

Decentralizing Healthcare and Securing with Blockchain Technology

R. Punitha Gowri¹, S. Muralitharan², G. Nivin³, M. Sanjay Aravindh⁴

¹Assistant Professor, Department of Computer Science and Engineering, Erode Sengunthar Engineering College, Perundurai, Erode, Tamilnadu, India.

^{2,3,4}Student, Department of Computer Science and Engineering, Erode Sengunthar Engineering College, Perundurai, Erode, Tamilnadu, India.

E-mail: ¹punithagowri@gmail.com, ²muralisam8778@gmail.com, ³nivinnithish6@gmail.com, ⁴sanjayaravindh2003@gmail.com

Abstract

It has been shown in recent years that the safe interchange of medical data improves people's care and treatment, thereby enhancing their quality of life. Blockchain technology has the power to revolutionize healthcare management systems by improving data security, interoperability, and integrity, thanks to its decentralized and unchangeable structure. As an emerging option for achieving balance in the healthcare ecosystem, blockchain technology facilitates interoperability between diverse healthcare systems through the use of smart contracts and standardized data formats. Despite its potential advantages, interoperability remains an ongoing challenge in the healthcare environment. From an architectural perspective, trade-offs must be considered in the design of a blockchain-based system. However, obstacles such as user acceptance, scalability issues, and regulatory compliance impede the implementation of blockchain in the healthcare industry. This study provides valuable insights into the evolving landscape of healthcare data management by highlighting the potential advantages and challenges associated with integrating blockchain technology into healthcare management systems. Additionally, it suggests a Blockchain-based electronic healthcare

management (EHR) model that could address some of the limitations of the existing systems.

Keywords: Decentralization, Security, Blockchain, Electronic Health Record, Health Care Management

1. Introduction

Recent years have witnessed a growing interest in the use of blockchain technology in healthcare management systems, with the potential to completely transform the ways in which patient data is exchanged, stored, and protected. This breakthrough holds promise for resolving persistent problems related to interoperability and security in the healthcare industry. The healthcare sector has long struggled with interoperability issues that hinder the seamless transfer of patient data across different providers, resulting in inefficient and fragmented treatment. Ensuring the privacy and security of sensitive patient data remains crucial, especially in light of the increasing risks of data breaches and cyberattacks [1].

Through an analysis of the existing state of affairs, an investigation of potential applications, and an assessment of the forthcoming technical and regulatory obstacles, this study explores the crucial role that blockchain will play in resolving these pressing issues. The intention of this study is to shed light on the potential of this technology to alter healthcare data management and enhance patient outcomes by examining the relationship between blockchain, interoperability, and security in healthcare management systems.[2]

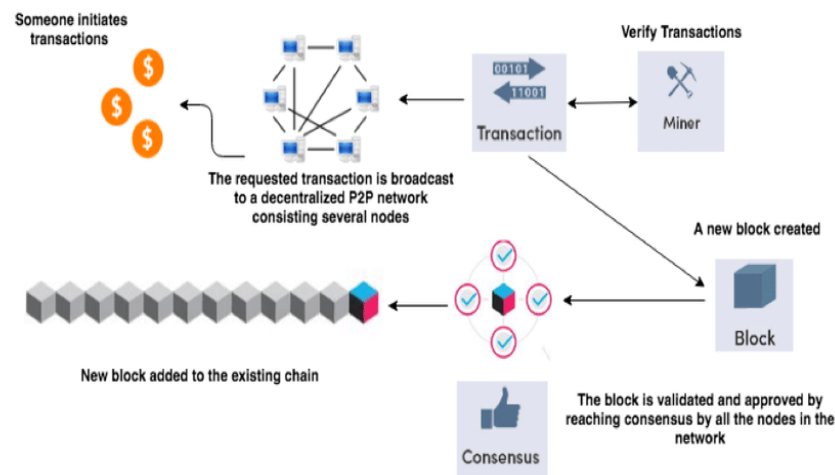


Figure 1. Functional Block Diagram of Blockchain [11]

