GladMeds - Medical Report

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An Efficient Design and Implementation of Blockchain Architecture

Midsem report for the OUR project

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***Abstract*—Blockchain technology has revolutionized how we manage secure, decentralized transactions across various industries, from finance to supply chain management. However, traditional blockchains, which use basic structures like linked lists(used in bitcoin [12]), merkle trees(used in hyperledger [11]), face issues with transaction speed, scalibility, and energy efficency. Directed Acyclic Graph-based blockchain marks a shift from traditional blockchains, enabling significantly higher throughput through concurrent storage and execution. We have explored DAG structures like Tangle which is used in IOTA, MorphDAG, LightDAG etc.**

I. Introduction

Blockchain technology is widely used for secure and transparent digital transactions. its decentralized structure ensures trust without the need for intermediaries. However, many existing blockchain systems face issues like slow processing, high energy use, and limited scalability.

This OUR project plans to present a more efficient blockchain design to address these challenges by improving data storage, optimizing transaction processing, and using better security methods; our approach enhances performance while keeping the system secure. Our primary focus will be on speed, however. We also plan to compare our design with existing blockchain models to show its advantages in future.

As from our literature review we found out to work on DAG based structures, we are currently exploring the MorphDAG technology and understanding its code, algorithm and the Maths behind it in Depth before we apply our methodology.

II. Literature Review

Here are a few things I learnt from online resources and research papers available in this field (briefing some of them) to explore more about this topic :-

A. Basic Blockchain terminologies and concepts

Before diving into the world of Blockchain I had the opportunity to learn about basic blockchain working, terminologies and what are all the types of blockchain available in the market.

B. Research Paper-Implementation of directed acyclic graph in blockchain network to improve security and speed of transactions

This paper explores how DAGs type structures improve blockchain networks by enhancing transaction speed and security. Unlike traditional blockchains, they allow parallel transaction processing, reducing delays and fees. This structure eliminates mining, making transactions faster, scalable, and fee-less, ideal for IoT and financial applications.

C. Research Paper-A Comparative Analysis of DAG-based Blockchain Architectures

Since we knew how DAG is very promising from previous paper, this one analyzes DAG-based blockchains like IOTA, Nano, and Byteball, highlighting their scalability, speed, and efficiency over traditional blockchains. It compares their consensus mechanisms, transaction validation, and security to identify best practices and proposes an optimized hybrid DAG model for improved performance.

D. The Merkle Tree structure

A Merkle tree is a data structure used in blockchains to organize and verify transaction data efficiently. it follows a binary tree format, where each leaf node contains a cryptographic hash of a transaction, and each non-leaf node stores the hash of its two child nodes. this process continues recursively until a single hash, known as the Merkle root, is formed at the top. The Merkle root is stored in the block header, allowing efficient verification of transaction integrity without requiring the entire dataset. bitcoin and ethereum use this structure to secure transactions.

E. Why DAG, and not Merkle tree

- **Higher scalability** – DAG enable parallel transaction processing, whereas merkle trees follow a sequential validation approach.
- **Greater throughput**– DAG efficiently process high transaction volumes, while merkle trees may create bottlenecks in large networks.

TABLE I
DIFFERENT DAG TECHNOLOGIES

Comparing Factor	DAG Technologies		
	MorphDAG	***Tangle***	***JointGraph***
Scalability	High (Dynamically adjusts DAG structure)	High, but may suffer from orphaned transactions	Moderate (designed for consortium blockchains)
Transaction Speed	Very High (adaptive transaction processing)	Fast, but can slow down in low-participation scenarios	High (but limited by supervisory node bottlenecks)
Storage Efficiency	Elastic storage reduces redundant data	Prone to unbounded DAG growth	Snapshots reduce memory load
Latency	Lowest (adaptive consensus process)	Low, but varies based on network activity	Low (due to direct voting mechanism)
Security Model	Stronger (adaptive conflict resolution)	Secure, but susceptible to network attacks	Strong (malicious nodes removed)
Ideal Use Case	Large-scale decentralized applications	IoT and microtransactions	Consortium blockchains

- **Faster confirmations** – Transactions in a DAG validate each other, reducing delays compared to merkle tree-based proof-of-work systems.
- **No reliance on mining** – Some DAG-based networks remove the need for mining, making them more energy-efficient.

F. Research Paper-Jointgraph: A DAG-based efficient consensus algorithm for consortium blockchains

This paper helped us to understand and learn how combining consensus with DAG strucutre can be a optimal solution as unlike traditional blockchains, JointGraph allows parallel transaction processing, reducing confirmation delays and improving efficiency. It addresses Byzantine faults by isolating malicious nodes and optimizes memory through periodic snapshots.

G. Research paper- Tangle the Blockchain:Towards Connecting Blockchain and DAG

Tangle is a hybrid Blockchain-DAG integration to improve scalability and efficiency, particularly for IoT. It introduced a connector component that facilitates seamless interaction, using Blockchain for data storage and Tangle for fast, scalable transactions.This system enhances flexibility, reliability in decentralized networks.

H. Research paper- MorphDAG: A Workload-Aware Elastic DAG-Based Blockchain

This is the technology I am currently exploring. I am breifly explaining it here:-

- MorphDAG is a workload-aware DAG-based blockchain designed to improve scalability and storage efficiency.
- It dynamically adjusts its DAG structure based on transaction patterns, optimizing performance for hotspot and cold transactions.
- By implementing elastic storage techniques, MorphDAG reduces memory usage while maintaining fast consensus.
- The system is tested under real-world workloads, demonstrating high throughput, low latency, and adaptive resource allocation, making it well-suited for large-scale decentralized applications.

III. PROPOSED METHODOLOGY/FUTURE WORK

We plan to work on the structural code of MorphDAG and propose a new blockchain structure which would have some additional features which could potentially increase throughput and transaction speed as MorphDAG as workload aware, the new structure could give very promising results. We plan to :-

- To work on the code so that it can **allow cyclic dependencies** in isolated segments of the DAG for temporary local consensus which could increase speed
- Divide the DAG into priority zones like **High-priority zones** process time-sensitive transactions (e.g., real-time payments) and **Low-priority zones** handle bulk, non-urgent transactions (e.g., file storage).
- Allow nodes to create additional dynamic edges between non-parent events based on: **Similarity** (e.g., same sender, timestamp proximity), **Dependencies** (e.g., transactions involving the same assets or participants).
- Optimize the DAG structure for energy-efficient validation so, Nodes calculate the energy cost of validating specific transactions and **prioritize low-cost paths**. Transactions with higher costs are deferred or aggregated for batch processing.
- Also plan on checking that which blockchain **consensus algorithm** can result in highest throughput not compromosing the basic security of the system
- I am attaching the MorphDAG code link here for reference [https://github.com/CGCL-codes/MorphDAG/blob/main/README.md]

Some existing plans might be modified/ more plans be added depending on our understanding of this code

IV. CONCLUSION

The DAG blockchain structure shows a lot of promise and once we have completed the code modification and testing under real-life workloads like Etherium we would be able to present a blockchain structure which would result in a higher throughput and wont compromise safety too. For now we continue to work on the code of MorphDAG which is a latest technology we found and has a lot of caliber.

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