Blockchain and Interconnection of Shipping Community Systems

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Introduction

- The advent of bitcoin in 2008 revolutionized the concept of money, transfer of value, and financial system. Throughout the years, this has captured the enthusiasm of futurist innovators and investors which saw boundless value in a peer-to-peer digital currency not subject to the control of entities such as governments, banks, or companies.
- The International Maritime Organization (IMO) and UNCTAD estimated that in 2016 approximately 90% of world trade was transported by sea.
- the reduction of supply chain barriers to international trade currently caused by inefficient business processes, could increase world trade by 15% and world GDP by 5% .

The merchant shipping industry

- Vessels are the industry's main assets and the international flags displayed on them allow shipping companies to choose their legal jurisdiction, indicating which tax and financial environment they are associated with.
- the shipping industry in cross-border transport networks, supporting global supply chains, and enabling international trade.

The ports environment

- “the interface between land or sea … providing facilities and services to merchant ships and their cargo, as well as the associated multimodal distribution and logistic activities.”
- Three entities that form the port environment, namely:

  the port, the port authority, and the terminal.
- Also provide storage facilities for goods bound for further transportation.

The maritime logistics system

- “the process of planning, implementing, and managing the movement of goods and information involved in the ocean carriage” .
- There are three main actors within maritime logistics:

  the shipping company, the port/terminal operator, and the freight forwarder.
- Customs authorities play an important role in the clearance of goods entering and leaving a country.
- The bill of lading (B/L), is issued by a shipping company to the shipper, confirming that the goods have been received. Therefore, it serves as a proof of receipt obliging the carrier to transport the goods to the consignee. it contains general information about the goods, the vessel, and the port of destination. Ultimately, it is considered a required export and import document by customs authorities

The Blockchain technology

- A blockchain contains a database, or ledger, in which all transactions are stored and recorded in a sequential manner. Furthermore, blockchain may be considered a “continually-growing digital register of transactions”.
- It consists of a linked sequence of blocks, holding timestamped transactions that are secured.
- Once an element is appended to the blockchain, it can not be altered.
- Each transaction is time-stamped and shared with the members of a peer-to-peer structured network.

System architecture

A blockchain system have been divided into three main sections, namely:

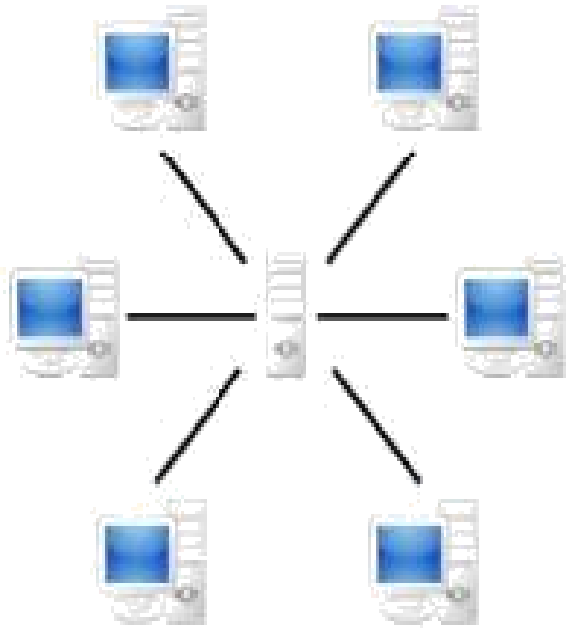
- *Decentralised database and digital assets*,
- *Peer-to-peer network*,
- *Public or private network.*

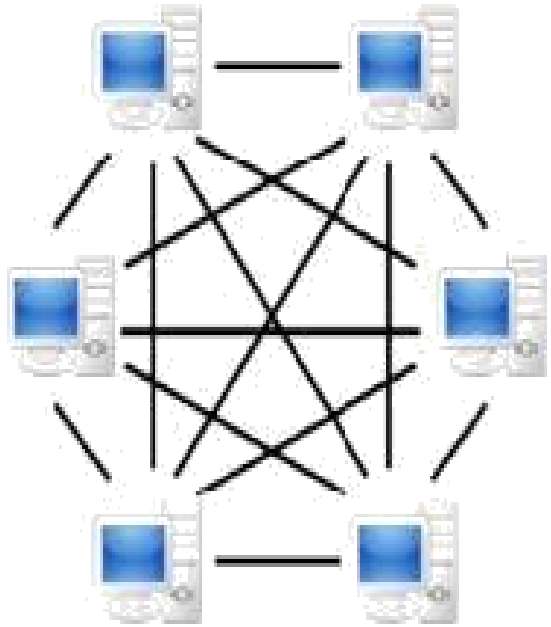
Decentralised database and digital assets

