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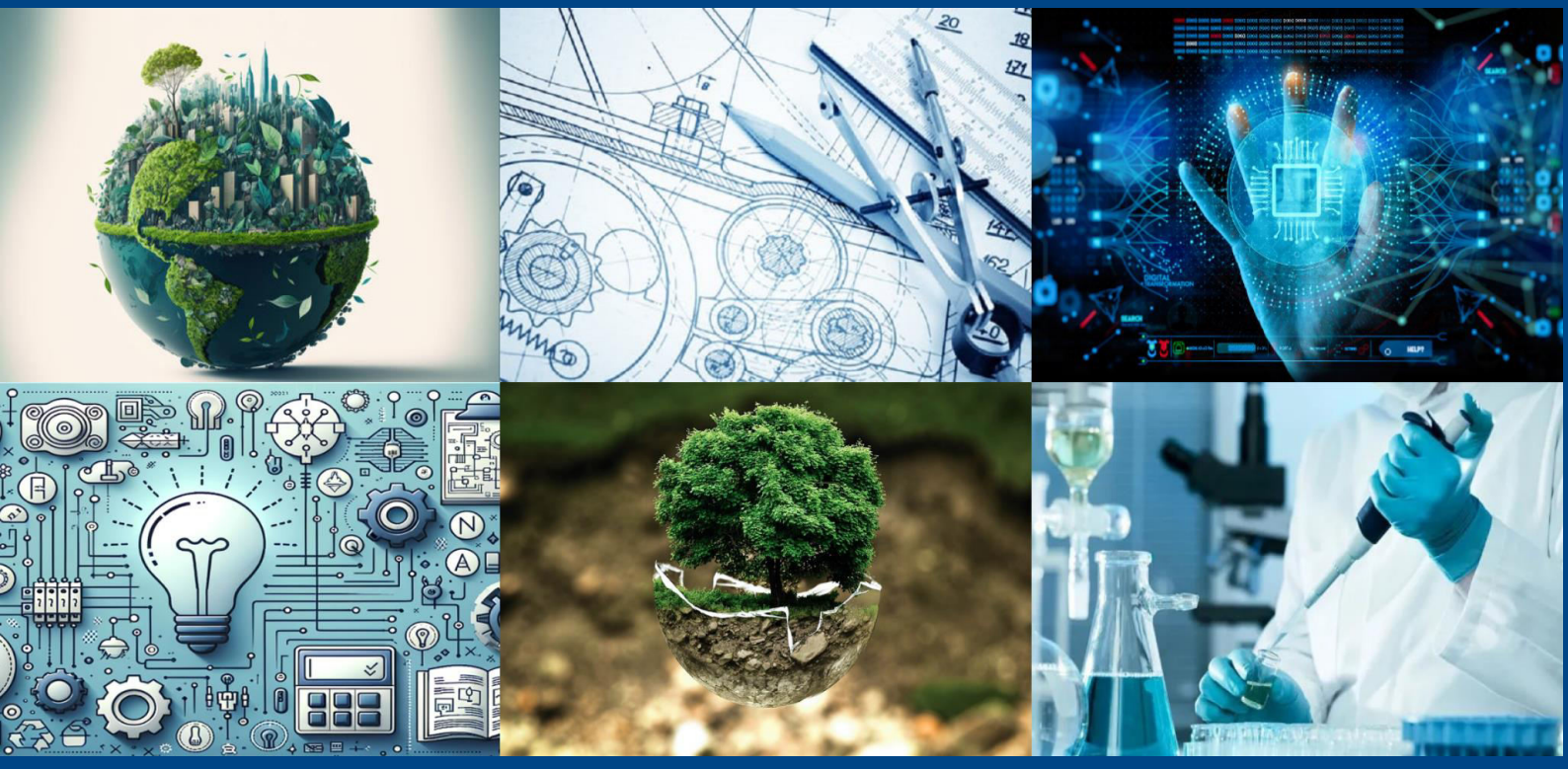

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Enhancing Traffic Event Security And Verification with Blockchain Technology

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ABSTRACT: The Internet of Vehicles (IoV) enables smart vehicles to communicate with each other and with traffic systems. However, verifying traffic events such as accidents, congestion, and roadblocks remains a challenge. Existing systems rely on central servers to collect and share information, making them prone to cyberattacks, false reports, and slow response times. To address these issues, a blockchain-based framework is introduced for accident prevention in IoV networks. Instead of relying on a central authority, smart vehicles equipped with sensors detect hazardous situations and send event data to a decentralized blockchain network. Upon verification, warnings are sent to all vehicles, triggering automatic speed reduction to prevent collisions. The system is evaluated using real-world traffic datasets, demonstrating improved reaction times to anomalous situations, surpassing human response capabilities, ensuring reliable and secure traffic event verification in IoV-based transportation systems.

