Computer Science and Information Systems 19(3):1075–1092 https://doi.org/10.2298/CSIS210930032S

Blockchain-based Raw Material Shipping with PoC in Hyperledger Composer

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Abstract. In today's world, a lot of various kinds of raw materials are shipped from one place to another as per the requirement of industries. This shipping process involved many multiple levels with multiple personalities or authorities. The intermediates may be influenced by some illegal external factors and there may be some theft or modification in the raw material which is in the shipping process. This generates a significant loss if the material is of high cost. Presently, the advancements in information technology precede a method to restrict this loss and it is blockchain. Blockchain technology is an essential feature in enabling a comprehensive view of events back to origination. The shipping chain of raw materials that provides integrity and tamper resistance for raw materials in the shipping process is proposed in the manuscript. we have also provided proof of concept (PoC) in Hyperledger Composer with performance evaluation.

Keywords: Blockchain, SCRM, PoC, Hyperledger, Raw Material.

1. Introduction

Presently, the ever-growing industrial world needs a rapid consumption of various kinds of raw materials. In the shipping process, this raw material can be modified or partially theft or mixing can be possible at some level during the shipping process. Therefore, the digital evidence of such illegal activities is significant during the investigation. In the investigation process, the integrity and originality of the evidence are ensured throughout the life cycle of the investigations [3], [17]. The multilevel life cycle of shipping raw materials involved multiple personalities with multiple identities. If there is an unwanted activity with the raw materials during the shipping process by any of them due to some influencing personalities or factors then with the physical evidence it is difficult to identify the culprit. In such cases, digital evidence will play an important role, so, by completing the investigation process, this digital evidence must be secured.

The shipping chain of raw materials (SCRM) is defined as a process to maintain the integrity of raw materials and keep all the documentation of interaction or raw materials with different identities and their work with all history in digital form. SCRM plays an important role in Digital investigation, if requires, as it maintains all minute-by-minute records of events in digital documentation. Different kinds of raw materials pass through different hierarchies starting from mining or production to delivery and verification of receiving, and in this process, digital records are the important weapons to record the whole process. SCRM logs the information such as how, when and what digital evidence of events are recorded and preserved transparently. This evidence will be important in any kind of investigation if needed.

A system that guarantees the four facts like transparency [2], [6], authentication [23], [18], security [12], [1] and auditability [7], [14] for ensuring the integrity of recorded digital events in blockchain and it is achieved by SCRM. As per the Gartner Hype Cycle for Supply Chain Strategy, 2020, as shown in Figure 1 there are a healthy number of capabilities to the left of the peak, which reflects the many emerging capabilities that supply chain organizations are exploring. On the right are the capabilities that companies should be actively adopting at scale to optimize their performance. So, blockchain is also aligned to potentially fulfil critical and long-standing challenges presented across dynamic and complex global supply chains that traditionally have held centralized governance models. Current capabilities offered by blockchain solutions for supply chains include a loose portfolio of technologies and processes that spans middleware, database, verification, security, analytics, and contractual and identity management concepts. Blockchain is a linked representation of blocks and a block contains immutable information of the events. In this way, it generates a distributed system of linked representation. Using SCRM a real-time audit can be performed without bias and with accuracy.

In the case of shipping raw materials, there are three major concerns including document workflow management, financial processes, and device connectivity. These concerns are having a problem of adaption due to lack of trust, information security, miscommunication, different accounting system usage, and various digitized formats. With the different processes involved in the above-mentioned activities, there is a fair possibility of biasing unknowingly or knowingly which leads to a significant loss in the process of shipping raw materials. Besides, it is also difficult to track back the transactions in the traditional systems of shipping raw materials.

Therefore, to overcome the above-mentioned problem it is quite necessary to identify an automated solution which maintains all the artefacts during the whole shipping process. This record keeping should be secure, transparent and scalable and it is SCRM chain proposed in the paper.

The rest of the paper is written in different other sections including section 2 gives a brief idea about the process of shipping raw materials, tools required to generate blockchain, discussion of the feasibility test of blockchain for shipping raw materials. Section 3 provides motivation for the work. Section 4 presents the proposed shipping chain of raw material with PoC in Hyperledger Composer. Section 5 illustrates the performance analysis of the proposed blockchain framework. Section 6 gives the conclusion of the paper and at the end, a list of references is provided.