2. Related Study

Tran Le Nguyen et al. [1]. explores the rising acceptance of Bitcoin and cryptocurrencies, particularly in healthcare, proposing a conceptual model for a medical app using blockchain to manage patient and physician databases during surgeries. The study addresses a gap in previous models concentrated on banking, offering insights into blockchain's application in healthcare. The envisioned app facilitates Bitcoin payments, empowering doctors in efficient patient management and assisting patients in informed decision-making. The study emphasizes blockchain's decentralized and secure nature, highlighting its role as a distributed ledger in various sectors beyond finance. The findings contribute valuable insights for medical stakeholders and underscore the global impact of blockchain technology study

Tanesh Kumar et al. [2] emphasizes the broader applications of blockchain technology beyond finance, with a focus on its potential impact on healthcare systems. Their study delves into the utilization of blockchain in healthcare, identifying key requirements like transparency and trustlessness for effective integration. The research also explores the role of smart contracts in establishing agreements among stakeholders. Beyond healthcare, the study highlights the versatility of blockchain in supply chain management, logistics, and the Internet of Things (IoT), offering secure, decentralized databases that eliminate the need for third-party intervention. The cryptographic measures of blockchain ensure secure data sharing in healthcare, addressing concerns about exposure of sensitive patient information. With advancements in internet and network technology, blockchain provides decentralized solutions that enhance healthcare services, empowering patients with greater control over their data and mitigating flaws in current healthcare systems.

Pinyaphat Tasatanattakoolet al [3]. In the last decade, blockchain technology has emerged as a transformative innovation, distinct from its often-associated application, Bitcoin. The authors emphasize that blockchain's versatility extends beyond finance, with applications such as smart contracts and hyperledger utilizing its decentralized and secure database storage. Blockchain's resistance to fraudulent manipulation makes it a robust technology. The authors underscore the need to recognize the diversity of blockchain applications, emphasizing its adaptability based on specific requirements. In this exploration, the study defines blockchain as a distributed system for storing data, clarifying distinctions between blockchain and Bitcoin. Future research directions involve implementing blockchain technology for electronic health

records, investigating how external parties can securely access patient health records from hospitals or health authorities without compromising privacy, showcasing the expanding potential and applicability of blockchain in various domains beyond finance.

Noor Adilah Rashid et al. [4]. In response to the limitations of traditional healthcare record systems, this research focuses on developing a web-based Electronic Health Record System (EHRS) with a feedback mechanism to enhance user trust. The proposed prototype, built on the Laravel platform using HTML and CSS, will feature feedback and review pages, allergy sections, doctor background information, and past record sections, all stored in a MySQL database on cloud computing. Rigorous testing and validation processes will ensure the system's smooth functionality. The project aims to revolutionize medical data storage by addressing challenges in traditional record systems, improving public healthcare systems through enhanced surveillance, decision-making, investigation accuracy, and stakeholder communication. The transition from manual to electronic systems is prompted by issues like inconsistent records, storage limitations, and misdiagnosed cases. The proposed EHRS addresses these concerns by incorporating a feedback mechanism accessible to both patients and healthcare providers, aiming to improve overall system efficiency and patient outcomes, showcasing the potential benefits of modern EHRS in transforming healthcare record management study.

Richard NueteyNortey et al[5]. In recent years, the electronic health record system (EHRS) has evolved significantly, allowing for the widespread access to individuals' medical records, leading to the emergence of big data in healthcare. While big data offers benefits in terms of cost-saving, reducing fatalities, and predicting disease outcomes, concerns about privacy breaches and security lapses during data collection have surfaced. To address these challenges, the proposal advocates for a platform that leverages blockchain technology to protect patient privacy while collecting, managing, and sharing EHRS data. The use of blockchain ensures complete confidentiality, integrity, and control over access to distributed electronic health records throughout the distribution process. Through simulations, the proposed method demonstrates the creation of a secure network for sharing EHRS in medical settings, balancing both privacy and transparency. As electronic health records contain sensitive information, restricting access becomes crucial. Existing literature emphasizes using blockchain alongside access control techniques to safeguard patients' medical information,

eliminating the need for trusted third parties. Despite the benefits of current approaches, this proposal suggests a blockchain-based architecture in a cloud computing environment to address privacy and security concerns. While cloud computing offers scalability and improved patient care, the model acknowledges the need for more straightforward implementation processes as blockchain technology continues to evolve, emphasizing the importance of ensuring usability in the quest for a secure and private EHRS.