- The use of a decentralised database structure avoids the necessity of routing communication or sharing files through a centralised network or electronic platforms such as Google Drive, Facebook or Gmail.
- Decentralised and encrypted communication protocols, messages can be retrieved, stored and transferred at any time without the need of any form of intervention from trusted intermediaries or third parties.
- Decentralised database storage also enables both decentralised and secure manner of data exchange. Because of the distributed nature of blockchain, no single party controls the data or information stored.
- A blockchain frequently contains assets which are digitally represented. In the case of bitcoins they are not stored as digital files, such as mp3 files, but rather as transactions. Transactions include information of who sent the money and who received it, as well as the value transferred.

Peer-to-peer network

- The decentralised database of the blockchain is shared among the participants in a peer-to-peer (P2P) network.
- P2P differs from a traditional client-server model where resources are stored in a centralised server and only shared with the client upon request.





Public or Private networks

- Throughout the years since the invention of the bitcoin blockchain, two kinds of networks have been developed.

- Private or permissioned and public or permissionless “The two vary in the degree to which participants may access and contribute to data in the system”.
- **Public networks** are openly accessible to anyone who wishes to join and no restrictions on membership are present. Any data stored on a public network is visible to all network participants, in an encrypted form.
- **Private networks**, on the other hand, limit the users that can contribute to the system and view the data recorded. Private networks allow the operator of the network to restrict access to only trusted users.

Data encryption

- Within the context of digital security, data encryption is considered a fundamental technology.
- The **first technique**, simply known as *encryption*, is a one-to-one translation from one set of data to another. With this method, if data is encrypted with a mathematical formula it can be decrypted with knowledge of said formula.
- The **second technique**, known as *cryptographic hashing*, is used in a blockchain system. If a transaction is executed within the system, its contents are cryptographically hashed, meaning that the original data is condensed through a mathematical algorithm. Hence, with this encryption technique it is not possible to decrypt a hash within a blockchain.
- This is because a hash within a blockchain is merely a condensation of the original data.
- It is possible to use the hash to verify the full contents of a transaction.

Verification of transactions

To verify that a transaction has occurred and is valid a specific process will occur:

- **Firstly**, a blockchain user cryptographically hashes the record of a transaction.
- **Secondly**, this hash is transmitted throughout the peer-to-peer network as proof that a transaction has occurred or event has been logged.
- **Thirdly**, single nodes within the network receive the transmission, and once a certain number of them has agreed that a set of transactions is valid. Those transactions may be added as a block.
- **Furthermore**, future blocks can be added to form a chain where each consecutive block is linked with the previous one by building upon the information contained previously.

"This ensures that there is a continuity in the recorded history of transactions."

Three main security measures

- Three main security measures which may be used to verify transactions within a blockchain system:

- *Timestamping*,
- *Proof-of-work*,
- *Proof-of-stake.*

Timestamping

- *Timestamping* enables the blockchain to record the timing of when the transaction was created.
- When a node verifies a transaction, it checks it against timestamps of previous transactions.
- Timestamping serves as a link tying individual blocks together.
- Timestamp allows data stored in a blockchain to be placed chronologically by including a reference to the timestamp of the previous transaction, ultimately making a “chain” of transactions