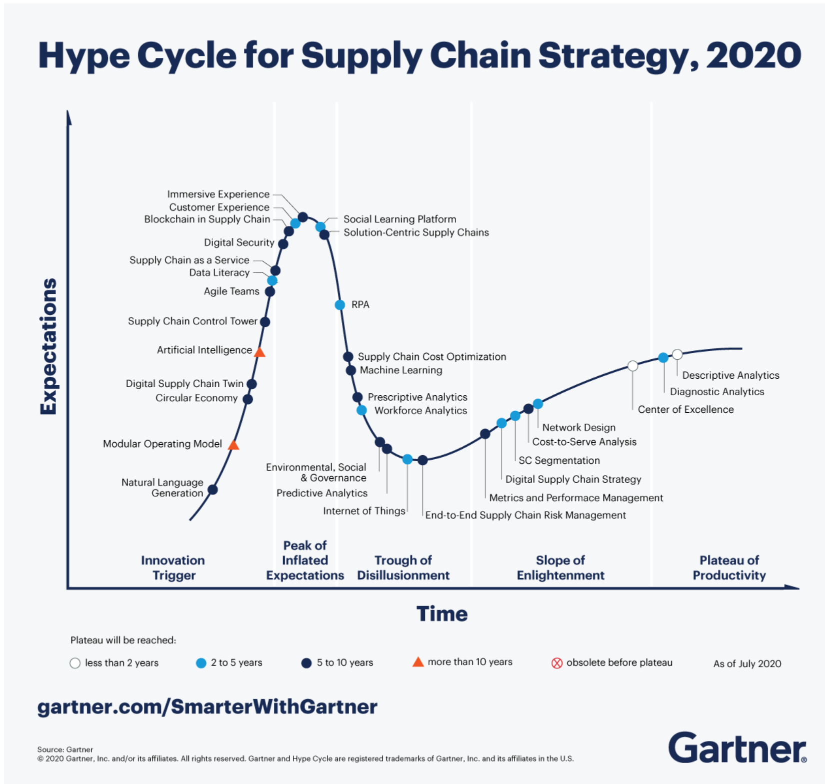

Fig. 1. Gartner Hype Cycle for Supply Chain Strategy, 2020

2. Shipping Process of Raw Materials

The shipping process includes many actors throughout the process like Importer, Exporter, Bank, Insurance Company, Freight Forwarder, Shipping Company, Customs House Agent (CHA), Customs Authorities, Port Authorities, and Intermodal Transport Providers. Information exchange happens when the raw material moves from one actor to another. In this case, willful illegal information exchange may lead to some morphing in raw material.
Therefore, a secure chain of information exchange has to be maintained and that has to be immutable and transparent to all the actors. In this paper, this chain is proposed by referring to SCRM. As SCRM is a blockchain-based chain and it has all the information exchange records in the form of blocks which are immutable, secure and transparent to all the actors involved in the process [9], [15]. In addition, all the digital records remain integrated in SCRM. Figure 2 depicts the detailed shipping process of raw materials starting from the origin to the destination after including all the actors involved in the whole process. Further, the shipping process is depicted in figure 3 in the form of SCRM, where recordkeeping of all the steps including identifying the raw material to reporting at different actors is displayed.

Hyperledger Composer [5] in an open blockchain application development environ-

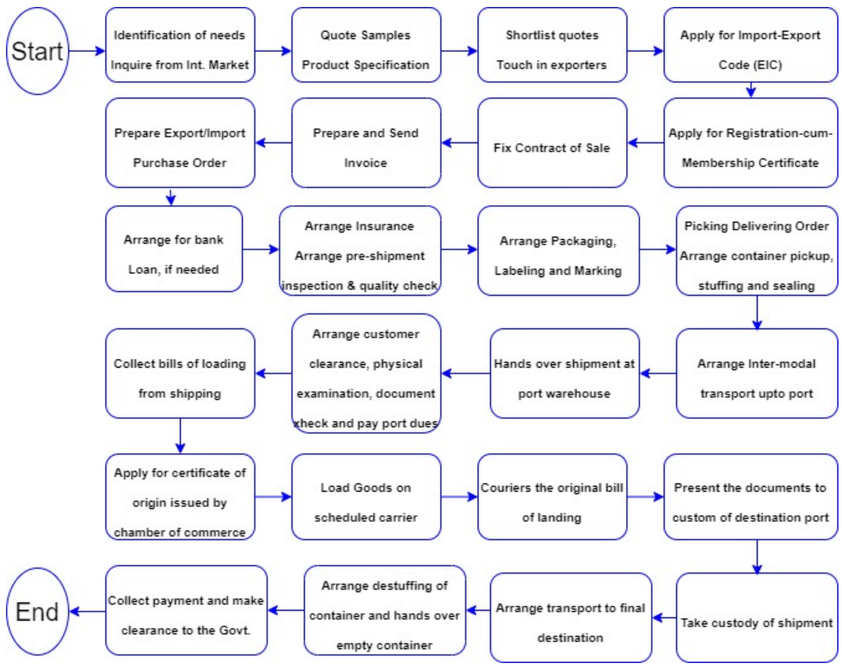

Fig. 2. Shipping Process

ment and toolset. It is used to develop blockchain applications rapidly. Integration of data with blockchain applications can also be done by the use of Hyperledger Composer. Blockchain business application networks contain assets, participants, and transactions across multiple blockchain networks that have to be recorded by the Hyperledger Composer. The transaction can be done by various stakeholders as per their roles such as buyers, sellers, and viewers in the blockchain. After doing registration of these parties in the blockchain they can do the transaction. Figure 4 shows a systematic framework of Hyperledger composer framework.

Hyperledger composer framework works in three layers [10]. In the first layer, the composer is used to create a business network definition comprised of the model, script ACL, and query files. The second layer packages up the business network definition and export it as an archive which is ready to deploy anywhere. Finally, the third layer uses ID cards to deploy business network definitions to a distributed ledger.

2.1. Tool for performance evaluation of blockchain

The performance of the blockchain is major concern before it is deployed anywhere and for this, it needs a tool. Here, we have used Hyperledger Caliper [8] to evaluate the performance of our proposed blockchain SCRM with predefined use cases. Hyperledger Caliper provides a number of reports for different performance indicators including time per transaction (tps), latency during transactions, utilization of a resource etc. On the basis of these reports, the suitability of the blockchain is decided as per the user's requirement.

