

INTEGRATION OF IOT WITH BLOCKCHAIN: BENEFITS AND CHALLENGES

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Abstract : Internet of Things (IoT) has a significant role in our life. It is basically a network of various devices and sensors that works together to achieve a specific goal. Besides the benefits, IoT has a major drawback, which is security. On the other hand blockchain is known for its security features. So by integrating blockchain with IoT we can achieve a higher level of security. But blockchain have its own limitations which can affect the effectiveness of IoT devices. No doubt, their integration eliminated some major drawbacks of IoT but some scalability and other major issues of blockchain also have to be considered. Blockchain can be used as a support to secure IoT but it should not be considered as a complete solution. This research concludes that there are many future research challenges in blockchain technologies with IoT.

IndexTerms – Internet of Things, IoT, Blockchain, Integration.

I. INTRODUCTION

With the aim to make human life much comfortable, Internet of Things uses network of interconnected sensors and nodes that collect the data, and after applying semantics, transfers it over the network. But these devices can also explore owner's privacy and integrity to outer world because they have many flaws in their security system. IoT devices collect lots of information about our surroundings and send it through the network. Any intruder can launch an attack and malfunction the working of devices or can steal the information to misuse it, because of ubiquitous nature and centralized model of these devices.

Decentralization, if achieved, would have the advantage to reduce the amount of data that are transferred to the cloud for processing and analysis, and it would lead to concerted and autonomous operations [1]. And this decentralization can be achieved by Blockchain. In 2008, Satoshi Nakamoto introduced Bitcoin which features distributed computing and decentralised data sharing. By using above mentioned characteristics of blockchain we can enhance the security level in IoT.

Integration of IoT with blockchain opens plethora of possibilities. Since blockchain can handle large amount of transactions and it also based on peer-to-peer communication, integrating with IoT would not require client-server based communication anymore, results in eliminating soft core of IoT. This paper reflects various aspects and challenges of this integration.

The rest of the paper is organised as follow: Section II describes the functioning of IoT and its security requirements, Section III describes blockchain technology and its features. Section IV presents Benefits of integrating blockchain with IoT whereas Section V presents its challenges. Conclusion is given in Section VI.

II. WORKING OF IOT

IoT platform devices collect data with the help of sensors and other equipment and send it through the common IoT Gateway/hub to user or back-end system. These devices also exchanges data between themselves. IoT platforms will then analyze the data to extract valuable information and share it with other devices to initiate specific commands or actions. The result is a better human experience, greater automation and improved efficiencies [2]. The IoT architecture generally has four stages that are discussed below:

1. Things: In 'Internet of Things' term Things refers to sensors and actuators which emit and accept signals. They collect data from environment and send it through gateways.
2. Gateways: It acts as an interface between things and cloud to provide connectivity and filtering of data.
3. Network Infrastructure: This layer includes modems, routers, hubs and other devices that ensure exchange and delivery of data between one another.
4. Cloud Gateway: Storage, processing and main servers together makes cloud gateway. Actual processing of data and storage held here. And after processing all the information, it is transferred to end user.

Security Challenges for IoT

- i) **Centralized Model:** As discussed above the IoT architecture is based on centralized model. The main disadvantage of this model is that all nodes in the network communicate through IoT gateway instead of one to one. So it is more vulnerable to data theft and manipulation.
- ii) **Missing of Universal Standards:** The existing security protocols of IoT are not universalized. Security standard of most of the devices is different and they become prone to attacks when two or more devices connected without same standard.
- iii) **Open for Malicious Attacks:** There have been many cases like: Mirai, Stuxnet etc. in which the security of these IoT devices compromised.
- iv) **Small IoT Attacks:** Several botnets and other small bugs are present in these devices which are difficult to locate and it takes some time to know the presence of them.

- v) **Device Updates:** Security patches and updates of the security devices are not very easy to locate. If anybody wanted to update the devices then it is really difficult because of their heterogeneity and distribute environment.
- vi) **Ubiquitous in Nature:** Because these devices are easily detectable to devices outside the network so it is not a big deal to launch some attack and take over them.

III. BLOCKCHAIN TECHNOLOGY

Unlike the banking system where all the data regarding transaction is stored in one ledger and maintained only by bank, blockchain technology based on distributed computing, where data is distributed among all the participants in the form of blocks. Each time when any transaction takes place it has to be verified by majority of clients. Each block gets a hash number and a time stamp. Since each block is linked with the previous block it is very hard to modify the data, since all the blocks in the chain would have to be modified [3]. According to [4], blockchain technology is based on four central concepts: i) peer-to-peer network ii) open and distributed ledger iii) ledger copies synchronization and iv) mining.

