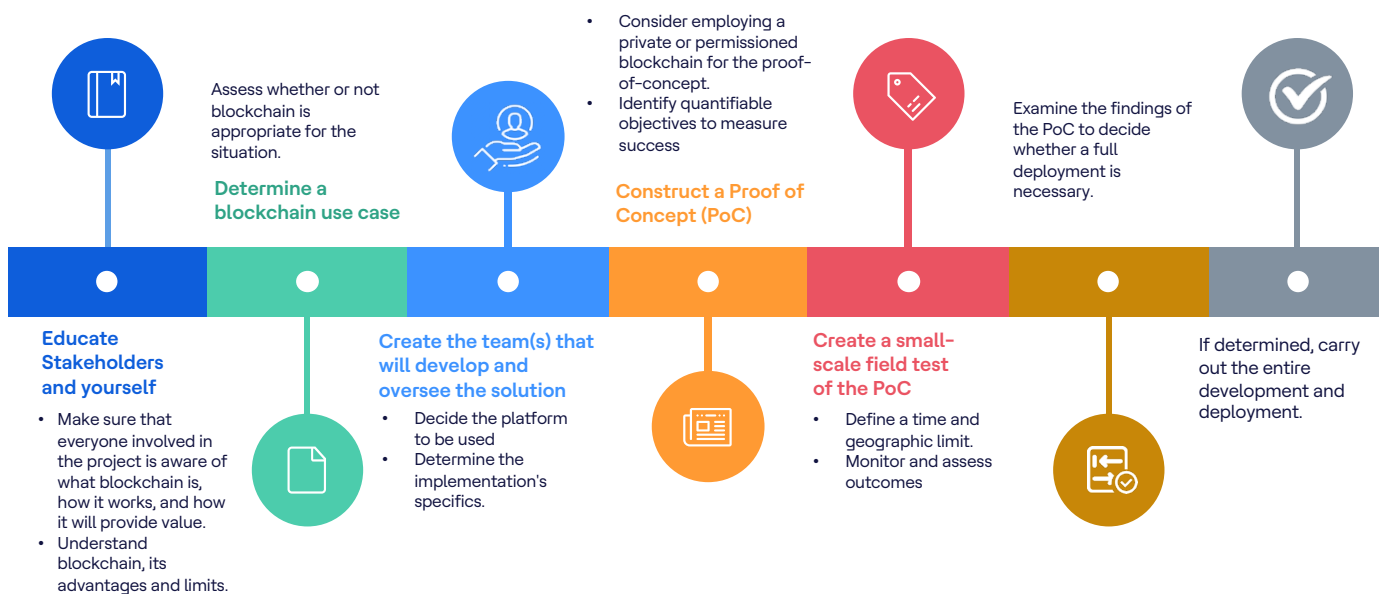
Fig: Steps of implementing Blockchain (Source: blockchaininstituteoftechnology.com)

XI. Limitations of using Blockchain

Blockchain in Transport Alliance (BiTA) which is founded in 2017 and which is the largest commercial Blockchain consortium in the world and includes 500 members in 25 countries, in association with industry big shots such as FedEx, UPS, BNSF, JD Logistics analysed the obstacles they would face owing to the incorporation of Blockchain technologies in the supply chain networks [8]. Blockchain provides the solution to numerous stumbling blocks, but it must get the better of the challenges mentioned below:

1. The global supply chains involve numbers of players and operate in a convoluted environment. So, getting a consensus of all stakeholders is a real challenge. To implement Blockchain as a technology taking confirmations and consensus of changing or inserting information in any node is a must.
2. Blockchain as a technology is immutable. Once there is a change in the network it is very difficult to revert to the original. The only way you can do modifications in a Blockchain-enabled network is to append a block of a new transaction without deleting the original one, which makes the implementation complex and data consumption gets increased rapidly as it keeps a copy of each transaction happened in the network.
3. It requires a significant extent of intense computerization to implement Blockchain to enhance supply chain performances. Due to economic limitations, few countries can't implement Blockchain on a wide scale; So, Blockchain as technology will never be leveraged to its full potential in global supply chains.
4. The dearth of Scalability is a concern in implementing Blockchain in the supply chain industry. Blockchain keeps track of every single transaction along the chain in a network and as a result, you end up with many datasets. So, Blockchain is one hand that ensures data security whereas, on the other hand, it raises a concern in the form of scalability.
5. Managing private keys without which implementing Blockchain would have been impossible is another real pain area for technology specialists. Blockchain uses cryptography to keep the track in a network who does what. So, these private keys are critical to keeping the safety and integrity of the Blockchain.
6. Blockchain as technology takes too much time to process which is another challenge that needs to be addressed. While there is a need to have a very fast centralized database where yosu can just make a change and those changes need to be reflected instantly when you are dealing with Blockchain, you have multiple copies of blocks and you have to wait until you get consensus from all the present nodes that have a copy of that Blockchain so as a result time to process can be far slower than a centralized database solution.

Stakeholders in any global supply chain spread across the globe, thus connecting them requires a significant effort across the globe, whereas in the case of small chain partners they build a large network of small partners in a global network. One of the major facts is, the turmoil caused due to shifting from a conventional cloud or centralized database solution to a Blockchain-based solution is challenging and needs to be handle with cautions and care and the effects of this in the network are implicit to these changes.

Authors

Tapobrata Banerjee
Associate Manager, HCLTech
Digital Business-SaaS-SCM Presales

Divyansh Sengar
Senior Management Trainee, HCLTech
Digital Business-SaaS-SCM Presales

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