A Pragmatical Study on Blockchain Empowered Decentralized Application Development Platform

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A Pragmatical Study on Blockchain Empowered Decentralized Application Development Platforms

Samiur Khan
Computer Science
American International University-Bangladesh
Dhaka Bangladesh
samiurk70@gmail.com

Md.Al-Amin
Computer Science
American International University-Bangladesh
Dhaka Bangladesh
alamin@aiub.edu

Hrittik Hossain
Computer Science
American International University-Bangladesh
Dhaka Bangladesh
Hrik101762@gmail.com

Nawshad Noor
Computer Science
American International University-Bangladesh
Dhaka Bangladesh
reshad947@gmail.com

Md. Wahid Sadik
Computer Science
American International University-Bangladesh
Dhaka Bangladesh
wahidswapnil55@gmail.com

ABSTRACT

Blockchain has been a latest trend and many of its applications show promising results in terms of transactions, validations, finances etc. and recently it has become an apple of eye for the tech industry and investors. The concept of decentralized application (commonly known as dApp) and the blockchain platform itself can help to reform many unresolved solutions for the betterment of services and generate new opportunities for the developers to focus on creating applications in a decentralized environment with ease. The adaptation of blockchain technology through dApps is increasing drastically; thus opportunity for the developers and entrepreneurs are growing rapidly. Considering the impactful revolution of dApps, the developer communities are getting more interest to the dApps development tools, frameworks and platforms. This paper is presenting a comprehensive study on some popular blockchain powered decentralized or distributed dApp platforms. In this paper we made analysis of these platforms based on different factors and parameters. This analysis provides an impactful direction to the developer and enterprise community in adopting of the development platform.

CCS CONCEPTS

Information systems → Information systems applications → Computing platforms

KEYWORDS

Blockchain, Decentralized Application, dApps, Ethereum, Hyperledger Fabric, Corda, Development Platform.

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1 INTRODUCTION

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Traditionally software applications have been based on a centralized environment where the limitations were faced on a large scale as the technology evolved with bigger user base requiring higher scalability, new threats and hacking maneuvers that needed new security protocols and internal stability issues that would require backups and better recovery methods. With all these troubles at hand the companies started to adopt new methods and changes that would go out of the centralized environment and would venture forward toward something known as distributed and decentralized system. Practically a total conversion to this new environment would cause new problems so the companies did the smart thing to adopt the new features at a time to its required areas. New technologies started to emerge from this newly found environment among which

cryptosystem, distributed ledger, smart contract and blockchain are noteworthy. Regarding blockchain it was created for bitcoin's transaction ledger by Satoshi Nakamoto in 2008. Later on it was found that many of the features which blockchain provides can be of use to the current tech industry and it can help developers to create new types of decentralized applications commonly referred to as "dApps" [1]. Many Platforms started to show up providing decentralized and blockchain services that have seemed to attract many tech enterprises who are now investing and even developing their very own blockchain divisions to bring better solution to records, transactions, voting, property and cloud storages. With a platform based on such resourceful technology that is totally immutable can help to usher a new technological era for all the current enterprises that would benefit from its features and provide the developers with new ways of building applications.

2 TERMINOLOGY

2.1 Content Management System (CMS): It is a software application that aids to create, manage or modify digital content. Besides, any published content of a website can be added, edited or deleted by using this tool. CMS also has the responsibility to moderate various web contents and many companies depend on this very feature for overall maintenance of their websites. For the sake of documentation and asset management users are given the ability to use CMS as an alternate storage for such purpose. As such a term has been given to CMS by the professionals and it is called "Drivers" for its effective storage capability [11].

2.2 Blockchain as a Service (BAAS): It is such an extraordinary technology that utilizes the ideology of the Software as a Service (SAAS) infrastructure to maintain and host cloud services by means of providing the blockchain applications to its clients and subscribers as well as optimizing the resource allocations and service limitations that are often faced when a new or unskilled users first try to deal with the blockchain technology. This is a great innovation in the terminology of the blockchain applications where it tries to accommodate all its users in such an ecosystem where everyone gets a clear and authentic understanding of how to utilize the blockchain services and how its resources can bring about benefits in business and transactions [12].

