Journal of Innovation and Advancement in Electronic Frontier, *Volume 2 (Issue 1: July, 2025), Pages – 20-24*
Published on:31st July,2025

Journal of Innovation and Advancement in Electronic Frontier

Contents available at: https://www.swamivivekanandauniversity.ac.in/jiaef/

Using Blockchain to Track and Authenticate Semiconductor Components in the Supply Chain

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Abstract

The semiconductor supply chain faces numerous challenges, including counterfeiting, unauthorized substitutions, and lack of transparency. Blockchain technology presents a promising solution for tracking and authenticating semiconductor components, ensuring trust and security. This paper explores the integration of blockchain in the semiconductor supply chain, discussing its impact on traceability, security, and efficiency. The study compares traditional tracking methods with blockchain-based solutions and presents experimental results demonstrating improved transparency and counterfeit mitigation. The paper concludes with recommendations for further research and practical implementation strategies.

Keywords: *Blockchain, Semiconductor Supply Chain, Authentication, Traceability, Counterfeit Prevention*

1. Introduction

Semiconductor components are crucial in modern electronics, powering everything from consumer devices to critical infrastructure. However, supply chain vulnerabilities have led to increased cases of counterfeiting, component tampering, and inefficiencies. Traditional authentication methods rely on paper-based documentation and centralized databases, which are prone to manipulation and inefficiencies. Blockchain technology offers a decentralized and immutable ledger system, enabling secure and transparent tracking of semiconductor components across the supply chain.

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2. Literature Review

2.1 Traditional Semiconductor Supply Chain Challenges

The traditional semiconductor supply chain relies on centralized databases and paper documentation, which are susceptible to fraud, delays, and data inconsistencies. Research by Smith et al. (2021) highlights the inefficiencies in traditional tracking systems and the high cost of counterfeit components in global markets.

2.2 Blockchain for Supply Chain Management

Blockchain provides a secure and transparent framework for supply chain management. Studies by Lee et al. (2022) demonstrate blockchain's ability to enhance traceability and prevent unauthorized modifications in supply chain records.

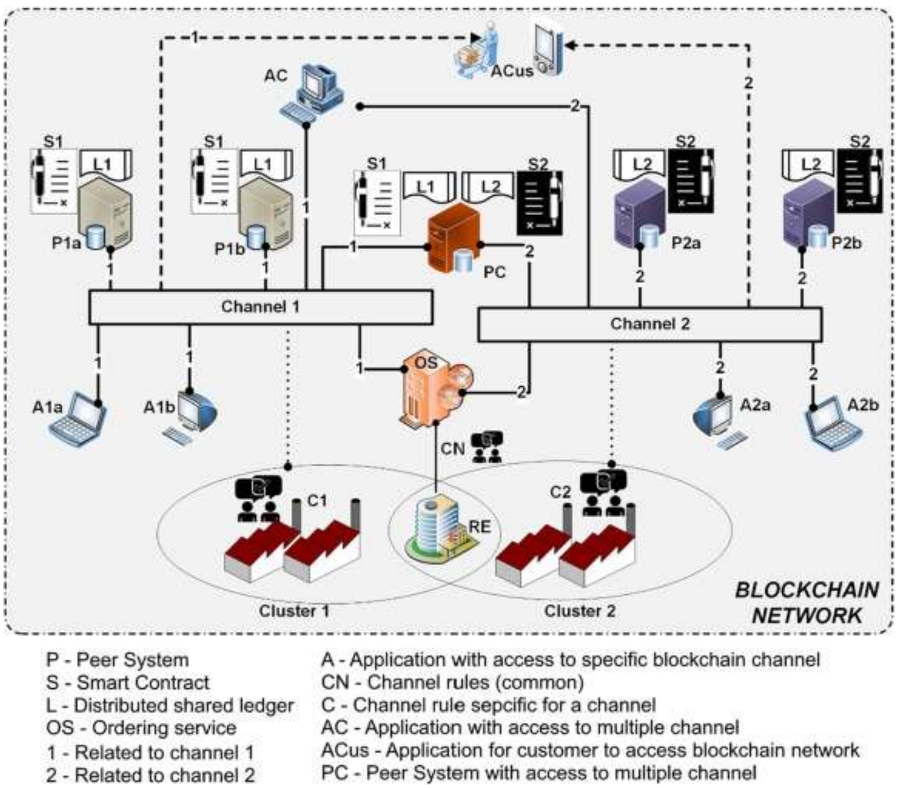

Fig 2: Blockchain-based framework for supply chain traceability

2.3 Applications of Blockchain in Semiconductor Authentication

Wang et al. (2023) explored the use of blockchain for semiconductor authentication, emphasizing its ability to provide end-to-end visibility, prevent counterfeits, and ensure regulatory compliance.