So we can say that there is no master computer, rather each computer has its own copy of chain. And if we want to alter any record we have to modify each nodes data, which is almost impossible in a larger chain.

3.1 Features of Blockchain

Following features of blockchain makes it more valuable for IoT:

- i) **Decentralization:** With decentralization there is no need of any controlling agency. Hence transaction can be approved automatically without verifying it with any third party.
- ii) **Anonymity:** Anonymity helps users to keep their identities secret so that no one can trace back them. So it creates a private atmosphere.
- iii) **Peer-to-Peer Communication:** Every node in the network sends messages to other nodes directly. With elimination of central server messages are stored in nodes themselves. This way, there are less chances of any unauthorized access to messages.
- iv) **Irreversibility of Records:** Once the transaction write in to the block, then block is added to the chain, and each block has fingerprints of other blocks. It makes difficult to alter any contents of the block, because all the information stored in the block is encrypted and moreover it is speared over large number of other nodes.
- v) **Transparency:** Every transaction that takes place in blockchain is publically visible to all the other nodes. And every node in the chain can read the data stored in other node with some private keys. When a new transaction occurs, it is broadcast to the entire network. All miners who receive the transaction verify it by validating the signatures contained within the transaction [5].
- vi) **Smart Contracts:** Devices in the blockchain can create agreements about accessibility and data transmission on their own. There is no need of intervention of any third party. Thus it allows greater automation with cheaper and more secure transactions.

IV. BENEFITS OF INTEGRATING IOT WITH BLOCKCHAIN

So far we have discussed the main features of blockchain along with drawbacks of IoT. If we manage to integrate both the technologies than we get rid of most of the problems exist with IoT. The intrinsic decentralized, autonomous, and trustless features of the BC make it suitable to be applied in several different scenarios such as “Smart Home,” “Smart Industries,” “Smart Grid,” and “Smart City” as well [4]. However much of the work have been done in this regard. Below are the benefits:

- i) **Data Privacy:** Blockchain solves the major problem of IoT i.e. data privacy. As all data is encrypted with in the block and each block has its private/public to access its data, so any other resource in the IoT chain cannot access the data without proper authentications. And each block is linked to other block that makes it hard to decrypt. Without adding blockchain to IoT, the data stored and transmitted among them is not so secure. That is the main reason behind this integration.
- ii) **Free form third party:** Blockchain removes the risk of having accessed by any third party device or application. The complete process is completed and handled without any outer support. So it drop out the risks exist with third part support.
- iii) **Immutability:** The ledger is distributed among all the other nodes in the network. So any changes made in the ledger must be verified by majority of the nodes. So immutable ledger is one of the main benefits of blockchain.
- iv) **Anonymity:** The transaction takes place between both the devices cannot be traced back since both the sender and receiver did not know the identity of one other. So without knowing each other any transaction or transmission among IoT devices can easy take place.
- v) **Robustness:** Decentralized devices are less likely to fail accidentally because they rely on many separate components [6]. The blockchain makes the IoT a robustness network. At any point of time if any node fails it will not affect the whole network. Because each node is standalone and has its own copy of ledger and processing capability. So the structure is completely robust.
- vi) **Decentralization:** Any devices in the network need not to take permission of any centralized command centre for any operation to perform. It empowers them to take decision on their own. And also there does not exist any single storage on which the devices have to rely on. Therefore, there is a massive amount of trust included since the majority of the participants in the network have to reach an agreement to validate transactions [7].

vii) **Cost Reduction:** The central servers and IoT gateways are most expensive in IoT architecture. Communication, data exchanges, and device information are conducted on a peer-to-peer basis, removing any additional traditional protocol, hardware, or communication overhead costs [8].