2.3 Cryptocurrency: Cryptocurrency is a virtual mining currency that uses crypto-graphical functions to complete transactions in a decentralized system. The main difference between traditional currency and cryptocurrency is that cryptocurrency is decentralized. For cryptocurrency-based transactions blockchain is used to ensure transparency and security. Because of the decentralized nature cryptocurrency is not affected by government rules and regulations [13].

2.4 Serverless: It is one kind of software design pattern where third-party services are hosted. The developer eliminates the need for server software and hardware management. Applications are broken up into individual functions that can be invoked and scaled individually [15]

2.5 Function as a Service (FAAS): It is the concept of serverless computing via serverless architecture. This technology allows the developers to efficiently execute any sort of actions, deployment or business content. They are expected to start within milliseconds and process individual requests and then the process ends [15].

2.6 Decentralized Application (dApps): dApps are apps that have a decentralized nature. These are usually open source and autonomous. All its operations are cryptographically stored in public blockchains for all to see. A set of tokens are generated by following a set of algorithms and these tokens are needed to use the app and any contribution to the app rewards the contributor with these tokens. All changes made are done by majority vote. These apps have the potential to be vastly successful than even the most successful apps prevailing today due to their flexibility, transparency, resiliency etc. [16].

2.7 Smart Contracts: A smart contract is a computer protocol that allows credible transactions without the interference of third parties. In this process there is no need for a middleman, and thus there is no need to pay extra for the transactions. Smart contacts help us exchange money, properties, information in a transparent, hassle free, easy way without the need for any middleman. The best comparison is to a vending machine which gives us products directly [17].

3 DAPP INFRASTRUCTURE

3.1 P2P Network: The term P2P means "Peer to Peer" which is an abbreviation for a cluster of devices connected to each other by means of the internet and have the ability to share and access files between them. They can perform this transition task without the need of a centralized entity. Moreover, each and every device within the P2P network can act as a client and as well as a server. The prerequisite for using this network in a device is to have a program that can configure P2P and a working internet connection. After getting connected in the network all the users can access the files available on the other user's machine. This access is granted in only one specified folder which the user allowed to be shared in the network [18].

3.2 Distributed Data Ledger: A Distributed Ledger Technology (DLT) happens to be a digital system that records transaction of assets where the details of the transaction are recorded at the same time in multiple places (distributed ledger technology [19, 20]). A distributed ledger doesn't require any central database to operate unlike traditional databases and also no administrative permission is required in order to access it.

The verification process of every item in Digital Ledger is performed by means of nodes. Each of these nodes processes and verifies every item and generates a record for each item the respective node has processed and creates a consensus on those items. The security is ensured by means of cryptographic keys and signatures.

3.3 Blockchain: The Blockchain is a concept derived from distributed ledger technology. For easy understanding Blockchain is a growing list of records, where the records are called blocks and these blocks are linked with one another using cryptography. All these blocks are organized and chained together in and append only mode. It is managed by a peer-to-peer network just like the previously discussed DLT. The reason for its inalterability property is because for changing data in a specific block all the blocks preceding it has to be altered which is unachievable. The transactions stored in the blocks of the Blockchain system are encoded into a Merkle Tree also known as the hash tree. The mechanism of the Merkle Tree manages the hash algorithms and ensures that fraud data cannot enter in any block of the block chain [21].

3.4 Consensus Algorithm: The major parts of the blockchain system which fulfills the authenticity of the transactions and the cryptographic solutions that helps to increase the record chain all relies on some algorithm. The most notable properties that make the blockchain function properly rely on the algorithm. So, in short the Algorithm in Blockchain is the set of rules and mechanics that determines how the validation should take place and in which order the record chain should be supplied [22]. One of the most popular algorithms is the Consensus Algorithm and it is of two types: one is Proof of Work (POW) and another is Proof of Stake (POS) [22].

4 RELATED PLATFORMS

4.1 Ethereum

Overview: Ethereum was launched in July 2015 and it is by far the most successful open-ended decentralized software platform that can help to build Smart Contracts and Distributed Applications.

Context: The main scope of Ethereum is to facilitate a platform that can develop peer-to-peer contracts and distributed applications. One such extension of Ethereum is Hyderchain.[3].

