The Emergence of Blockchain Technology in Ubiquitous Computing

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Abstract — Blockchain Systems and Ubiquitous computing are changing the manner we work together and lead our lives. A standout amongst the most imperative utilizations of the Blockchain technology is in automation processes, digital assistants and Internet-of-Things (IoT). Machines have so far been *constrained* in ability primarily because they have restricted capacity to exchange value. Any monetary exchange of value which is of significant worth must be supervised by humans or human based centralized ledgers. Blockchain technology changes all that. It allows machines to have unique identities and hence a virtual presence. Blockchain technology even allows for automated verification by the network of machines itself. It permits machines to exchange value and introduce the element of discretion in the hands of Machines. This can form the basis for ultimately developing IoT going on to Artificial Intelligence. This paper aims to investigate and expound couple of most impactful use-cases of blockchain technology in ubiquitous computing/omnipresent processing.

Keywords— Blockchain, ubiquitous computing, IoT, cryptocurrency, crypto wallet.

I. INTRODUCTION

Ubiquitous computing technologies are reaching a stage of technical maturity that is enabling their application in everyday business environments. With the advancement in IoT, Machine learning, Natural language processing, Artificial Intelligence etc., our day to day life is tremendously changing and the way we do businesses is changing in a fast pace.

Recent literature suggests ubiquitous computing technologies present considerable potential to significantly change how work is performed at organizational, team and individual levels in numerous ways. The design of organizational business processes and the exploitation of information technologies constitute a recursive relationship, in which IT is a key enabler in transforming, as well as supporting, business processes. With increasing intelligence and mobility, seamless integration into physical environments, and declining costs, the adoption and application of ubiquitous computing technologies by organizations are enabling substantially new and distinctive service options and business processes, and, consequently, creating a variety of impacts on organizations.

Business processes defined as - logically related tasks performed to achieve a defined business outcome, typically consist of structure, inputs, outputs, internal or external customers, and owners. Processes reflect how work is performed and can be strategically changed or redesigned to provide organizations with significant improvements. The role of IT has been shown to be fundamental and multi-faceted in this endeavour, enabling and facilitating organizations in implementing radically improved processes, rather than merely automating current ones.

So far, Machines and business processes have been limited in their ability primarily because they have restricted capability to exchange monetary value. Any monetary value must be supervised by humans or human based centralized ledgers like banks [1]. With the advent of blockchain technology, this limitation no longer exists. Every machine participating or constituting in the ubicomp environment can have a unique identity and hence have a virtual presence via which transaction could be performed.

Rest of the paper is organized as follows, Section II contains the Index terms elaborated, Section III illustrates the current approaches and issues in the current approaches, Section IV throws light on the proposed approach with prominent use-cases explained in detail, Section V elucidates the challenges in implementing the proposed approach and Section VI concludes research work with future directions.

II. INDEX TERMS ELABORATED

A. *BlockChain Technology*

A blockchain is a widely disseminated archive of data that maintains a continually expanding register of records fully and reliably protected from any alteration, deletion or modification. Each block has a timestamp and link to the preceding block as shown in figure (a).
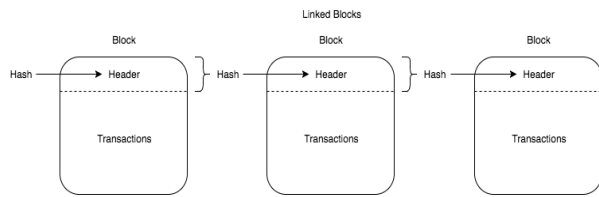
Fig (a): Block structure in a Blockchain Network.

The blockchain is an incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value.
How blockchain technology works can be explained as follows.

Step 01: Someone requests a transaction.
Step 02: The requested transaction is broadcast to a P2P (blockchain) network consisting of computers, known as nodes. These nodes are the part of the blockchain network.
Step 03: The network of nodes, validate the transaction using cryptography.
Step 04: Once verified, this transaction is represented as a new block.
Step 05: The new block is then added to the existing blockchain as shown in figure (a).
Step 06: The transaction is complete!

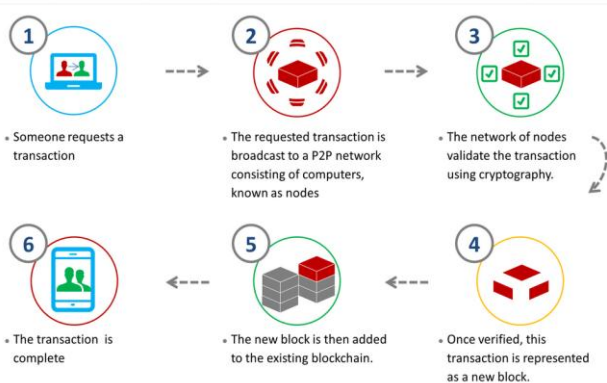The above steps can be depicted diagrammatically as follows in figure (b).