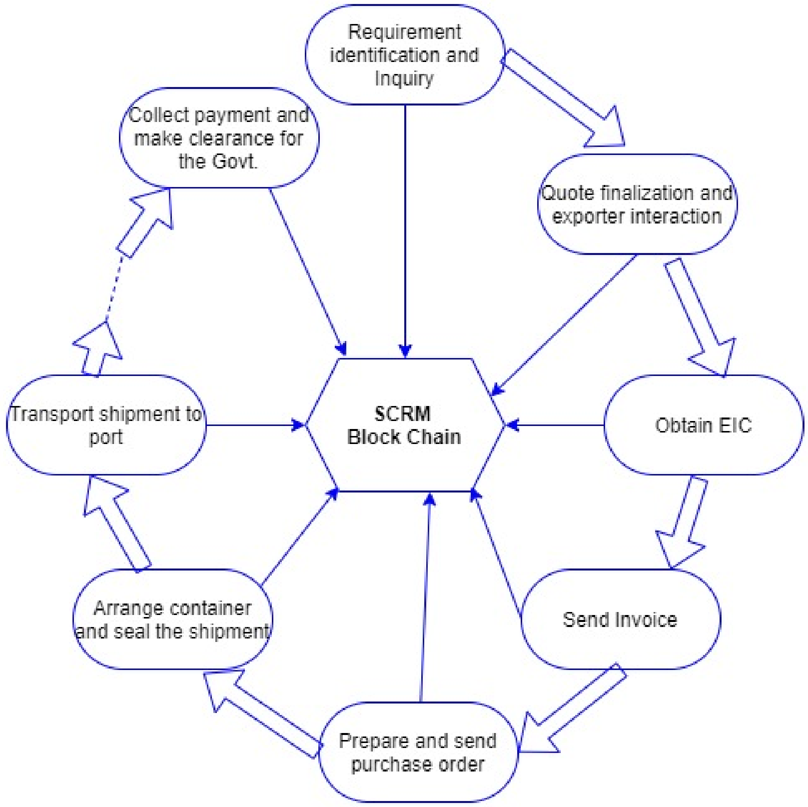

Fig. 3. Process model for SCRM blockchain for raw material shipment

2.2. Feasibility test of blockchain for shipping raw material

The feasibility of the blockchain solution can be decided on the basis of four facts given below-

- Is a shared database required to store the data and state of a transaction? If it is not then the blockchain solution is not feasible.
- Are there multiple users who want to write in the blockchain? If it is not then the blockchain solution is not feasible.
- Is there a high degree of trust among the users? If it is then the blockchain solution is not feasible.
- Is there a third Trusted Party (TTP)? If it is then the blockchain solution is not feasible.

Figure 5 depicts the flowchart for testing the feasibility study of our proposed blockchain i.e. SCRM. In raw material shipping, all these characteristics are satisfied and hence a blockchain solution is feasible.

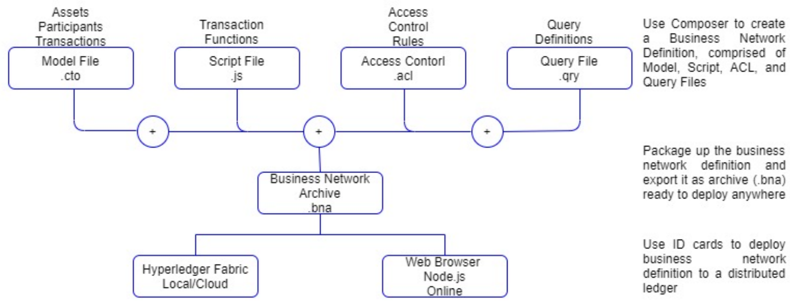

Fig. 4. Framework of Hyperledger Composer

3. Proposed Model

The selection of a blockchain development environment and toolset is an important step before implementing a blockchain application. There are two major options out of many other options that are blockchain implementation using the Ethereum network, and Hyperledger Fabric.

In the case of Ethereum, network anonymity is at the principal edge and in the Ethereum blockchain, anyone can do the transaction but there is no way to identify who has done it. This is not in our favour as we want to track back the history to know who is involved in a transaction. However, Hyperledger Composer is providing all the requirements to develop a blockchain-based application with all robust, transparent and secure records. Therefore, we opted to use Hyperledger Composer for implementing our proposed SCRM system. In the Hyperledger Composer, a functional flow of the SCRM is created as depicted in figure 6. In this, the whole functionality of SCRM is divided into four sections including participants, core modules, blockchain modules, and distributed storage.

Participants: They are the real stakeholders in the raw material shipping process. They can change the state of SCRM by doing transaction-related activities.
They are authorized persons in the SCRM for doing transactions and all the details of the transaction by any participant are recorded transparently, securely, and with integration in SCRM.

Core Modules: Core modules are responsible for managing the communication among participants and our proposed blockchain i.e. SCRM. A call of appropriate core module participants can get details of the transaction or submit a transaction.

Blockchain Module: In the case of the blockchain module there are P2P networks and consensus protocols to control the communication through the P2P network.

Distributed Transaction Store: It is the combination of distributed database and a module responsible for the authorization and authentication of participants. All the transaction details are distributed and stored in this module. When any participant wants the details they can get these details after authentication.