V. CHALLENGES OF IOT WITH BLOCKCHAIN

- i) **Processing Capabilities:** IoT is a network of different devices having different characteristics of processing power. Blockchain need good amount of processing in order to encrypt the transaction. Not all the devices in IoT are capable to encrypt each and every transaction in required speed.
- ii) **Scalability:** IoT is combination of large number of sensors and devices. Each moment this number is increasing rapidly. There might arise some issues as the current blockchain technology is not able to handle such a large number of devices.
- iii) **Storage:** As the network grows the data size will also grow. Since in blockchain technology there is no central server which can store the data and it is distributed among the devices itself, these IoT devices are not designed to store such a huge amount of data which may lead to storage problems.
- iv) **Lack of Technical Skills:** There are very less number of experts who understand the working of blockchain technology and know how to implement it. Integration of blockchain with IoT makes it more complicated task. So without sufficient expertise we cannot make that integration make happen.
- v) **Legal Issues:** With the help of blockchain people from all over the world would be able to connect through their IoT devices, and that is a serious concern because every country has its own set of rules. It is still a developing platform and as of now there is no any legal documentation available for these devices that can be followed by the manufacture companies.
- vi) **The IoT Structure:** The design and working structure of blockchain and IoT is completely different. There is great significance of the IP address of client in the blockchain. An example is the Bitcoin application in which the IP addresses of some “senders” are embedded within the Bitcoin client and used by nodes to build the network topology [9].
- vii) **Credential Security:** Even though the blockchain is known for its high-security levels, a blockchain based system is only as secure as the system’s access point. When considering a public blockchain based system, any individual has access to the private key of a given user, which enables him/her to “sign” transactions on the public ledger, will effectively become that user, because most current systems do not provide multi-factor authentication [10].
- viii) **Interoperability:** Interoperability means when communication takes place among heterogeneous devices i.e. with different technical specification and protocols. This problem needs to be solved if want to integrate both the technologies. If not, we can end up with a situation where we are connected to multiple isolated decentralized networks that work well for their purpose but can’t necessarily talk to other devices for which they were not specifically designed [11].
- ix) **Energy Consumption:** As all the devices in blockchain network has its own processing storage capabilities therefore the energy consumption will increase significantly. IoT devices need very small amount of power to function but with the integration of blockchain they will require more energy. According to [12], blockchain method will increase the energy consumption by 0.07 (mj).

VI. CONCLUSION

IoT provides so many features that it has become an important part of our life. But the security concerns cannot be ignored. In this paper some of the main security concerns have been discussed. And we have analysed that these flaws can be overcome by integrating IoT with Blockchain. But as we know everything which has some advantages also has some drawbacks. The challenges of this integration are also discussed. We can observe that with more future research work, the challenges can be handled and we can enjoy more benefits out of it. Thus this research paper concludes that future research work needs to be done in this field to come out with more dedicated blockchain model which can be integrated with IoT.

REFERENCES

- [1] Gokhan Sagirlar, Barbara Carminati, Elena Ferrari, John D. Sheehan, Emanuele Ragnoli, ” Hybrid-IoT: Hybrid Blockchain Architecture for Internet of Things - PoW Sub-blockchains”. arXiv:1804.03903v3 [cs.DC] 5 Jul 2018
- [2] <https://cointelegraph.com/news/how-significant-is-blockchain-in-internet-of-things>
- [3] Johan Älvebrink, Maria Jansson, “Investigation of blockchain applicability to Internet of Things within supply chains”. TVE-MILI 18 012 Examensarbete 30 hp Juni 2018.
- [4] Alfonso Panarello , Nachiket Tapas , Giovanni Merlino, Francesco Longo and Antonio Puliafito, “Blockchain and IoT Integration: A Systematic Survey”. Sensors 2018, 18, 2575; doi:10.3390/s18082575.
- [5] Ali Dorri, Salil S. Kanhere, and Raja Jurdak, “Blockchain in Internet of Things: Challenges and Solutions”.
- [6] Abid Sultan, Muhammad Sheraz Arshad Malik, Azhar Mushtaq,” Internet of Things Security Issues and Their Solutions with Blockchain Technology Characteristics: A Systematic Literature Review”. iMedPub Journals. <http://www.imedpub.com/>. Vol.6 No.3:27
- [7] M. Samaniego and R. Deters, “Blockchain as a Service for IoT,” 2016 IEEE Int. Conf. Internet Things IEEE Green Comput. Commun. IEEE Cyber, Phys. Soc. Computer. IEEE Smart Data, pp. 433–436, 2016.
- [8] Siva Gopal, “Blockchain for the Internet of Things”.Tata Consultancy Services White Paper.

- [9] Hany F. Atlam, Ahmed Alenezi, Madini O. Alassafi, Gary B. Wills,” Blockchain with Internet of Things: Benefits, Challenges, and Future Directions”. I.J. Intelligent Systems and Applications, 2018, 6, 40-48
- [10] <https://datafloq.com/read/iot-and-blockchain-challenges-and-risks/3797>.
- [11] <https://cointelegraph.com/news/how-significant-is-blockchain-in-internet-of-things>.
- [12] Ali Dorri, Salil S. Kanhere, Raja Jurdak, Praveen Gauravaram,” Blockchain for IoT Security and Privacy: The Case Study of a Smart Home”. Conference Paper · March 2017.