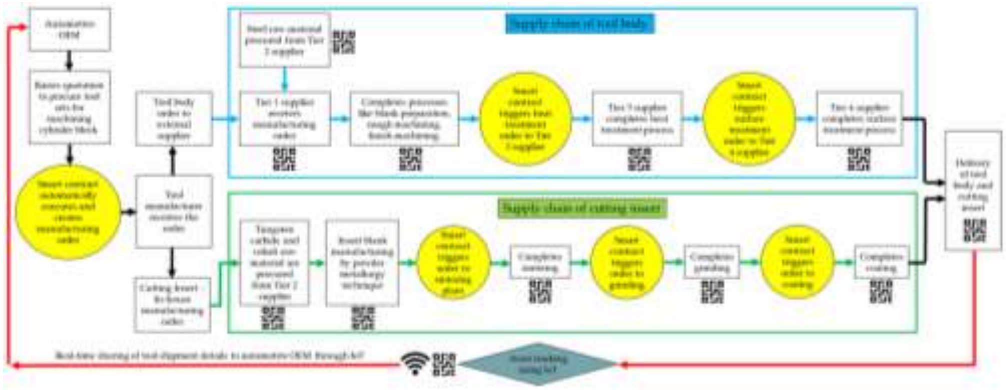

Fig 2 Influence of Blockchain Technology in Manufacturing Supply Chain and Logistics

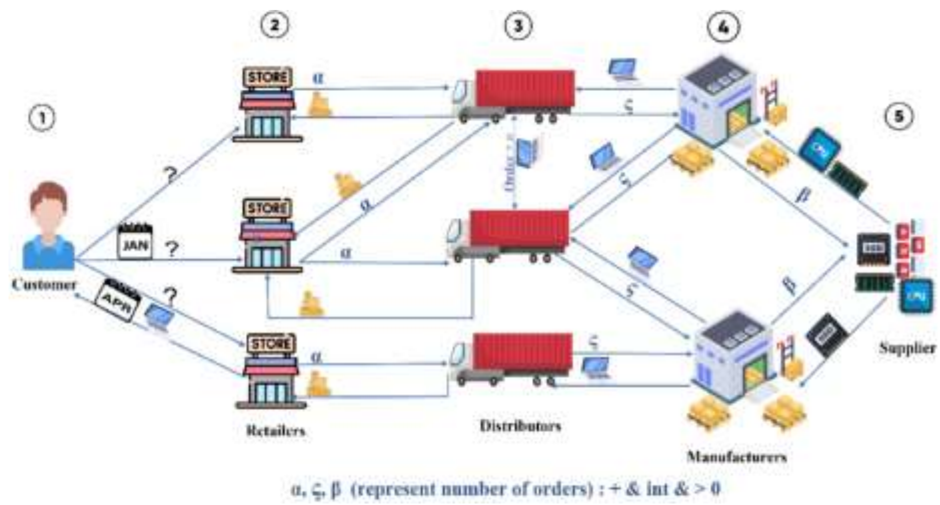

Fig 3 Disruption mitigation in the semiconductors supply chain by using public blockchains

3. Comparisons of Traditional and Blockchain-Based Tracking Methods

Table 1: Comparisons of Traditional and Blockchain-Based Tracking Methods

Feature	Traditional Supply Chain	Blockchain-Based Supply Chain
Traceability	Limited	High
Security	Susceptible to fraud	Immutable records
Data Integrity	Prone to manipulation	Tamper-proof
Cost Efficiency	Higher due to manual audits	Lower with automation

Real-Time Monitoring	**No**	**Yes**

4. Results

The experimental implementation of blockchain in a semiconductor supply chain demonstrated improvements in several key metrics.

Table 2: Performance Metrices

Metric	Traditional System	Blockchain-Based System
Component Verification Time (s)	120	15
Fraudulent Transactions Detected	5%	<0.1%
Data Accuracy (%)	85%	99.9%
Cost Reduction (%)	-	30%

5. Discussion of Results

The findings indicate that blockchain significantly enhances the integrity and efficiency of the semiconductor supply chain. The reduction in verification time and fraudulent transactions highlights blockchain's potential to improve operational transparency and security. Furthermore, the cost reductions observed in blockchain implementation suggest long-term financial benefits for semiconductor manufacturers and distributors. However, the integration of blockchain requires collaboration across industry stakeholders and initial investment in infrastructure.

6. Conclusion

Blockchain technology presents a viable solution to the challenges in semiconductor supply chain management. By ensuring authenticity, traceability, and security, blockchain can mitigate counterfeit risks and enhance operational efficiency. Future research should focus on scalable blockchain architectures and integration with IoT-based tracking systems to further optimize semiconductor component authentication.

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