I. INTRODUCTION

Smart vehicle development has gained a lot of attention in the transportation sector in recent years. These vehicles, which come with cutting-edge sensors and communication systems, are made to enhance traffic control, road safety, and the driving experience in general. It's still difficult to guarantee that traffic event reporting is accurate, though. The use of blockchain technology is relevant here. Blockchain offers a decentralized, safe method of storing and validating traffic event data, which makes it dependable and impenetrable. A blockchain-based system for smart vehicle traffic event verification is investigated in this work. Blockchain technology is used in the proposed system to enable vehicles to recognize and report dangerous road circumstances, such as congestion, weather condition, accidents or traffic jams. The system's use of a decentralized network guarantees that only confirmed and validated events are captured, lowering the number of false reports and enhancing traffic safety.

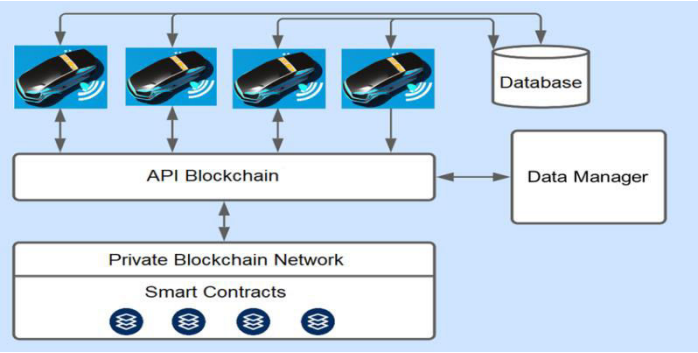

Figure 1: System Architecture

The Blockchain-Based Framework for Traffic Event Verification enhances road safety by securely detecting, verifying, and sharing event data. It operates within a private blockchain, allowing only authorized smart vehicles to participate. Vehicles use sensors to detect anomalies and report them to the blockchain, where Proof of Authority (PoA) validates events. Smart contracts on Hyperledger Besu automate verification, preventing misinformation. A dedicated API

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enables real-time interaction, while Tessera ensures data privacy. Future improvements include machine learning for better event classification.

II. LITERATURE REVIEW

The potential of blockchain technology to improve the efficiency, scalability, and security of smart car communication and traffic event verification has been thoroughly investigated. Blockchain integration with the Internet of Vehicles (IoV) has been the subject of numerous studies in an effort to enhance data integrity, privacy, and authentication. This integration enables secure, real-time data sharing among vehicles and infrastructure, reducing the risk of data manipulation.

[1] S. K. Singh, J. H. Park, P. K. Sharma, and Y. Pan, "BIIoVT: Blockchain-based secure storage architecture for intelligent Internet of Vehicular Things," IEEE Consumer Electronics Magazine, vol. 11, no. 6, pp. 75-82, 2022.
This study introduced a Blockchain-based Secure Storage Architecture (BIIoVT) for the Industrial Internet of Vehicular Things (IIoVT). The framework ensures secure vehicle-to-vehicle (V2V) communication using a Distributed Hash Table (DHT) for decentralized storage and an application layer for intelligent traffic management. The findings highlighted enhanced security and reduced storage costs, making the approach suitable for real-world IoV applications.

[2] A. A. Laghari, A. A. Khan, R. Alkanhel, H. Elmannai, and S. Bourouis, "Lightweight-BIoV: Blockchain distributed ledger technology for Internet of Vehicles," Electronics, vol. 12, no. 3, pp. 677, 2023.
This paper introduced Lightweight-BIoV, a blockchain-based framework for securing vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. The model utilizes Practical Byzantine Fault Tolerance (PBFT) consensus to improve computational efficiency and transaction validation, leading to a 55% reduction in unauthorized access and enhanced road safety.

[3] C. Oham, R. A. Michelin, R. Jurdak, S. S. Kanhere, and S. Jha, "B-FERL: Blockchain-based framework for securing smart vehicles," Information Processing & Management, vol. 58, no. 1, pp. 102426, 2021.
This study proposed B-FERL (Blockchain Framework for Event-Driven Road Logistics), which employs Hyperledger Fabric as a permission blockchain to validate and store critical road events, such as accidents and congestion. The approach demonstrated a 20% reduction in false traffic event reports, improving trust and efficiency in smart vehicle networks. The findings highlighted enhanced security and reduced storage costs, making the approach suitable for real-world IoV applications.