Fig (b): Steps involved in Blockchain technology

As seen in the steps, this technology is not just suitable for financial transactions but for anything of value which needs to be protected against modification or deletion.

B. *CryptoCurrency & Crypto wallet*
A cryptocurrency is a medium of exchange using cryptographic techniques to safeguard transactions and manage the formation of additional units of the currency. Bitcoin is an example of cryptocurrency. When people send

money to each other, someone must keep account of who spent how much at what time. In case of fiat money (paper money) it is done by Banks for which they charge a commission. But in case of crypto coins, it is registered on a ledger called blockchain with nil or minimal fees.

A Crypto wallet is an encrypted electronic device that allows an individual to make electronic cryptocurrency transactions. Each wallet will have a public key visible to anyone. But it can be operated by only a person who has a private key. Transactions on the crypto coin network are usually anonymous.

C. *Ubiquitous/Pervasive Computing and IoT*
The term ubiquitous, meaning appearing or existing everywhere, combined with computing to form the term Ubiquitous computing (**UbiCom**) is used to describe ICT (Information and Communication Technology) systems that enable information and tasks to be made available everywhere, and to support intuitive human usage, appearing invisible to the user [3].

It is a paradigm in which the processing of information is linked with each activity or object as encountered. It involves connecting electronic devices, including embedding microprocessors to communicate information. Devices that use ubiquitous computing have constant availability and are completely connected. Ubiquitous computing focuses on learning by removing the complexity of computing and increases efficiency while using computing for different daily activities. Ubiquitous computing is also known as pervasive computing, everyware and ambient intelligence.
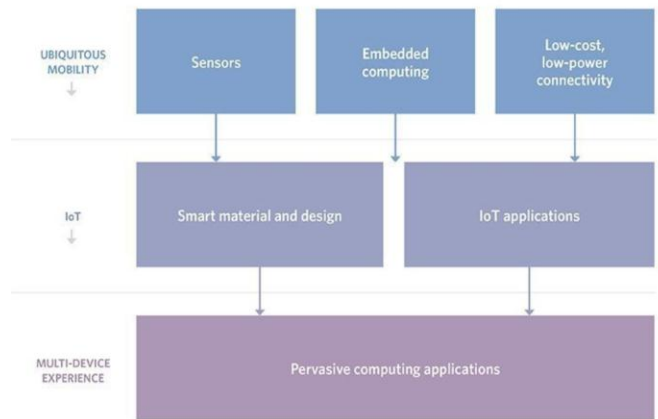

Fig (c): Block Diagram of a typical UbiCom Application

IoT is a network of items which have embedded in them, electronic chips that will allow such items to gather and exchange information. IoT will enable the items to be controlled via the internet or any appropriate network. IoT is closely associated with the concept of ubiquitous computing.

III.   CURRENT APPROACH AND ISSUES

a)   Current Scenario
Currently we have smart devices, smart environment and smart interactions which encompasses the ubiquitous environment. Machines are becoming smarter and becoming more context-aware.

b)   Issues
So far, Machines and business processes have been limited in their ability primarily because they have restricted capability to exchange monetary value. Any monetary value must be supervised by humans or human based centralized ledgers like banks. With the advent of blockchain technology, this limitation no longer exists.

Every machine participating or constituting in the ubicomp environment can have a unique identity and hence have a virtual presence via which transaction could be performed.

IV.   PROPOSED APPROACH

The idea is to treat UbiCom and Blockchain as concepts that are complementary rather than treating them as separate individual concepts. When these two powerful concepts come together, the possibilities are endless. A few use-cases of how blockchain is complementary to Ubiquitous computing is discussed below:

Smart homes, smart grids, smart city and even smart transport can be made possible by the IoT and the concept that underpins this possibility is the Blockchain technology. Earlier, transactions made by machines had to be verified by banks or other human intermediaries. Blockchain technology allows the network of machines itself to verify the transaction obviating human intervention.

Now it is possible for our fridge to recognize that the quantity of milk is going low and can order milk cartons via IoT and also pay for it using Blockchain and cryptocurrency, all by itself without any human intervention. The network will verify and validate the transaction, all by itself.