Vidisha Bhatt et al [6]. Electronic health record (EHR) systems have become integral to healthcare, streamlining patient data access and secure sharing but suffer from time-consuming manual data entry. Addressing this issue, the developed solution, DocPal, shows promise in enhancing accuracy, efficiency, and usability, aiming to reduce data entry times and improve patient care. Despite the benefits of EHR systems in improving coordination, efficiency, and error reduction, manual data entry remains a significant time burden for healthcare professionals. In response to the need for more efficient care, the implementation introduces a voice assistant based on Alexa, called DocPal. This HIPAA-compliant Alexa skill aims to alleviate the time spent on data entry by allowing medical professionals to provide instructions verbally and perform tasks efficiently, contributing to a more effective use of patient-provider time. While the adoption of voice assistants in healthcare has been slow due to regulatory concerns and user confidence, this implementation strives to overcome these barriers by integrating voice assistants like Alexa into healthcare workflows, aligning with the industry's goal of improving patient care and reducing the administrative burden on healthcare professionals.

Sai Mounika Tadaka et al [7]. Blockchain technology operates on a decentralized system of interconnected blocks, each containing digital assets and linked through a continuous chain of transaction data. Originating from the concept of tamper-proof document timestamps in 1991, blockchain gained prominence with the invention of Bitcoin in 2008 by Satoshi Nakamoto. This page showcases diverse examples of blockchain applications, including its role in healthcare, fraud prevention, Electronic Health Record (EHR) management, and integration into Industry 4.0 and cyber-physical systems. It explores the decentralized nature of blockchain, emphasizing its transparency, security, and lack of centralized control. Despite challenges like scalability and interoperability, blockchain continues to evolve with the introduction of private, public, and consortium blockchains and different consensus algorithms.

The technology's expansion into healthcare, as seen in projects like those in South Africa's healthcare system, demonstrates its potential to enhance efficiency and security across various industries. As blockchain technology evolves, its applications continue to grow, contributing to transformative changes in sectors beyond finance.

Zuobin Ying et al[8]. Advancements in technology, particularly the emergence of e-healthcare cloud systems, enable widespread sharing of electronic health records (EHRs) but raise concerns about data privacy. To mitigate potential risks posed by malicious users in the cloud, a novel approach named black-box traitor tracking is proposed. This method employs partial policy hiding attribute-based encryption, restricting access to encrypted EHRs and preventing privacy breaches caused by users leaking decryption privileges. The scheme has demonstrated full security and superior performance in terms of computing overhead and storage requirements compared to existing systems. In the context of e-health, the transition from study -based health records to digital EHRs accessible via the internet enhances the convenience and scalability of managing and sharing medical information among healthcare professionals. However, the sensitive nature of EHR data, encompassing genetic history and blood glucose levels, necessitates robust security measures. The proposed e-healthcare FHPT system, operating within the e-healthcare cloud environment, utilizes traitor-resistant encryption based on partially-hidden access policies (CP-ABE) to ensure comprehensive security for patient information in EHRs study.

Mohammad I. Zarour et al [9]. Blockchain technology, a groundbreaking innovation in information technology, has become a pivotal force in the digital age, with anticipated transformative impacts, particularly in healthcare technology. Safeguarding the sharing of sensitive medical information, especially in Electronic Health Record (EHR) systems, requires a systematic approach in selecting an appropriate blockchain model that balances security and accessibility. This study offers a scientific evaluation of blockchain technology's impact, incorporating input from 56 healthcare management experts. Utilizing a decision model and Fuzzy Analytic Network Process (F-ANP) for criteria weights, the study addresses uncertainties and evaluates solutions using Fuzzy-tool for Order of Preference by Similarity to Ideal Solution (TOPSIS). The findings serve as a valuable reference for selecting the most suitable blockchain model to ensure breach-free EHR. Despite challenges in contacting primary healthcare providers and rising healthcare difficulties globally, blockchain technology holds promise for healthcare sector transformation. Functioning as a decentralized database,

blockchain records all electronic transactions, providing precise, verifiable records and potential cost savings. In healthcare, where data breaches are a significant concern, various blockchain models, such as private, public, hybrid, permissioned, consortium, and decentralized applications, are being explored for their transformative potential