[4] R. Jabbar, E. Dhib, A. B. Said, M. Krichen, N. Fetais, E. Zaidan, and K. Barkaoui, "Blockchain technology for intelligent transportation systems: A systematic literature review," IEEE Access, vol. 10, pp. 20995-21031, 2022.
This systematic review analyzed blockchain applications in intelligent transport systems (ITS), comparing consensus mechanisms (PoW, PoS, PBFT) and highlighting PBFT as the most efficient model for balancing security and transaction speed. The review also identified scalability and regulatory challenges as critical barriers to large-scale adoption.

[5] M. G. M. M. Hasan, A. Datta, M. A. Rahman, and H. Shahriar, "Chained of Things: A secure and dependable design of autonomous vehicle services," in Proc. IEEE 42nd Annual Computer Software and Applications Conference (COMPSAC), pp. 498-503, 2018.
This paper presented a blockchain-based security model for autonomous vehicles, using Elliptic Curve Cryptography (ECC) to encrypt communication between vehicles and ensure data integrity. Results demonstrated a 30% reduction in incident reporting times, showing the effectiveness of blockchain in securing vehicular networks.

[6] G. Bendiab, A. Hameurlaine, G. Germanos, N. Kolokotronis, and S. Shiaeles, "Autonomous vehicles security: Challenges and solutions using blockchain and artificial intelligence," IEEE Transactions on Intelligent Transportation Systems, vol. 24, no. 4, pp. 3614-3637, 2023.
This study integrated Blockchain and AI to enhance real-time anomaly detection and cybersecurity in autonomous vehicles. The combination of AI-driven anomaly detection and decentralized identity management led to a 40%

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reduction in cybersecurity risks related to smart vehicles. The findings highlighted enhanced security and reduced storage costs, making the approach suitable for real-world IoV applications. The review also identified scalability and regulatory challenges as critical barriers to large-scale adoption.

[7] A. R. Javed, M. A. Hassan, F. Shahzad, W. Ahmed, S. Singh, T. Baker, and T. R. Gadekallu, "Integration of blockchain technology and federated learning in vehicular (IoT) networks: A comprehensive survey," Sensors, vol. 22, no. 12, p. 4394, 2022.
This paper explored how federated learning (FL) and blockchain can work together to ensure data privacy and decentralized learning in Vehicular Ad Hoc Networks (VANETs). The system validated AI model updates using blockchain consensus, preventing data breaches and enhancing decentralized intelligence.

[8] C. T. Nguyen, D. T. Hoang, D. N. Nguyen, D. Niyato, H. T. Nguyen, and E. Dutkiewicz, "Proof-of-Stake consensus mechanisms for future blockchain networks: Fundamentals, applications, and opportunities," IEEE Access, vol. 7, pp. 85727-85745, 2019.
This research examined Proof-of-Stake (PoS) as an alternative to Proof-of-Work (PoW) consensus, demonstrating that PoS significantly reduces energy consumption and transaction confirmation time by 50%, making it ideal for large-scale smart vehicular blockchain networks.

III. METHODOLOGY OF PROPOSED SURVEY

Programming improvement life cycle (SDLC) is a movement of stages that give an average understanding of the item assembling process. How the item will be perceived and made from the business understanding and necessities elicitation stage to change over these business contemplations and requirements into limits and features until its utilization and movement to achieve the business needs. The extraordinary computer developer should have adequate data on the most capable technique to pick the SDLC model taking into account the endeavor setting and the business requirements.

Thus, it may be normal to pick the right SDLC model as shown by the specific concerns and necessities of the endeavor to ensure its flourishing. I composed one more on the most proficient method to pick the right SDLC; it can follow this connection for more data. Besides, to dive more deeply into programming life testing and SDLC stages are follow the connections featured here. It will investigate the various kinds of SDLC models and the benefits and disservices of every one and when to utilize them. That can imagine SDLC models as devices that can use to all the more likely convey product project. Thusly, knowing and seeing each model and when to utilize it, the benefits and drawbacks of everyone is essential to know which one is appropriate for the undertaking setting.

Types of Software developing life cycles (SDLC)

V- Model

The V-Model (Verification and Validation Model) is a software development methodology that follows a sequential process, similar to the Waterfall Model, but with an emphasis on testing at each stage. It is called the V-Model because the development and testing phases are arranged in a V-shape, where each development phase has a corresponding testing phase.