Front End: Front end is responsible to provide an interactive interface for participants to our proposed blockchain i.e. SCRM. This interface is created by using composer-REST-server and Yeoman Framework of Hyperledger Composer. Composer-REST-server

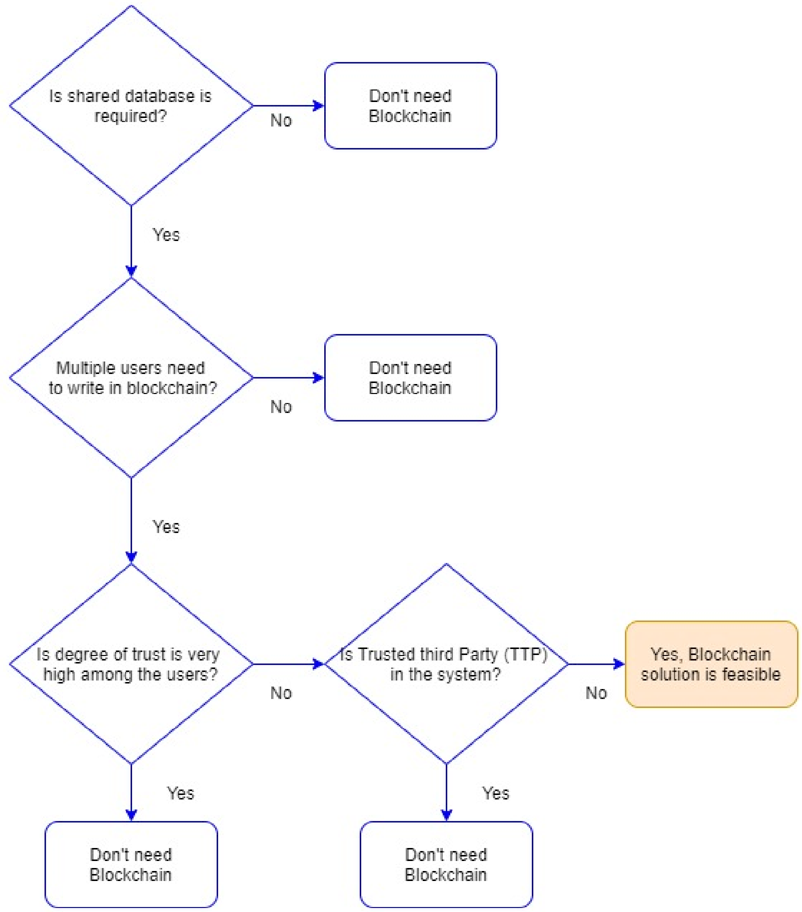

Fig. 5. Framework Flowchart for the feasibility of Blockchain

is responsible to generate the RESTful APIs for all the entities of the SCRM including assets, participants, and transitions. On the other hand, the Yeoman Framework is responsible to generate LoopBack Application. Figure 7 is depicted the Communication of the SCRM blockchain with participants through the front end.

3.1. Proof-of-Concepts

Assets, participants, and transactions are the major components to describe the blockchain applications [20], [4]. Instances of these components are stored in the blockchain. In the case of SCRM their components are described below.

Participants: Suppliers, Buyers, Manufacturers, Distributors, Transporters, Govt. authorities, and Customers are the significant participants of SCRM. Here, the administrator is not a modelled participant as it has only a Composer identity and will not invoke a transaction.

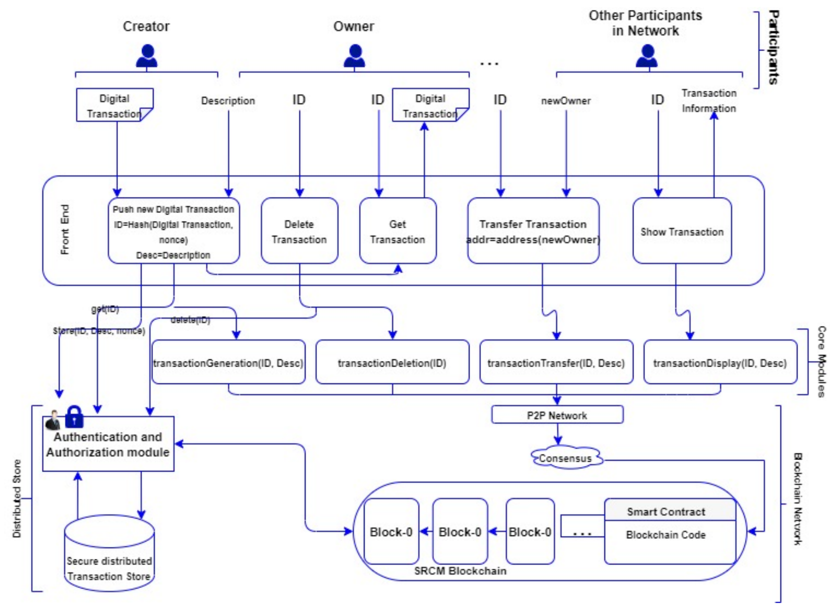

Fig. 6. Functional Flow of SCRM Blockchain

Assets: Any object having value can be an asset. These assets can be shared and transacted in the blockchain. In our case, raw materials, containers, warehouses, etc. are the tangible assets and workforce, securities, IPRs, or any referral documents are intangible assets. Specifically, the data records, used throughout the shipping process, are major assets which are used to track back the history. A model file is used to model the participants. New instances can be created and registered in the registry file. Identities of the participants are also recorded in the identity registry file. Who so ever participates is involved in any of the processes, a record of that task with the performer's identity has to be recorded by the organization of the blockchain consortium.