Proof-of-work

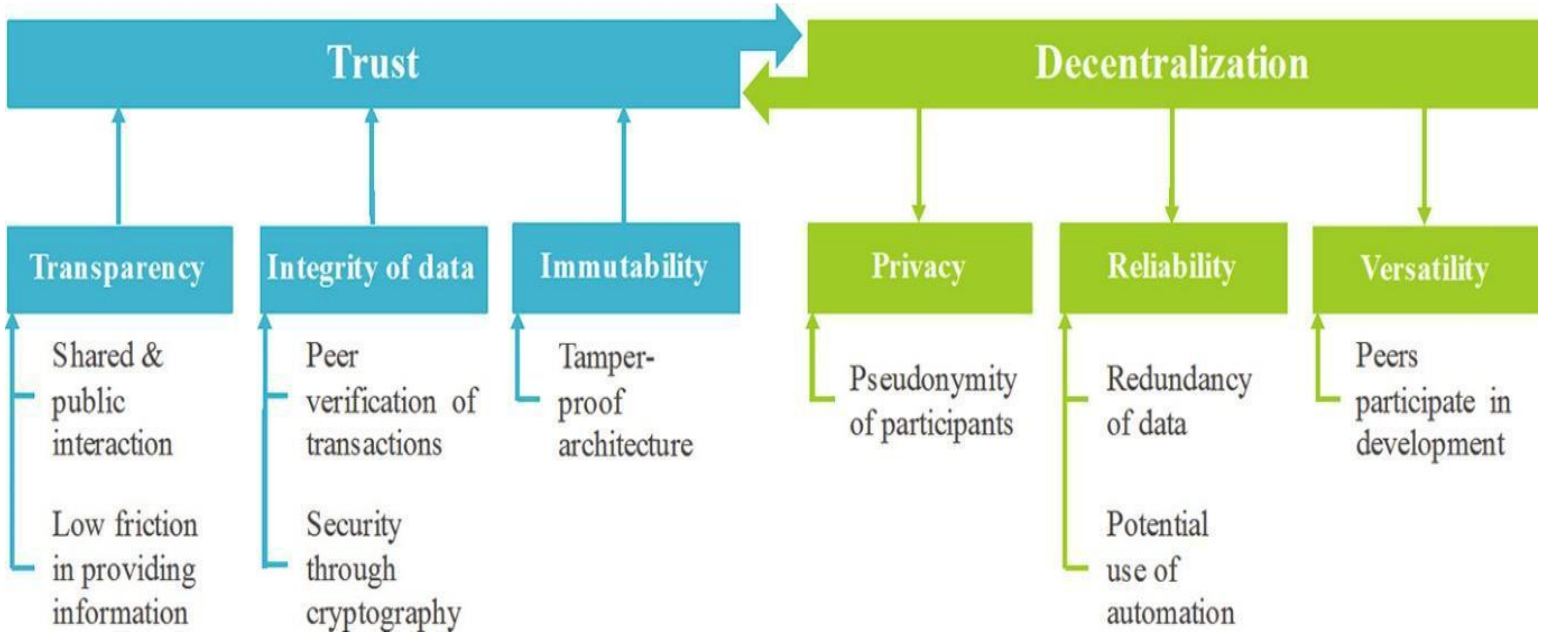
- Each transaction is broadcasted throughout the network so that a certain number of users may verify the legitimacy of the transactions.
- The blockchain makes use of a network security protocol known as '*proof-of-work*' (PoW) making it invulnerable to a Sybil attack.

Proof-of-stake

- Protocol known as '*proof-of-stake*' (PoS) was developed as an alternative to the PoW.
- PoS protocol in order to verify a transaction a user must own some of the assets on the blockchain.

Blockchain technology characteristics

- *Decentralised nature*
- *Trust enabling feature*



Blockchain in the shipping industry

- **Maersk** partnered with IBM to develop its own blockchain solution aimed at digitizing global trade.
- A team of Maersk IT specialists tracked a shipment of avocados and roses from East Africa to Europe. The project found that the shipment involved 30 organisations and over 200 interactions between them, this formed the basis for their blockchain project.
- A greater administrative costs and shipping times caused by the complexity of international trade, the maritime supply chain is also subject to fraud, especially in emerging markets, as well as being vulnerable to cyber attacks.
- World Economic Forum estimated that corrupt practices increase the cost of doing business up by 10%, consequently reducing foreign direct investments (FDI) in corrupt countries.

- A blockchain system has the ability to place shipping documents on a shared ledger which enables the parties involved in the transportation process such as the: exporter, importer, freight forwarder, carrier, port, and customs authority, to view the entire progress of the shipment.
- **South Korea** formed a government backed shipping and logistics consortium focusing on developing and testing blockchain solutions in order to strengthen its national shipping industry. The consortium consists of 15 members including shipping giant Hyundai Merchant Marine (HMM).
- HMM announced a successful pilot voyage to test blockchain technology along with other members of the consortium.
- In **Japan**, a similar consortium has been set up to develop and test a blockchain enabled data sharing platform among Japanese shipping giants Mitsui OSK Lines (MOL), Nippon Yusen Kaisha (NYK Line) and Kawasaki Kisen Kaisha (K Line), in addition to other Japanese trade related companies

- Another initiative was recently formed in **Singapore**, where shipping company Pacific International Lines, port operator PSA International, and IBM Singapore, signed a memorandum of understanding (MoU) expressing their intention to jointly develop blockchain-based network solutions, to reduce fraud and documentation errors.