The process consists of Requirement Analysis, System Design, Architectural Design, Module Design, Implementation, Unit Testing, Integration Testing, System Testing, and Acceptance Testing. Each phase must be completed before moving to the next, ensuring a structured approach with early defect detection. The V-Model is best suited for projects with well-defined requirements, as changes in later stages can be costly. While it enhances software quality through rigorous validation, it lacks flexibility for projects with evolving needs.

Phases of V- Model

The V-Model (Verification and Validation Model) is a sequential software development process where each phase has a corresponding testing phase, ensuring early defect detection. The process begins with the Requirement Analysis phase, where system requirements are gathered and documented. Next, the System Design phase defines the software architecture, database, and structure based on the requirements. The Architectural Design phase focuses on high-level module design, followed by the Module Design phase, where detailed component-level designs are created.

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Once the design is finalized, the Implementation phase involves coding according to the specifications. Each development phase has a corresponding validation phase: Unit Testing ensures individual components work correctly, Integration Testing verifies module interactions, System Testing checks overall functionality, and Acceptance Testing ensures the final product meets user requirements.

After successful validation, the Deployment phase releases the software for real-world use. Finally, the Maintenance phase involves updates, bug fixes, and improvements as needed. This model is ideal for projects with well-defined requirements, as it ensures a structured approach with a strong focus on quality.

V-Model is broken down into multiple phases

1. Verification Phase

The Verification Phase focuses on planning and designing the system before actual development begins. Each stage ensures that the requirements are well understood and structured before moving to the next step.

a) Requirement Gathering

In this phase, all system requirements are collected from stakeholders, including users, clients, and business analysts. The focus is on understanding what the system should do, without delving into how it will be implemented. The output of this phase is a Requirement Specification Document, which serves as the foundation for development and validation.

b) System Analysis

System analysis involves refining the collected requirements and identifying potential technical challenges. It determines whether the system is feasible based on available technology, cost, and time constraints. This phase ensures that all requirements are clear, consistent, and achievable before proceeding to the design phase.

c) Software Design

In this phase, the system's architecture and high-level design are created based on the analyzed requirements. The database structure, user interface design, and interactions between different components are planned. This phase ensures that all technical aspects of the system are well-defined before coding begins.

d) Module Design

The module design phase focuses on the detailed design of each software component. The system is broken down into smaller, manageable modules, and each module's internal structure, logic, and data flow are defined. This phase ensures that individual components are well-planned, making the coding phase smoother.

2. Implementation Phase

Developers write code based on the module design. Each module is implemented as per the specifications defined in the design phase. The goal is to develop efficient, error-free, and well-documented code. This phase marks the transition from design to testing.

3. Validation Phase

The Validation Phase ensures that each implemented feature meets the original requirements through systematic testing. It emphasizes requirement traceability**,** ensuring that every feature is directly mapped to the initial specifications, verifying completeness and correctness.

a) Unit and Integration Testing

Unit testing checks individual modules to ensure they function correctly as per design. It helps detect bugs early, reducing errors in later stages. Integration Testing then verifies that combined modules interact properly. This phase ensures smooth communication between system components.

b) System and Acceptance Testing

System Testing evaluates the entire software to ensure all functional and non-functional requirements are met. It includes performance, security, and usability testing. Acceptance Testing is the final validation stage, conducted by end-users or clients. It verifies if the software meets business needs and is ready for deployment.

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4. Maintenance Phase

Once the software is deployed, ongoing maintenance is required to fix bugs, update features, and improve performance. This phase ensures that the software remains functional, secure, and efficient over time.

Advantages

- Clear Structure
- High Software Quality
- Early Defect Detection
- Reduces Risk
- Better Quality Assurance

IV. CONCLUSION AND FUTURE WORK

In this paper, Smart vehicles with advanced sensors and communication technologies are transforming transportation but face challenges like sensor reliability, secure networks, and system security. A Blockchain-based framework can enhance accident prevention by enabling vehicles to monitor road conditions and share verified hazard alerts, prompting automatic speed adjustments. This decentralized system ensures tamper-resistant, real-time data sharing, reducing human errors and improving traffic safety. Future enhancements could integrate AI for predictive analysis and edge computing for faster processing, further optimizing road safety measures. Implementing such advancements will ensure a more intelligent, scalable, and responsive Internet of Vehicles ecosystem. Implementing decentralized access control will ensure that only authorized users can retrieve specific data, and interoperability with other systems, such as government databases and navigation apps, will enhance its applicability in real-world scenarios. These enhancements will make the system more robust, secure, and efficient, ensuring reliable traffic event verification.

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