Issue: All of the transaction histories like state of the balance, contracts and details are stored in a network of nodes and Ethereum relies on it. With number of transactions getting higher and requiring 10-12 seconds more for processing in new blocks causes scalability issues and also using proof of work needs higher energy consumption.

Solution: Sharding is a process that can be used in ethereum to not process all operations in every node but into the shards itself. As the shards are partitioned network segments having its own records and organized state.

4.2 Hyperledger Fabric

Overview: It is one of the most active and successful framework for the blockchain applications that has achieved the ability to evaluate business use cases. The origin of such framework came into being as an incubator Hyperledger projects that was mainly created by Digital Asset and IBM. It emerged as a successful project and came into full functioning state by March 2017.

Context: The traditional blockchain networks had its limitations of not being able to support the major components of a business featuring confidential contracts and private transactions. But this framework proved to be an alternative to that very problem as it is designed to be more scalable, secured, and modular. Most of the blockchain developers supports this framework as it happens to be open source and it has some of the most important featuring memberships that needs permissions, identity verification of every participant in the private network, monitoring activity of all participants, better network scalability and keeping the number of trust levels low [4].

Issue: Some people argue that Hyperledger fabric is not totally public. The consensus algorithm used in Hyperledger fabric is not as secure as proof of work. Also there is no system for tokens like we see in other cryptocurrencies like bitcoin incentivize the miners to keep the network secure. Some critiques also say that there are no real immutability without proof of work [39].

Solution: Transactions in Hyperledger happens only between trusted participants so there is no reason for full transparency. All the users of the network are verified beforehand so there is no need for expensive algorithm such as POW. No anonymous transactions happen between the users so generating token to incentivize miners is not necessary. Hyperledger fabric is tamper evident which gives the chance to take corrective measures if some tampering is done during the transactions.

4.3 R3 Corda

Overview: This is an open source distributed ledger created by a blockchain software firm called R3. It was founded by David E Rutter who made the R3 blockchain consortium back in 2014 [5].

Context: The firm developed this project for making it easier to solve the similar problems of companies. One of the sole reasons for developing this platform was to manage, synchronize and record business contracts and financial agreements between different enterprises and also to bring about a change to the already existing and unreliable independent systems that was in charge of storing all the essential contracts [5].

Issue: Higher rate of cost consumption for different services and also issues resolving around its design pattern has been acknowledged by many experts. It doesn't generate any cryptocurrency and uses Ripple XRP as an alternative.

Solution: Adopting optimal methods in order to overcome the lacking in terms of cost rates and maintenance of services. As a large number of its clients include banks, a better DLT integration seems much more favorable.

4.4 IBM Blockchain Platform

Overview: The world famous mega corporation IBM has been engaged in one of their own platform that would provide solutions for all sorts of business and transactions in the current market by ensuring a perfectly functioning public blockchain network and in order to create such a decentralized network by themselves and they have been hard at work for some time now.
Context: IBM Blockchain platform is a platform that provides BAAS that allows deploying it at the user's desired environment. It is developed by the famous company IBM computers. It's a platform that is fully integrated enterprise-ready blockchain performed which is designed to help to accelerate the development, governance and operation of a multi-institution business network. There are basically two ways IBM supports building blockchains for business. One is developer side another is Hyperledger side which is open source blockchain for business. Developer can use IBM for blockchain platforms, food trust, identity, trade finance, worldwide payments, etc. IBM discloses its "Blockchain as a service" today. It is based on the open source Hyperledger Fabric, version 1.0 from The Linux Foundation. Public can use IBM blockchain to build secure blockchain networks because it's a public cloud service. It is a business ready platform which addresses the full lifecycle of a multi-organization blockchain network [14]
Issue: External CA configuration is not supported. Sometimes another issue happens is that chaincode containers can be stopped unexpectedly.
Solution: Generating and uploading admin certificated through the network monitor works. If the chaincode suddenly stops then retrying the installation can help to solve the problem.