The repercussions of this possibility are immense. Embedded chips in objects will provide them a digital identity and a virtual presence. A coffee mug on a table will have a defined existence in the digital world. One can sell the mug, loan it or pawn it on the internet. One can rent one's car to someone for a week. As soon as the week is over, you can automatically lock the car, trace it and take back control of your vehicle. With ubiquitous computing, business too will become ubiquitous. IoT will not only enable automation, it will accelerate automation to a level which may not be possible by other means. The basis for this kind of development will be Blockchain technology.

Machines will be able to talk to machines, transact among themselves, settle their accounts and keep doing it for ever without slowing down or getting tired. The various machines involved in manufacture of goods will be able to automatically order for parts or raw materials for production. Supply chain can become fully automatic.

A. Some **Generic use cases** where blockchain and UbiCom converge are:

a) Supply Chain Management: Smart products with IoT sense data and quantity and order for parts automatically via blockchain.
b) IoT Network Management: This constitutes the management of a whole IoT network in a distributed encrypted ledger format.
c) End-User Authentication: This involves the authentication using distributed ledger aka blockchain and IoT.
d) Ondemand Asset Sharing & Management: Machines will be able to talk to machines, transact among them and this allows on demand sharing of resources with high security via blockchain (as each block has transaction data).
e) Smart Contracts & Compliance: Contracts could have a virtual presence with IoT and and carry on transactions with blockchain. Ex: Real estate – land details can be captured in a blockchain.
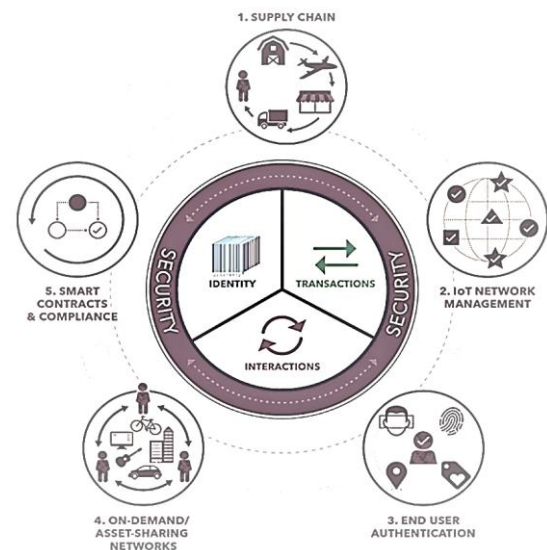

Fig (d): Generic Use cases of Blockchain in UbiCom

B. Concrete Use Case 1: Shipping and Logistics - Improving workflow and real-time visibility on the status of shipments

Ninety percent of goods in global trade are carried by the ocean shipping industry each year, however, the supply chain is slowed by the complexity and sheer volume of point to point communication across a loosely coupled web of land transportation, freight forwarders, customs brokers, governments, ports and ocean carriers.

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International trading parties require both improved workflow and better visibility. They need a faster, security rich and more efficient way to handle the documentation processes needed to move goods across international borders. The costs associated with trade documentation processing and administration are estimated to be up to one-fifth the actual physical transportation costs. A single vessel can carry thousands of shipments, and on top of the costs to move the paperwork, the documentation to support it can be delayed, lost or misplaced, leading to further complications.

By using blockchain technology to establish transparency among parties, the solution can help reduce fraud and errors, reduce the time products spend in the transit and shipping process, improve inventory management and ultimately reduce waste and cost.

C. Concrete Use Case 2: Asset Lifecycles and History

Asset lifecycle is a great example – any industry where there is a long lifecycle associated with a complex business critical, not to mention life critical, piece of equipment – mining equipment, tractors, and telecoms equipment – are types of critical assets which have very long lifetimes – anywhere from 10 to 30 years. Take the example of an aircraft, which over the course of its lifetime, might have as many as three or four owners. An aircraft certainly has different parts replaced over its lifetime. Are the parts on an aircraft – over the full course of its life – with multiple owners genuine, in good working order, original and not counterfeit? How do we know if a record has been falsified? Blockchain with IoT is the answer!

Blockchain minimizes reliance on blind trust, while enabling real-time visibility into supply and demand – across the entire ecosystem. Using blockchain and IoT ensures each part receives its own unique identity as part of the supply chain.

D. Concrete Use Case 3: Guaranteeing the safety and reliability of the food supply chain

Ever wonder where the ingredients from a store-bought noodles came from – how far they traveled, if they are safe? The issue of being able to track and trace where food comes from, and how it flows from farm to fork, has always been something organizations have had an interest in, however up to now efforts have been inconsistent, with few standards.
There's a lot of complexity in the food supply chain – involving many interim processing steps. For instance, one farmers produce might first enter a food processing facility, then move on to a distribution center. Each point in the chain has a one-step view up or back, there's no full view [4].