SuparatYongjoh et al[10]. The Internet-of-Healthcare Systems serves as a specialized version of the Internet of Things, uniquely tailored for healthcare applications. This system efficiently connects and centralizes patient medical data from diverse hospitals, utilizing blockchain technology to address security and administration concerns. Currently adopted by over 350 hospitals, these systems, operating through the Message Queueing Telemetry Transport protocol, seamlessly integrate with various health information systems used by member hospitals, facilitating the creation of a national integrated health records system. The network architecture, collectively known as an Internet of Special Things, showcases its ability to manage numerous local systems effectively. Access to patient data stored in the central blockchain is facilitated through mobile apps, ensuring strong access control via Amazon Web Services and the Key Management System. Feedback from medical staff emphasizes user-friendliness, ease of installation, maintenance, updates, and robust security measures. As part of the national development strategy, Thailand 4.0, this system aligns with the increasing importance of Electronic Health Care Systems (E-Health systems) in national public health administration, recognized by organizations like the World Health Organization (WHO). The data collected from collaborating medical institutions is referred to as Electronic Health Records (EHRs), contributing to the creation of a fully integrated digital public health information system.

Table 1. Comparative Study

Ref. No	Title	Authors	Journal & Year	Methodology	Demetries
1	Blockchain In Healthcare: A New Technology Benefits For Both Patients And Doctor	Tran LeNguyen	2018	Conceptual model of Medical app tomanage all data base of patients and doctors when they have Surgery.	Data fragmentation combined with a lack of system interoperability. Accessing data becomes increasingly difficult as the number of computers increases.
2	Blockchain Utilization in Healthcare: Key Requirements and Challenges	TaneshKumar,VidhyaRamani, IjazAhmad	2018	Implementation of Block chain technology ensures Security and Integrity of the Medical Information.	Blockchain-based healthcare solutions must be properly addressed prior to adoption.
3	Blockchain: Challenges and Applications	Pinyaphat Tasatanattakool	2018	It satisfies al l stake holders suchas Hospitals, Healthcare, Health Authorities bymeeting information consumer's needs and Protecting patient privacy by using blockchain.	A patient's health records may be lost or copied illegally.
4	Web-Based Electronic Healthcare Record System(Ehrs) Based On Feedback.	Nurul ShazminBtNasaruddin, Izzatdin AbdulAziz, NoorAdilahRashid	2018	Development of prototype of EHRS that enhance trustelement between patient and health institution throughthe Feedback system.	Storing information online leaves it vulnerable to data breaches and illegal access.

5	Privacy Module for Distributed in EHRs Using Blockchain.	RichardNuetey Nortey,PromiseRicar doAgdedanu,Michael Adjeisah	2019	A platform of blockchain for privacy preserving during collection, management and distribution of HER data.	Lack of complete data deletion.Once data is uploaded to the block chain, it is exceedingly difficult to remove or edit.
6	DocPal:AVoice-based EHR Assistant for Health Actitioners.	Vidisha Bhatt,Juan Li, BikeshMaharjan.	2020	Using water fall model, A Sequential task based SDLC ,developed the voice assistant, DocPal.	It has some security flaws and exposes confidential patient information.
7	Application of Blockchain in Healthcare, Industry 4and Cyber-Physical Systems	Sai MounikaTadaka, Lo'aiTawalbeh	2020	Offline wallets , used alternative Hashing algorithmsand alternatives to proof of work.	This causes delays and greater costs for maintaining and extending the infrastructure.
8	FHPT: Fine-Grained EHR Sharing in E-Health care Cloud with Hidden Policy and Traceability	Zuobin Ying ,Yuanping Si ,Jianfeng Ma,Ximeng Li ,and ShengminXu	2020	A new Black boxtraitor tracingscheme based on partial policy hiding attribute basede ncryption and performs fine-grained access control on encrypted.	Increases administrative burden, possible overhead, and system complexity. leads to issues in policy management.
9	Evaluating the Impact of Blockchain Models on Secure and Trustworthy Electronic Health Records	Mohammadzarour, Mdtarique jamalansari,Mamdou halenezi, Amalkrishna sarkar,Mohd faizan,Alka agrawal,Rajeev kumar ,and Raeesahmad khan	2020	It isused toimplement MCDM technique in a fuzzy setting so as tochoose the most appropriate solution.	The framework offers a sophisticated approach to addressing issues with data security, access management, and other centralized systems.