Transactions: Action on assets done by participants is known as a transaction. It can be in different forms like- the creation of transactions, updating a transaction, deletion of transactions, and transfer of a saved transaction on the network. A data structure is used to define an SCRM transaction as shown below:

```
struct transaction contains
string/bytes32 transactionID;
address creator;
address owner;
string transactionDescription;
unit caseID;
address transferChain[];
dateTime transferTime[];
//other possible options
```

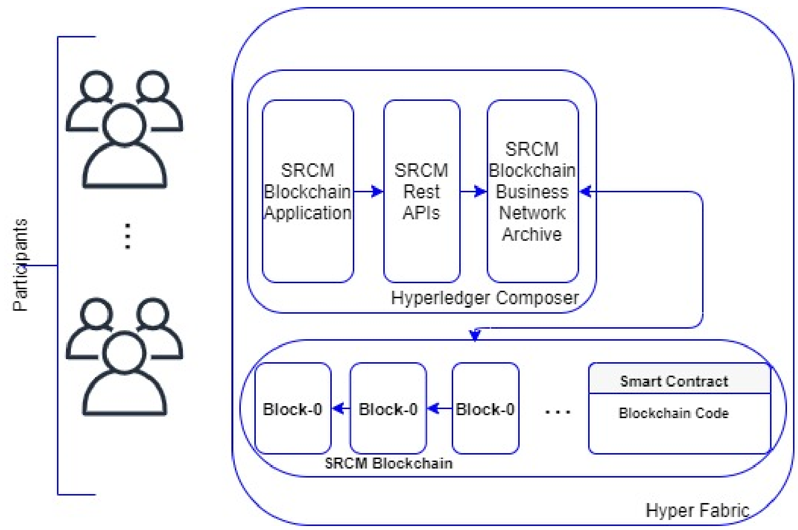

Fig. 7. Communication of SCRM blockchain with participants

3.2. Description of Terminology used

We have used different terminologies in the process and it is mentioned in the following table 1 along with its brief description.

Table 1. Terminology used

Terminology	Brief description
transactionID	It is a unique random number generated by SHA256 for every
digital transaction.	
creator	It is the participant who inserted the transaction in the first place.
owner	It is the participant who possesses the transaction presently.
transactionDescription	It contains the necessary attributes to define a transaction.
caseID	Unique number for material shipment to initialize the smart contract.
transferChain	It contains the address of the owner of the transaction and it is an array.
transferTime	It contains the date and time of the transaction and it is an array.

The SCRM model has essential functionalities including transaction creation, transaction update, transaction deletion, and transaction display from the blockchain. These functionalities are triggered by the participants of the SCRM. Rules to access a particular functionality by a particular participant are mentioned in permissions.acl file of SCRM blockchain of Hyperledger composer. Different classes are used in the implementation of the SCRM and their script segments are shown below:

```
Script Segment#1: Transaction class
Transaction class {
  "$class": \org.example.basic.Transaction", \ID":
        \0xPQRSTUVWXYZ",
  "creator": \resource : org.example.basic.
        Participants#9876",
  "owner": \resource : org.example.basic.
        Participants#9876",
  "Description": \Necessary information
        describe to transaction",
  "transferChain": [\resource : org.example.
        basic.Participants#9876"],
   "timeChain": [\2020-12-30 T15:03:756z"]
}
Script Segment#2: Participant class
Participant class {
  "$class": \org.example.basic.Participants",
  "ParticipantID": \9876",
  "firstName": \XYX",
  "lastName": \PQR"
}
Script Segment#3: Transaction Transfer class
Transaction Transfer class {
  "$class": \org.example.basic.TransactionTransfer",
  "ID": \resource : org.example.basic.
        Transaction#0xPQRSTUVWXYZ",
  "newOwner": \resource : org.example.basic.
        Participants#6789",
  "transactionID":
        \34c3456-c356-8634-b7d7-c78b56a56d98",
  "timestamp": \2020-12-30 T15:12:755z"
}
Script Segment#4:
Transaction state after several transfers
between participants class {
  "$class": \org.example.basic.Transaction",
  "ID": \0xPQRSTUVWXYZ",
  "creator": \resource : org.example.basic.
        Participants#9876",
  "owner": \resource : org.example.basic.
        Participants#9876",
  "Description": \Necessary information
        describe to transaction",
  "transferChain": [
      "resource : org.example.basic.Participants#9876",
      "resource : org.example.basic.Participants#8769",
      "resource : org.example.basic.Participants#7698",
      "resource : org.example.basic.Participants#6987",
      ],
  "timeChain": [
      "2020-12-30 T15:12:852z"
      "2020-12-30 T17:12:955z"
      "2020-12-30 T18:12:457z"
      "2020-12-30 T15:12:753z"
  ]
}
```

This permissoned SCRM blockchain is built on the Hyperledger Composer and runs under the controlled environment governed by the consortium.

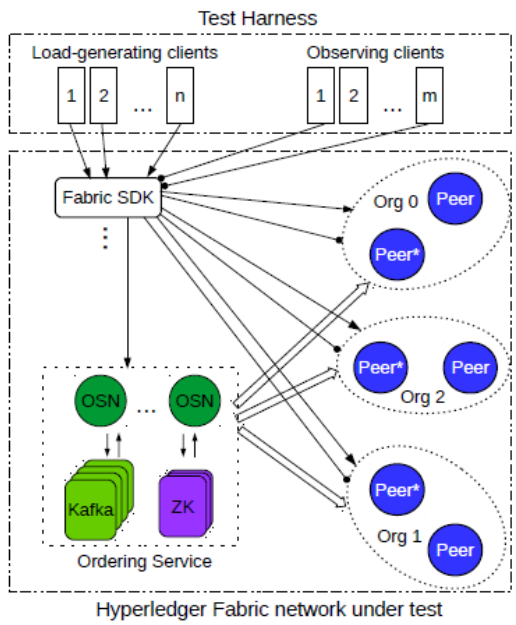

Fig. 8. Framework for Hyperledger Fabric VI performance evaluation [10]

4. Performance Evaluation

Due to the specific characteristics of the blockchain, necessary performance metrics has to be applicable to it. The central authority is not present in the blockchain and hence data or transaction is replicated for different peers of various organizations at different times. Instead of a single transaction, a block of transactions is committed after a consensus process [19], [11] and committed. The consensus process included all the blockchain nodes and until or unless a positive response is not achieved at least by two third of the nodes the transaction will not be committed. This process is dependent on the input traffic i.e. how many transactions are there in the queue for the commit and even on the hardware efficacy of the blockchain miner, therefore, it is uncertain to determine the commit time [13].