4.5 Quorum

Overview: This is Ethereum based distributed ledger technology which was mainly built on Go Ethereum.
Context: It has been developed for the sole purpose of monitoring and handling all sorts of financial use cases. It is configured to be permissioned and won't be accessible to anyone outside the permitted authority and also manages to ensure security via a protocol called Constellation, which is a mechanism that includes and enclave that takes part in encrypting data in communications and storing of transactions and also most of the cryptography [7].
Issue: Problems occur in case of geographical data networks and cannot interact with public blockchain unlike Ethereum.
Solution: Oracle services can be used in order to access outside networks, whether it be public or private to gain information and retrieve resources within the Quorum Blockchain network.

4.6 BigchainDB

Overview: Big-Chain DB has blockchain and as well as database properties. It was released on February, 2016. There is also a version 2 available. BigchainDB also implemented Byzantine Fault Tolerant (BFT). This means that a third of its nodes can fail but the system will still continue to function.
Context: It is a database which is based on scalable blockchain. It is modeled to integrate the better of two worlds. One is the distributed database world and the another one is traditional blockchain world. BigchainDB is completing to decentralized storage, processing and communication building blocks. People can use it side by side with higher level decentralized computing platform and applications [8**].**
Issue: BigchainDB nodes connect to a single rethinkDB cluster which if hacked or goes down can hamper the ability of other nodes to work because they don't have their personalized data storage. It is also a private blockchain so it does not go through the rigorous real life test that other public blockchains have to go through.
Solution: One solution could be to have separate storage for all the nodes so that they can work independently and does not have to rely on the rethinkDB node.

4.7 OpenChain

Overview: Openchain is an open source ledger technology developed by coinprism. It provides organizations a way to manage digital assets in a robust, secured and scalable way.
Context: OpenChain is a ledger technology which is distributed and is an open source. It is used for the organizations. The digital assets in a robust, secure and scalable way are managed and issued for the organizations wishing. A central server isn't used by it. It can work with the decentralized servers. Sometimes nodes and master nodes are referred by it [10].
Issue: In Openchain the transactions are done through centralized validation. So if for some reason the centralized validation system is down then there is no way to know what people might do. They can do anything since there is no validation which happens to be a major issue.
Solution: In bitcoin or other decentralized validation based blockchains miners can come and go but the validation technique always stands because of its decentralized nature. The solution for this issue is to keep the immutable aspects as they are.

5 THEORETICAL COMPARISON

Table 1 is holding the primary overview and the key comparisons of different platforms based on some key attribute.

Table 1. Overview and theoretical comparison

Platform	Source	Decentralization	Ease of Development	Maintenance
Ethereum	It is an open source platform [2].	It is a decentralized software platform [2].	Built a new crypto technology based framework [2].	It doesn't require any central authority to maintain [2].
AWS lambda	An open source platform where people can run any type of code [27].	It is a decentralized application [27].	Developed with the open source Hyperledger fabric that supports better tools for the developers [27].	Maintaining by the preventive monitoring [27].
Microsoft Azure	It is a computing platform [28].	It is the first decentralized infrastructure application [28].	It can be developed for building, testing and managing [28].	The system is governed by Microsoft without even involving internal staff [28].
IBM Blockchain	It is a platform that is fully integrated enterprise-ready blockchain [6].	It is a decentralized energy web application [6].	Develop with the open source Hyperledger fabric [6].	Maintaining by the preventive monitoring [6].
Hyperledger Fabric	This framework happens to be open source [4].	Its eco system allows it to be centralized and also function in decentralized environment as well [4].	It is preferred as it offers memberships that need permissions, identity verification of every participant in the private network, monitoring activity of all participants, better network scalability and keeping the number of trust levels low [4].	It needs a central authority to check and verify all sorts of components that are functioning within its module [4].
Quorum	It is an open source Ethereum based Blockchain platform [7].	It is a decentralized [7].	It acts on an overall decentralized environment [7].	There are many protocols that are followed within the network in order to keep verification of the nodes [7].
R3 Corda	This is an open source distributed ledger created by a blockchain software firm called R3 [29].	It is a decentralized ledger platform and also control of governance exists within its blockchain [29].	Its modularity allows existing databases to be integrated into the corda network and creates better scalability options for the developers in general [29].	Most of the major maintenance functionalities in corda include looking over of the transactions, crypto assets and node security [29].
Openchain	Most of the blockchain developers supports this framework as it happens to be open source [10].	It is a decentralized and public application [10].	Can be developed to manage the digital assets [10].	Maintenance of the Openchain Conformance Questionnaire [10].
BigChainDB	It is a database scalable blockchain platform [25].	It is a decentralized application [25].	Develop the assets with fast and flexible querying [25].	Because of the opened source code it can reach maturity as a stable [25].