10	Development Of An Internet-Of-Healthcare System Using	SuparatYongjoh, Chakchai So-In, PeerapolKompunt	2021	The Internet-of-Health-Care-Systems comprising specially the patient medical information system of webservices.	The decentralized network and data structures that define blockchains make tampering with recorded data exceedingly difficult, if not impossible.
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In the field of healthcare systems, the growing difficulty of data fragmentation, combined with a lack of system interoperability, presents substantial challenges. As the number of computers grows, accessing essential health information gets more difficult. Furthermore, concerns have been raised about the potential loss or illicit copying of patient health records when using blockchain-based solutions. Storing sensitive data online creates vulnerabilities that can lead to data breaches and unwanted access. Another problem is the permanence of data on the blockchain, as once published, it is extremely difficult to erase or change, limiting effective data management. Security weaknesses in the system reveal personal patient information, causing delays, higher expenses, administrative burdens, and increased system complexity. This convergence of obstacles causes issues with policy management and overall infrastructure upkeep. Despite these shortcomings, blockchain networks' decentralized nature and resilient data structures offer a sophisticated method to addressing data security and access management challenges. The tamper-resistant properties of blockchain make illegal alteration of recorded data practically difficult, providing an effective structure for addressing the problems of centralized healthcare systems.

3. Proposed Methodology

Blockchain technology can play a crucial role in the healthcare industry, striking a delicate balance between privacy and accessibility of electronic health records. It serves as a distributed database, enabling secure, transparent, and tamper-proof transactions. Initially developed for Bitcoin, blockchain has been adapted for various applications, proving particularly beneficial for health records. By granting patients control over data access and

utilization, it facilitates secure, transparent, and instantaneous transactions between patients and physicians.

The proposed system aims to revolutionize healthcare by leveraging blockchain technology, enhancing safety and transparency. Through the implementation of secure methods, the system establishes an unchangeable record system for patient medical data. Integrating blockchain into the electronic health record empowers patients with complete control over their medical records, facilitating access from anywhere and any device. Patients can selectively share records and monitor access history, taking advantage of the tamper-proof nature of blockchain, instilling confidence in the safety and security of their health records [12]. The figure.2 below depicts the block diagram of the proposed.

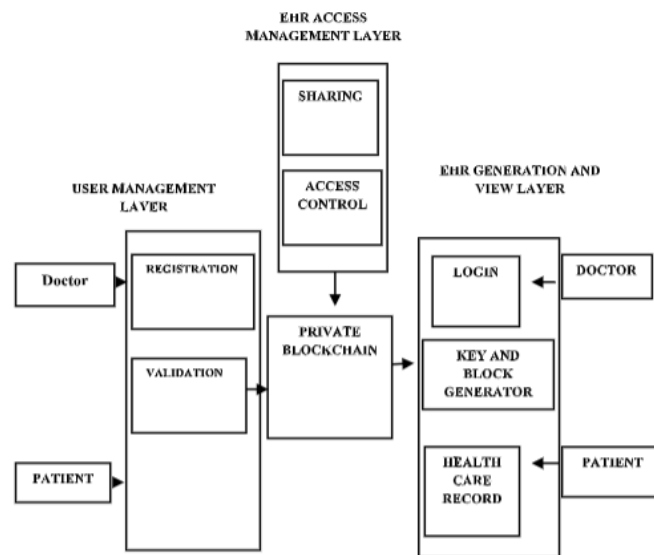


Figure 2. Proposed Block Diagram

The proposed system operates through three distinct layers: the user management layer, EHR access management layer, and EHR generation and viewing layer. It involves three key actors: patients, doctors, and third parties, which can be government agencies or private companies responsible for managing health records. The system utilizes cloud agents to store electronic health records (EHRs). Figure 3 below illustrates the functions of each layer in the proposed system [13].