4.1. Experimental setup

Hyperledger Fabric VI blockchain setup is used to evaluate the performance of SCRM and it is depicted in figure 8. In this, the test harness is the collection of nodes of two categories including Load-generating clients and Observing clients. Load-generating clients are responsible to submit the transactional and Observing clients are responsible to do the queries to know the state of the transactions. We have used the Hyperledger Representational State Transfer (REST) interface to provide the connectivity of clients and blockchain. The performance parameter of the blockchain is given below.

4.2. Transaction Latency

It is the time period taken by the process of blockchain to commit the transaction from the time it is submitted [21]. As transactions are committed in blocks after consensus so, it is difficult to find out the transaction latency for an individual transaction. Therefore, average transaction latency has to be calculated for the blockchain network and it is defined as below-

$$AverageTransactionLatency = \\ (\sum TransactionLatency)/TotalCommittedTransactions \tag{1}$$

5. Transaction throughput

It is the rate at which valid transactions are committed in blockchain in a definite time interval [22] and it is given as below-

$$\frac{AverageTransactionthroughput= \\ TotalCommittedTransactions}{TotalTime@percentageofcommittedtransactions} \tag{2}$$

5.1. Scalability

Scalability if defined as how much total time is maintained for low transaction latency with an increased number of workloads [16].

There are many organizations involved to transport the raw material and so at a time, many participants from many organizations can be involved to submit the transactions to the SCRM blockchain. These submitted transactions completed the consensus process and finally has a state such as committed or failed which is depicted by figure 9.

We have used four scenarios to test the performance of SCRM, 1-organizations- 2-client-10 test rums, 2-organizations- 6-client-10 test rums, 3-organizations- 10-client-10 test rums, and 4-organizations- 24-client-10 test rums. The test runs are completed on Ubuntu 16.04 system including Intel(R) Core(TM) i5-7400 CPU @ 3.00GHz, 3000 Mhz, 4 Core(s), 4 Logical Processor(s), and 8GB RAM. We have considered multiple fabric networks and measured the performance of SCRM blockchain. Table 2 represents the different values achieved for average latency and throughput for all four scenarios.

Throughput increases when the block size is increased for the same type of network and this pattern remains the same for all the other different types of networks. Therefore, the behaviour of the SCRM is non-fluctuated wrt throughput and this is depicted in figure 10. For block size 5 the minimum average latency is 1.8 ms and maximum average latency is 51.77 ms and the throughput range is from 4 to 9 transactions for all four scenarios. Similarly, almost the same kinds of patterns are achieved for other remaining block sizes

