IWS Term Paper

Blockchain for 5G Networks

Background Information

The evolution from the first generation of networks to the 4th and 5th generation of networks which we are using these days has seen drastic changes in the world communicates and it is expected to grow with each passing year. The speeds and the way we use cellular networks have changed drastically but they did bring challenges along with them. We have all been enjoying the 5th generation of wireless networks in our life for some time now. While the higher speeds are enthralling to use, there are a couple of drawbacks that seriously impact user and the efficiency of 5g networks. The first one is poor connectivity, and the other major issue are security vulnerabilities with respect to user privacy and data interoperability.

Current State of Art

The way 5g functions is that they are deployed for various types of devices in a heterogeneous networks. Heterogeneous networks are basically those networks which can support multiple types of network traffic without affecting the quality of service. However, the current 5g networks have not been able to do it efficiently since the users experience latency and not enough throughput. The current state of art is a centralized architecture and hence causing single point of failure and performance limitations.

To tackle the above problems, the researchers Nguyen et al. have done an extensive survey and their comprehensive paper is the first-ever literature review done on blockchain in regard to 5G and argues that 5G technologies cannot come to full fruition without the security and efficiency that blockchain would bring to the table.

Understanding Blockchain and Underlying Technologies

Blockchain: Although it is mainly considered as the idea behind Bitcoin, the core idea of blockchain is decentralization. This decentralized concept provides high robustness and security for database stored on blockchain with no single-point failure.

> **Blockchain Types:** Permissioned Blockchain (Private Blockchain) and Permissionless Blockchain (Public Blockchain) are the two main types of blockchain, and they are self-explanatory. Private blockchains are managed by a central entity and not everyone can access it unless invited whereas public blockchain is accessible to everybody.
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> **Distributed Ledger:** The chain of blocks(records) is called a ledger. The blocks contain transaction records. Ledger is a kind of database that is replicated over all network participants.In the distributed ledger, each record contains a unique cryptographic

signature decoupled with a timestamp which makes the ledger resistant to be modified – Immutability (Cannot be changed).

Immutability: Each block on the ledger is hashed (One Way function) and linked with others in such a way that the chain cannot be broken which is a secure characteristic that blockchain offers.

Consensus Mechanism: Consensus mechanism ensures visibility of the ledger to each member in the network.

Transparency: The transactions on public ledgers is visible to all the entities. The metadata about the transactions are available for public validation.

- This can help 5G to solve for secure data delivery and payment transactions where financial entities can trace and monitor transactions.

Technologies used by 5G currently

Cloud/Edge Computing: Cloud computing is being used for resource management and data storage. Edge computing computes services at the edge of mobile network which solves for faster computation and smaller delays.

Network Function Virtualization (NFV): This is basically to virtualize network functions. They use one piece of hardware and virtualize network functions around it to make deploying easier and increase scalability.

Network Slicing: It can go hand in hand with NFV where you create multiple physical networks on top of the physical network architecture. Along with NFV, it can have virtual applications and deploy them virtually over slices and solve for low latency since we can have multiple slices.

Device-to-Device Communications: Instead of going transmitting the signals via base stations, this allows devices in closer proximity to communicate directly.

The combination of cloud/edge computing and Software Defined Networking and Network Function Virtualization (NFV) can solve for flexible network deployment, scalability, and configurability.

Security Challenges in current 5G

- For cloud and edge computing, we are dependent on cloud providers like AWS and Azure which are centralized providers, and this can lead to a single point of failure.
- Network Function Virtualization is again done on a cloud environment which could include multiple cloud providers and transmission of data is reliant on the cloud

provider when deploying NFVs and it could lead to data leakage. We use Virtual Machines in NFVs and to migrate them and manage resource allocation is a tough task to manage in terms of security.