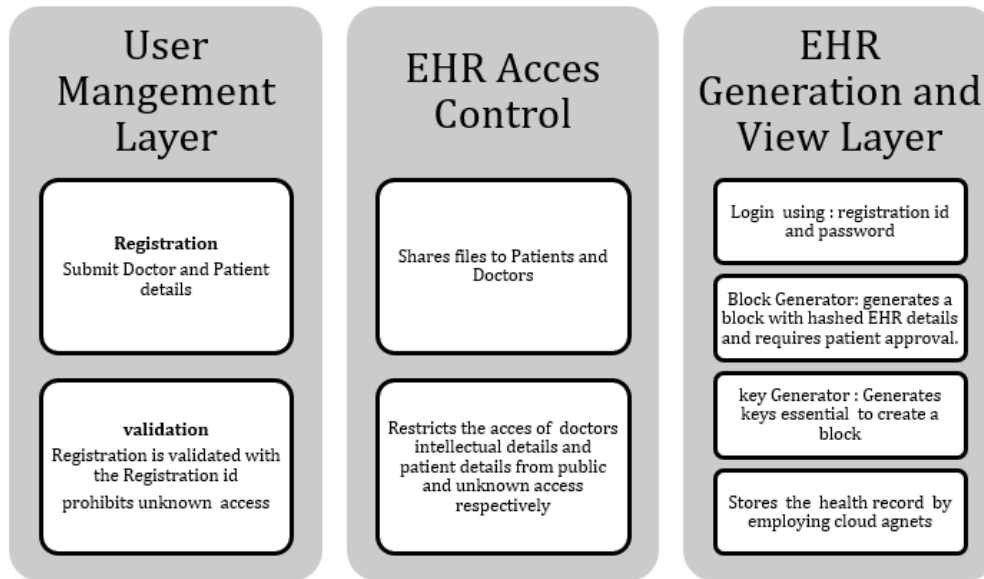


Figure 3. Functions of Proposed Blockchain-based EHR Layers

The proposed Blockchain-integrated EHR utilizes the hash-lock mechanism, employing a cryptographic hash function (such as SHA-256) to both secure and verify the data. The hash-lock mechanism safeguards patient data by hashing it, and the resulting hash value is stored on the blockchain. To access the actual patient data, the patient must provide the original data, and the system verifies it by hashing and comparing it with the stored hash value. This mechanism adds an additional layer of security, ensuring that only authorized individuals with the correct information can access or modify the data. The third parties involved in managing the records continuously verify the authenticity of the records and are involved in each and every process between the patients and doctors [14].

4. Discussion and Future Work

The proposed method emphasizes how blockchain technology could revolutionize healthcare management systems by enhancing data security, interoperability, and integrity. It highlights the potential for secure sharing of medical information to significantly improve patient care and treatment outcomes. Because of its decentralized and immutable nature, blockchain offers a robust solution for safeguarding the security and integrity of sensitive medical data across multiple systems, thus addressing key challenges in healthcare data management.

It also acknowledges the ongoing challenges associated with implementing blockchain in the healthcare sector. It stresses the critical importance of adhering to regulatory standards to ensure privacy and confidentiality when managing healthcare data. Additionally, scalability presents a significant hurdle as healthcare systems must effectively handle vast amounts of data while remaining efficient. Moreover, gaining user acceptance poses another major challenge, as everyone within the healthcare ecosystem needs to embrace and integrate blockchain technology into their everyday practices.

Furthermore, the study underscores the importance of analyzing data to evaluate the effectiveness and significance of incorporating blockchain technology in healthcare environments as future work along with the development of the user interface for the health care application.

5. Conclusion

In short, integrating blockchain technology into healthcare management systems shows great potential for enhancing people's lives by ensuring the safe sharing of medical information. Blockchain's secure and unalterable structure offers solutions to key healthcare challenges such as data security, interoperability, and integrity. To enable seamless communication between different healthcare systems, smart contracts and standardized data formats play a crucial role.

It's crucial to understand that creating blockchain-based solutions involves making thoughtful decisions about their design. The widespread adoption of blockchain in healthcare is hindered by problems like low user acceptance, scalability issues, and meeting regulatory requirements. However, despite these obstacles, the study reveals significant benefits that highlight the potential of blockchain technology to revolutionize how healthcare data is managed and suggests a proposed blockchain based frame work for health care management. The insights provided by the study offer valuable guidance for navigating the challenges and fully harnessing the power of blockchain in healthcare systems, especially given the ongoing advancements in the industry. Furthermore, the study underscores the importance of analysing data to evaluate the effectiveness and significance of incorporating blockchain technology in healthcare environments as future work along with the development of the user interface for the health care application.

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