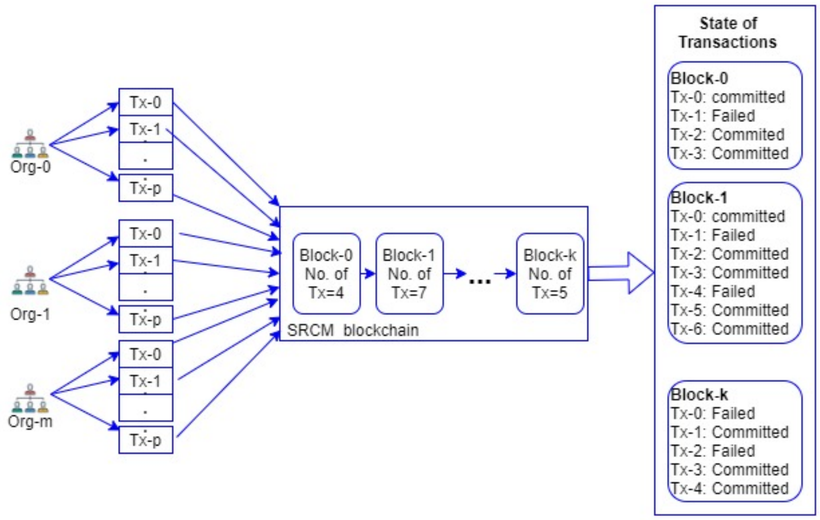

Fig. 9. Pictorial Representation of Performance Metric

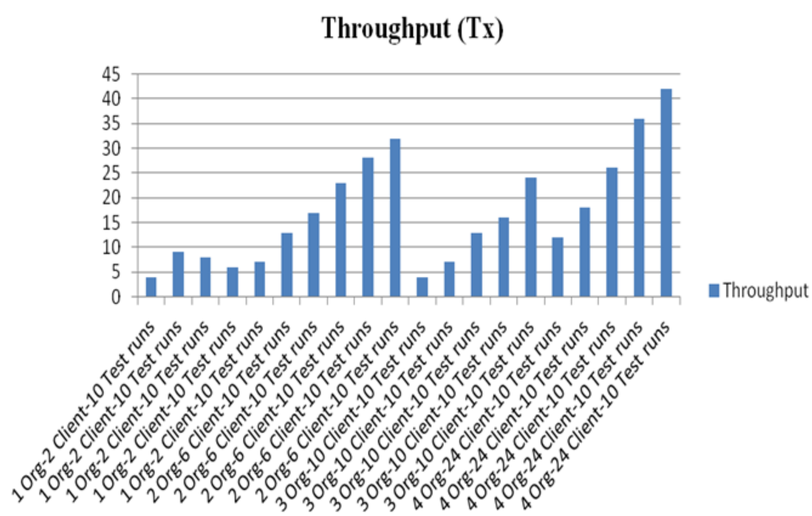

Fig. 10. Throughput for our all four scenarios

including 10, 15, 20, and 25 as depicted in figure 11. Therefore, block size up to 25 the SCRM is supporting the scalability perfectly. Average latency increases when the block size is increased for the same type of network and this pattern remains the same for all the other different types of networks. Therefore, the behaviour of the SCRM is non-fluctuated wrt of average latency and this is depicted in figure 12. We can infer from the results that the proposed SCRM solution is far better than the other traditional solutions like relational databases. In the relational database system, the transactions are not transparent

Table 2. Values achieved for average latency and throughput for all four scenarios

Terminology	Brief description				
Network Type	Block Size	Tx(tps)	Tx time	Avg Latency	Throughput
1 Org-2 Client-10 Test runs	5	8	40	1.8	4
2 Org-6 Client-10 Test runs	5	48	226	9.81	9
3 Org-10 Client-10 Test runs	5	176	365	35.68	8
4 Org-24 Client-10 Test runs	5	257	687	51.77	6
1 Org-2 Client-10 Test runs	10	3	33	0.39	7
2 Org-6 Client-10 Test runs	10	38	228	3.97	13
3 Org-10 Client-10 Test runs	10	187	379	19.19	17
4 Org-24 Client-10 Test runs	10	289	702	29.31	23
1 Org-2 Client-10 Test runs	15	9	58	0.76	28
2 Org-6 Client-10 Test runs	15	43	287	3.02	32
3 Org-10 Client-10 Test runs	15	165	366	11.45	4
4 Org-24 Client-10 Test runs	15	317	764	21.55	7
1 Org-2 Client-10 Test runs	20	7	54	0.48	13
2 Org-6 Client-10 Test runs	20	46	276	2.47	16
3 Org-10 Client-10 Test runs	20	199	403	10.44	24
4 Org-24 Client-10 Test runs	20	297	701	15.27	12
1 Org-2 Client-10 Test runs	25	11	65	0.61	18
2 Org-6 Client-10 Test runs	25	54	305	2.34	26
3 Org-10 Client-10 Test runs	25	178	376	7.59	36
4 Org-24 Client-10 Test runs	25	307	735	12.7	42

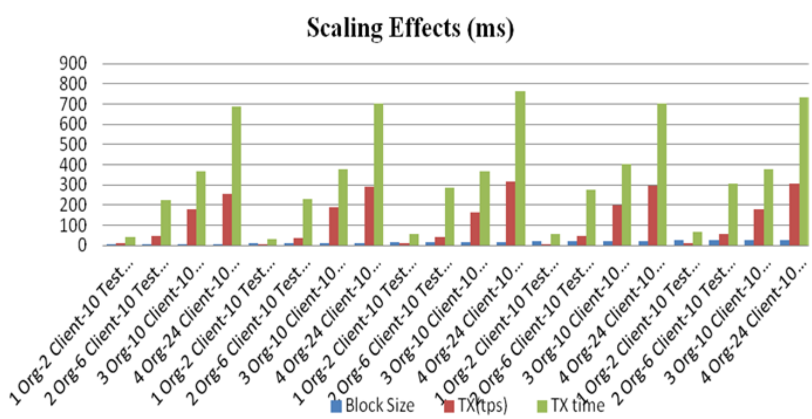

Fig. 11. Scaling effects for different block sizes

as they are under the control of the database administrator but in the case of blockchain the transaction is transparent to all the nodes of the blockchain once it is committed and no one can stop it. In the case of security, the database can be compromised by many means like SQL injection attacks but in the case of blockchain, it is next to impossible to breach the security as the key is almost unpredictable. In the case of scalability, the blockchain can be extended at any limit but the database can't be scaled after a limit as it has lots of consequences regarding efficiency due to exhaustive search space.

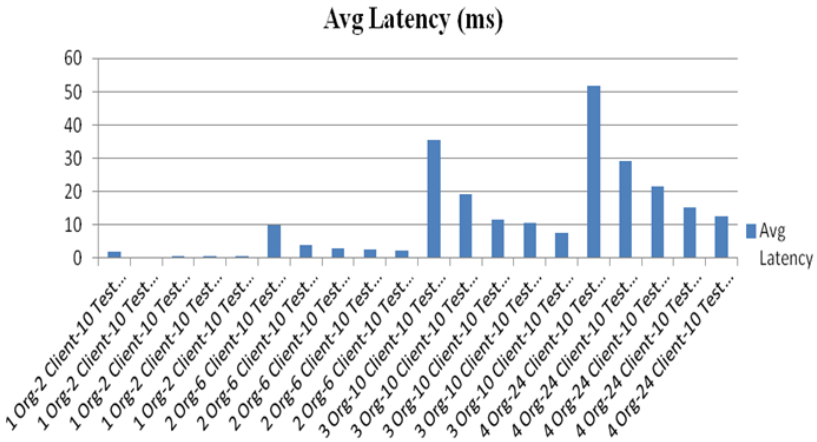

Fig. 12. Average latency for our four scenarios

6. Conclusion

SCRM chain has been proposed with a proof-of-concept for shipping raw materials. SCRM provides a secure, transparent, and integrated raw material delivery. It records all the transactions by various participants of different organizations transparently to all stakeholders. These records can be trackback if they need an investigation or if there is any fraud that occurred knowingly or unknowingly. A performance evaluation of SCRM is also provided by using the Hyperledger Caliper tool for different four types of modelled networks at different transactions per second. Scalability, Latency, and throughput behaviours for all four modelled networks are provided with that show acceptability of the SCRM. We hope it will be an important tool for automating the raw material shipping industry in future communication as well.