Blockchain regulatory compliance

- The shipping industry is heavily regulated by both the EU and the International Maritime Organisation (IMO). In July 2016, the IMO implemented the Verified-Gross-Mass (VGM) regulation as part of the SOLAS convention (International Convention for the Life and Safety at Sea), requiring shippers to report a container's VGM.
- EU recently implemented the Monitoring, Reporting and Verification (MRV) protocol attempting to reduce the industry's massive carbon dioxide footprint. The protocol requires every major vessel entering a European port to report its emission in a standardised way.
- The opportunity to develop a blockchain-based solution to facilitate the compliance to the VGM and MRV data on a blockchain to be shared with the regulatory authorities.
- solution will enable all participants to interact on a common system regardless of their current legacy systems.

Blockchain in ports and government authorities

- **Danish Maritime Authority** is currently attempting to digitize its entire ship registration process and has recently launched a project looking at utilising blockchain to “help bring an open, secure and more efficient approach to the date recorded in the registers of shipping”.
- **The port of Antwerp**, together with the logistics technology start-up firm T-mining, is working on removing physical paperwork and improving operational efficiency, similarly to the IBM-Maersk initiative.
- **Malaysia Institute of Supply Chain Innovation** (MISI), together with Shanghai Jiaotong University, formed a joint research project developing a blockchain solution to improve the Less-than-container-load (LCL) market in China, an area faced by fragmentation, low level of information sharing, and frequent delays. MISI proposes three advantages blockchain may bring to the LCL market: build trust among the participants by improving the flow of information.

Cryptocurrency initiatives

- **Hong Kong** is aiming to remove the lack of contractual discipline between shippers and carriers with the launch of a cryptocurrency for the shipping industry called TEU.
- The cryptocurrency will serve as a deposit during the booking process for container shipping.
- The deposit is lost for the shipper if it does not show up with the cargo to ship, and similarly, lost to the container line if it fails to load the cargo according to what was previously booked and confirmed.

Blockchain relative advantage

- Information on the blockchain cannot be deleted and this is believed to have an impact within the industry, as now actors within the ecosystem could be held accountable if they provided wrong information, which is difficult with current practices.
- It is possible to create blockchain solutions which use well known programming languages such as JavaScript, instead of having to learn new languages, which is the case of the Ethereum blockchain.
- The immutability, transparency and decentralised aspect of the blockchain creates advantages for business processes in the shipping industry. World Economic Forum describes blockchain as a trust enabling technology.

Blockchain relative disadvantage

- The complexity related to the understanding of blockchain technology. At this stage, the technology is still considered relatively immature causing the creation of different definitions which are leading to misrepresentations and misunderstandings.
- The absence of regulatory frameworks for important aspects of a blockchain system might slow down the adoption of the technology. Since, authorities may impede companies from using blockchain-based solutions before these issues are successfully addressed.
- Moreover, the initial slow progress of the ISO in the creation of standards, blockchain standards are still not available.
- The common fundamentals between blockchain applications are still extremely unclear, eventually forcing legislators to abandon any attempts in creating legal frameworks for blockchain.

BC in Maritime Education and Training

Record tracking and accreditation

- Under-graduate, Certificates of competency, post-graduate studies refresher courses and specialization training programs as an informal education, in addition to internships, training and experience.

Resume Authentication

- BC would prove the elements of a CV prepared by the user, preventing the manipulation or alteration of data

Copyright and digital rights protection

- Intellectual work as the case of Google Scholar (GS) for the accreditation of the scientific production (publications)

Blockcerts

- Issuer or the institution that creates digital certificates.
- Certificates adjusted with the requirements of the Open Badges initiative of the Mozilla Foundation, which contain a wide range of statements about skills, achievements, or characteristics of the student, all recorded in a chain of blocks.
- Verifier, that is, someone who, without having to depend on the "distributor", verifies that the certificate has not been altered, and that it has been issued by a particular institution, and that it corresponds to a particular individual.
- Wallet of each student where they store their certificates by sharing them with others, for example, with employers.

Q & A !

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