- The bandwidth required by modern day applications is huge and to provide quality of service based on the current architecture is difficult since resource scarcity and having continuous service functionalities is difficult since there are chances for single point of failure.
- To solve for high bandwidth, spectrum sharing between user and the operators has to be efficient and in current architecture, it is difficult to manage since we have a central point for attacks and malicious users can bring the network down
- Adding certificate authorities to solve the above problem would not be ideal since the quality of service would get affected.

How can blockchain help 5G

Blockchain can help enhance the security of 5G networks by using its technical characteristics.

Integrating blockchain with 5g can eliminate the single point of failure – which is a major disadvantage of the current network. Implementing decentralization would mean that the network infrastructure is distributed and there is no need for a third-party authority to manage this. Blockchain based cloud computing can help remove centralization at the core network.

The D2D communication can be further enhanced by using blockchain by creating a peer-to-peer network over blockchain, each D2D device becomes a blockchain node with the ability to hold a copy of the ledger and monitor transactions for increased system transparency and dependability.

Decentralized user validation can be implemented by using smart contracts and user validation can be done using the power of all the participants in the network.

Immutability and Decentralization are such characteristics that can help 5g by a great measure since they offer a secure way to store the data and sharing of the data. By deploying the immutable ledgers in the current heterogeneous networks can help network engineers to establish secure communication. Strong immutability can help prevent Denial of Service attacks.

Better storage and data management coupled with low latency and data retrieval can be brought to the fore by blockchain and it is better than the traditional databases. Distributed ledgers solve for high availability of the network.

In the existing network, the cloud authorities can manipulate the data and lay their hands on critical resources since they are in charge of the cloud. The current architecture is vulnerable to information modification attacks. Blockchain integration to the cloud can help with security and reliability and one such framework called BlockONet has been developed. Blockchain is used to to build a verification platform where the user access information is stored immutably on the

ledger, and it is secure from data manipulation attacks since the ledgers are immutable. Peer-to-peer ledges can help connect multiple clouds and it is an added advantage.

The authors cited a research in which the researchers have developed a system which can solve for the CIA Triad which is Confidentiality, Integrity and Authenticity. BSec-NFVO is claimed to provide for a way to securely orchestrate and deploy network functions virtually which can prevent data leakage when using NFVs.

Blockchain can act as a middle-secure layer in 5g IoT communications where it can establish a secure channel for the IoT devices to communicate using network slicing which saves the budget since it can replace the need for additional hardware. The consensus mechanisms for network slicing between the network provider and slice provider builds an efficient framework to deal with.

Blockchain's characteristics like transparency, traceability, user management makes it easy to provision data sharing. Managing user access and fast data sharing can be brought to the fore by using blockchain.

However, implementing blockchain would significantly improve the way 5g operates, enhances security and reliability.

Personal Opinion

Although blockchain can help 5G by leaps and bounds, I believe that the research with respect to integrating blockchain with 5G is still in the stage of infancy and a lot needs to be cleared out before considering this. The authors of this paper have conducted a survey and laid out possible ways in which blockchain can help 5G but none of this have been implemented and tested out to verify the legitimacy of the claims.

Despite considering the fact that the blockchain is a powerful technology, migrating such a humongous network from on premises and cloud to blockchain would be a major task. Although blockchain eliminates single point of failure, it would be difficult to debug and manage the network in such cases and to identify the point of failure would be the first measure in case of adversity.

Migrating the entire network architecture is also time and resource heavy process. Since the ledgers contain metadata as well, storing the ledgers would be a huge resource consuming task. We might end up utilizing a lot of data storage to use blockchain for the features it offers, but the question would be if that is a trade one is willing to do.

The entire paper resolves around solving the problem of single point of failure and providing immutability and decentralization to the existing technology.

Conclusion

Despite being a great technology, the research to implement blockchain for 5g is still in the stages of infancy and needs a lot of work before it comes to full fruition. To implement blockchain for 5G would be the biggest challenge for the people in charge and without prior testing, deciding to migrate to blockchain would not be a great idea. There is not much practical implementation and testing done on the same and hence there seems to be years between this being on paper to becoming fully active.

References

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