We summarize the consensus algorithms of current platforms and put it on the Consensus Evaluation table 2 for better understanding. Here is the summary of Consensus Evaluation of current platforms which is given below in the consensus evaluation table 2. This table is a further extension of table 1.

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Table 2. Consensus Mechanism Evaluation

Platform	Type of BlockChain	POW	POS	BFT	Other
Ethereum	Public and Smart Contract based	Ethash	Not used	Not used	Kafka, RBFT, PoET, Pluggable.
Hyperledger Fabric	Both Private and Public	Not used	Not used	Sumeragi	Kafka, RBFT, P

R3 Corda	Private	Not used	Not used	Not used	State Validity & State Uniqueness
Openchain	Private	Not used	Not used	Not used	Partionned Consensus
BigchainDB	Private/Permisson	Not used	Not used	Tendermint	None
Bitcoin	Public	Yes	Not used	Not used	Not used
Quorum	Private	Not used	Not used	Istanbul	Raft-based Consensus & Clique POA Consensus, Pluggable

6 MARKETSHARE REVIEW

This table contains the currency name and the coin market capita for different platforms. Here R3 Corda uses Ripple currency and Hyperledger has no currency yet and also has no record of any Coin market capita.

Table 3. Market Rating

Platform	R3 Corda	Hyperledger	Quorum	Ethereum	Ripple
Currency	Use Ripple XRP	By using Chaincordes it can be make [39].	Use ether	Ether	Ripple XRP [40].
Coin Market capita	$16,874,729,951	Not declared	$33,343,121,274	$33,343,121,274	$16,874,729,951

7 SECURITY & SCALABILITY ANALYSIS

This table is overall overview of the security and scalability of the platforms.

Table 4. Security and Scalability Analysis

Platform	Security	Scalability
Ethereum	It is more secure than we might think and all transactions must go through the main network and its base infrastructure provides secured options.	Scalable options have already been identified as the network itself happens to be expanding with the real world use cases being emerged [2].
Hyperledger Fabric	It is a permissioned system with great identity management [4]..	It has great transaction rate which is 3500+ tps .
R3 Corda	It uses decentralized database where nodes are designed to not trusted easily. They crossed check every work to reach consensus at the groups.	Here nodes can see only few transactions. In general throughput is count from the slowest node. Nodes of Corda can see only fraction of transaction for this it can do more transactions [29].
Openchain	It supports multiple levels of control which influences the administrator to look over the ledger and also there is a hierarchical system for accounts which sets permission for every level [10].	The clients who use this service can have high number of transactions take place within their network since the chain can be expanded at will of the client and admin to sustain high traffic [10].
BigChainDB	It use Inter Planetary database which is running like public database but there are lacks of transparency [25].	It is much scalable because it has unified the traditional database world to the traditional blockchain world [26].

8 SIGNIFICANCE & EFFECTIVENESS

All these platforms in a nutshell have its financial significance measured in terms of the blockchain market growth according to surveys done regarding this issue [31]. Companies like Netflix, Microsoft, Hulu and Amazon are proceeding to put forward to create decentralized system for their services using some of the previously mentioned platform and one of the core reason for using these platforms are the increase in revenue by means of respective cryptocurrencies [30]. Besides the current

applications of this platform in the networking and transaction sector of the tech corporations. A lot of efforts and investments are being made on its future applications and some of these are described as follows:

8.1 BMS: A Blockchain Management System short for BMS is similar to CMS platform like Drupal or WordPress. It mainly focuses on interface of blockchain similar to the CMS perspective of content manipulation. bPanel is one the unique BMS that will try to reinvent the same thing that CMS did with centralized databases but it will be for the decentralized databases [36].

8.2 IOT: Centralized solutions for IOT (Internet of Things) is not fruitful for its longevity as in future it has been estimated that over 1million devices will be over the IOT network within 2025. So a better approach would be to move towards the distributed model as it would increase the scalability, autonomy, security and affordability [37].