The process uses disparate methods, pretty much on paper – which means it's not fast and it is error prone, and there's no visibility along the whole chain. There have been some very

visible examples in the last few years ranging from spinach to peanuts. The time it takes for organizations like Walmart to react to something like an e-coli outbreak is critically important. Sometimes it can take weeks to figure out the source of a problem – the food's origin, where along the way it became contaminated.
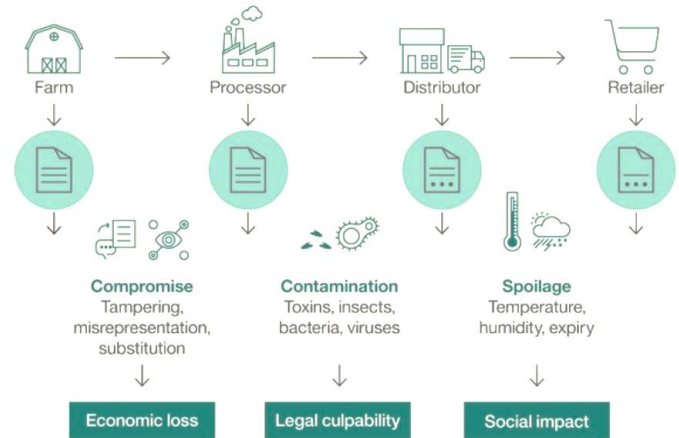

Fig (e): Blockchain in Food supply chain

What happens if one of the many ingredients in a noodle is tainted, or there's been some issue in the supply chain detected regarding a health risk? Think about the network of suppliers used to supply an ingredient? Using a combination of IoT sensors and blockchain, we could address these issues – radically improving the speed, traceability and trackability, using a trusted network along the blockchain. By using blockchain, if anything is tracked to a particular supplier, the wider network is not adversely impacted.

V. CHALLENGES

a) Scalability of Blockchain: One Major limitation of blockchain yet is its scalability, currently it has been used in use cases involving bitcoins or other cryptocurrencies and hence processing was not an issue. But, when UbiCom and blockchain come together, it poses a problem for handling the huge incoming big data by blockchain.

b) Security: Blockchain is proved to provide high levels of security but the security breach may happen anywhere in the UbiCom side. Security in UbiCom systems and IoT is still a daunting topic. This may impact the Blockchain – UbiCom Colloboration as well if not handled well.

VI. CONCLUSION

This paper discussed how blockchain technology empowers machines to freely exchange or add value in an economic system. Not only that, it also enables machines to improve their working and maintain themselves. This phenomenon

can lead to a possibility of a fully independent artificial intelligence.

It will take away a major burden of supervising and up keeping of machines from human hands and free human minds for greater pursuits. It has huge implications for the future of Mankind and Man-Machine relations. The challe ges in achieving this were discussed in Section V, of this paper.

REFERENCES

[1]   Kartik Hegadekatti, *Automation Process and Blockchain Process*, [Online], MPRA.
[2]   S.K. Sharma, L. Gupta, "*A Novel Approach for Cloud Computing Environment*", International Journal of Computer Sciences and Engineering, Vol. 4, Issue.12, pp.1-5, 2014.
[3]   Stefan Posland, *Ubiquitous Computing*, Wiley Publication, 2009.
[4]   The Internet of Money by Andreas M Autonopoulos , [Offline]
[5]   Blockchain for Dummies by Tiana Laurance. [Hardboumd]
[6]   Satwik.P.M., Geluvaraj B, T.A. Ashok Kumar, "A study on application of AI, ML, DL and Blockchain in healthcare and Pharmaceuticals and it's furture", International Journal of Computer Sciences and Engineering, Vol.6 , Issue.8 , pp.765-770, Aug-2018
[7]   Satish Chandra Gullena, "IoT architectures based on blockchain technologies", International Journal of Computer Sciences and Engineering, Vol.6 , Issue.7 , pp.874-878, Jul-2018
[8]   N . S . Tinu, " A survey on Blockchain technology – taxonomy, consensus algorithms and applications, International Journal of Computer Sciences and Engineering, Vol.6 , Issue.5 , pp.691-696, May-2018
[9]   Shahid Ul Haq, Yashwant Singh, "On IoT Security Models : Traditional and Block chain", International Journal of Computer Sciences and Engineering, Vol.06 , Special Issue.03 , pp.26-31, Apr-2018

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