References

1. Abreu, P.W., Aparicio, M., Costa, C.J.: Blockchain technology in the auditing environment. In: 2018 13th Iberian Conference on Information Systems and Technologies (CISTI). pp. 1–6. IEEE (2018)
2. Akram, A., Bross, P.: Trust, privacy and transparency with blockhain technology in logistics. In: MCIS. p. 17 (2018)
3. van Baar, R.B., van Beek, H.M., Van Eijk, E.: Digital forensics as a service: A game changer. Digital Investigation 11, S54–S62 (2014)
4. Banerjee, A., Banerji, R., Berry, J., Duflo, E., Kannan, H., Mukerji, S., Shotland, M., Walton, M.: From proof of concept to scalable policies: Challenges and solutions, with an application. Journal of Economic Perspectives 31(4), 73–102 (2017)
5. Baset, S.A., Desrosiers, L., Gaur, N., Novotny, P., O'Dowd, A., Ramakrishna, V.: Hands-on blockchain with Hyperledger: building decentralized applications with Hyperledger Fabric and composer. Packt Publishing Ltd (2018)
6. Casino, F., Dasaklis, T.K., Patsakis, C.: A systematic literature review of blockchain-based applications: Current status, classification and open issues. Telematics and informatics 36, 55–81 (2019)

7. Casino, F., Politou, E., Alepis, E., Patsakis, C.: Immutability and decentralized storage: An analysis of emerging threats. IEEE Access 8, 4737–4744 (2019)
8. Choi, W., Hong, J.W.K.: Performance evaluation of ethereum private and testnet networks using hyperledger caliper. In: 2021 22nd Asia-Pacific Network Operations and Management Symposium (APNOMS). pp. 325–329. IEEE (2021)
9. Farnaghi, M., Mansourian, A.: Blockchain, an enabling technology for transparent and accountable decentralized public participatory gis. Cities 105, 102850 (2020)
10. Kinory, E., Smith, S.S., Church, K.S.: Exploring the playground: Blockchain prototype use cases with hyperledger composer. Journal of Emerging Technologies in Accounting 17(1), 77–88 (2020)
11. Lashkari, B., Musilek, P.: A comprehensive review of blockchain consensus mechanisms. IEEE Access 9, 43620–43652 (2021)
12. Liu, M., Wu, K., Xu, J.J.: How will blockchain technology impact auditing and accounting: Permissionless versus permissioned blockchain. Current Issues in auditing 13(2), A19–A29 (2019)
13. Messias, J., Alzayat, M., Chandrasekaran, B., Gummadi, K.P.: On blockchain commit times: An analysis of how miners choose bitcoin transactions. In: The Second International Workshop on Smart Data for Blockchain and Distributed Ledger (SDBD2020) (2020)
14. Namasudra, S., Deka, G.C., Johri, P., Hosseinpour, M., Gandomi, A.H.: The revolution of blockchain: State-of-the-art and research challenges. Archives of Computational Methods in Engineering 28(3), 1497–1515 (2021)
15. Naz, M., Al-zahrani, F.A., Khalid, R., Javaid, N., Qamar, A.M., Afzal, M.K., Shafiq, M.: A secure data sharing platform using blockchain and interplanetary file system. Sustainability 11(24), 7054 (2019)
16. Shahriar Hazari, S., Mahmoud, Q.H.: Improving transaction speed and scalability of blockchain systems via parallel proof of work. Future internet 12(8), 125 (2020)
17. Soltani, S., Seno, S.A.H.: A formal model for event reconstruction in digital forensic investigation. Digital Investigation 30, 148–160 (2019)
18. Taylor, P.J., Dargahi, T., Dehghantanha, A., Parizi, R.M., Choo, K.K.R.: A systematic literature review of blockchain cyber security. Digital Communications and Networks 6(2), 147–156 (2020)
19. Wang, W., Hoang, D.T., Hu, P., Xiong, Z., Niyato, D., Wang, P., Wen, Y., Kim, D.I.: A survey on consensus mechanisms and mining strategy management in blockchain networks. Ieee Access 7, 22328–22370 (2019)
20. Wang, Y., Zhang, C., Xiang, X., Zhao, Z., Li, W., Gong, X., Liu, B., Chen, K., Zou, W.: Revery: From proof-of-concept to exploitable. In: Proceedings of the 2018 ACM SIGSAC Conference on Computer and Communications Security. pp. 1914–1927 (2018)
21. Yasaweerasinghelage, R., Staples, M., Weber, I.: Using architectural modelling and simulation to predict latency of blockchain-based systems. School of Computer Science and Engineering, UNSW Australia, Tech. Rep 201704 (2017)
22. Yu, G., Wang, X., Yu, K., Ni, W., Zhang, J.A., Liu, R.P.: Survey: Sharding in blockchains. IEEE Access 8, 14155–14181 (2020)
23. Zhang, R., Xue, R., Liu, L.: Security and privacy on blockchain. ACM Computing Surveys (CSUR) 52(3), 1–34 (2019)

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Received: September 30, 2021; Accepted: April 01, 2022.