8.3 Decentralized Voting: Already the first world countries have been researching on voting based on blockchain in order to counter the vote scheming. A decentralized process of voting can help the voters keep their record in respective storage [38].

9 CHALLENGES & SHORTCOMINGS

By reviewing all the platforms, this are the parameters by which one can easily judge a platform. And also can understand the challenges that need to be overcome for betterment.

Table 5. Challenges and Shortcomings

Platform	Memory Size	Node Complication	Miners	Smart Contract	Transactions per second
Ethereum	Not applicable	Yes	Yes	Yes	15 (Not good)
AWS lambda	Between 128 MB to 3 GB [23]	Undefined	Yes	Yes	1000 (Average) [23]
Microsoft Azure	Up to 14GB [28]	Yes	Yes	Yes	10 (Worst) [28]
IBM Blockchain	Not applicable	Undefined	No	Yes	1000+ (Average)
Hyperledger Fabric	Not applicable	Undefined	No	Yes	3500+ (Good)
Quorum	Not applicable	Yes	Yes	Yes	175 to 180 (Weak)
R3 Corda	Not applicable	Undefined	No	Yes	1678 to 600 (Need to improve)
Openchain	Not applicable	Undefined	No miners [10].	Yes	1000 (Average)
BigchainDB	Not applicable	For InterPlanetary Database (IPDB) [25]	No	Yes	636 (Main problem for this) [25]

10 ADAPTABILITY TO DEVELOPER REQUIREMENTS

10.1 CMS Integration: It is a software application that aids create, manage or modify digital content. Besides, it makes management of contents easier for web applications. CMS also has the responsibility to moderate various web contents and many companies depend on this very feature for overall maintenance of their websites. For the sake of documentation and asset management users are given the ability to use CMS as an alternate storage for such purpose. As such a term has been given to CMS by the Professionals and it is called "Drivers" for its effective storage capability [15]. Popular CMS like Drupal, Wordpress, Magnetom, Joomla has already been focusing on blockchain based content implementation where they can manage digital rights, validating news, improve fast-checking, countering disinformation etc [11].

10.2 Support for FAAS: FAAS is the concept of serverless computing via serverless architecture. This technology allows

the developers to efficiently execute any sort of actions, deployment or business content. They are expected to start within milliseconds and process individual requests and then the process ends [15]. One such application of FAAS that can assist the developers to easily develop an online dApp is Webiny. It's a developer-friendly serverless CMS that is powered by React and Node. The architecture is mainly based around a serverless environment that features full stack development options for everyone and admin options for moderating all services. Some of its scopes are CRA V2 that helps developers to easily use Create React App, GRAPH QL which is the next stage of API that helps to get quickly acquainted with the API, Open Source which makes it free, SSR helps the sites to be rendered on server side, Headless making the managing of content easier, FLOWJS makes codes easier for others to understand, INTEGRATIONS helps in modularity of the codes and contents, Security provided in all sectors and data access [32].

10.3 Plugins for Smart Contracts: A smart contract helps to eliminate the middleman in terms of negotiation and saves the time. It is basically a digital contract whereas in the traditional contracts there used to be agreements but smart contract functions with codes which enforce the negotiation of the contract and it also facilitates transactions without the need of a third party. Plugins on the other hand are basic necessities for the developers and in order to make a dApp they need smart contracts which will allow it to be connected to the blockchain. For such a major role, many popular web building technologies are starting to use plugins for smart contracts. One noteworthy among them is WP Smart Contracts which helps to connect WordPress with the Ethereum Blockchain [33].

11 CONCLUSION

The necessity of such a platform is already being felt by the major humanitarian aspects of world society where the banks are trying to develop interbank settlement, the law utilizing the smart contracts to investigate its legal side, sharing verified prescriptions and evidence in the healthcare, the transparency in financial aid and outcomes for NGOs; as well as bringing transparency in IoT ecosystems. As such the developers will also be benefitted by means of FAAS feature of such platform resulting in higher productivity and building better applications according to the client's demands and revolutionize the tech world towards a better decentralized future. In future domain specific more specialized dApps development platform could be developed that may accelerate the developer's productivity and could play a significant role in this ecosystem.

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