Information Sciences with Applications, Vol. 4, 2024
https://doi.org/10.61356/j.iswa.2024.4431

Block Chain Based Automated Multiresolution Channel Allocation of IoT

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Abstract: This research includes the growing popularity of the Internet of Things (IoT) in recent years. Internet of Things (IoT) security and privacy remain a major challenge, mainly due to IoT networks' massive scale and distributed nature. Blockchain-based approaches provide decentralized security and privacy, yet they involve significant energy, delay, and computational overhead unsuitable for most resource-constrained IoT devices. The Internet of Things is a real-time application for high data rates, and blockchain technology is real-time data storage technology. It is an effective way to transfer data from the communication node to the system in the IoT network using blockchain technology, the most recent each IoT node discovers and adjusts for better communication. It is necessary to have the confidence to integrate/maximize the channel's output of the wireless sensor networks' features. The change can be implemented. However, from time to time the channel for the information does not learn to transmit to the protocol. Changing the channel characteristics in these networks like IoTs for achieving and increasing the data transmission and network throughput of wireless sensor networks. Therefore, this research recommends a completely computerized nature-understanding and by-origin procedure designed which may completely automate data transfer communication between multiusers by completely applying channel time spectral and time attributes of wireless network and store the data through blockchain technology then fetch data from any node when you want. For this purpose, designed Protocol channel swapping, data storage from time to time through blockchain technology, and following the shortest path for communication. The planned designed protocol of this WSN is rare as it is understanding and proposed the issue to maximize the WSN intensity established upon the WSN network metrics. This network also permits every node inside that IoT to regularly identify the adjoining network station characteristics so that they will exchange networks which means swapping adjoining channels to realize maximum data transfer.

Keywords: Wireless Sensor Network; Internet of Things; Support Vector Machines; Time Spectrum Allocation; Block Chain Technology; IoT through Blockchain.

1. Introduction

The Internet of Things (IoT) has revolutionized various domains by enabling interconnected devices to share and process data seamlessly. However, challenges such as secure data transfer, energy efficiency, and optimal resource utilization persist [1]. Blockchain technology offers a robust solution for ensuring decentralized and tamper-proof data exchange in IoT environments. This paper proposes a novel blockchain-based automated channel allocation protocol to enhance the efficiency of wireless sensor networks (WSNs), leveraging machine learning for adaptive optimization [2]. The Internet of Things (IoT) built (WSN) wireless networks have been utilized for executing different applications associated with healthcare data traveling, communication and surveillance, and reconnaissance. An IoT structure comprises web-backed intelligent machines that use fixed processors, measuring devices, and transmission hardware to send and act on data they develop from their surroundings [1-2]. Wireless IoT devices share sensor data, and from time to time, these devices connect with nearby associated systems and act on the data they find from each other. This system works automatically without any interruption of the human body. But humans operate it by doing configuration of the system; when humans want to access the data they adjust the system configuration and access the data [4].

The IoT network (nets) includes more than sensor nodes that can feel their adjoining ecosystem. However, they have a maximum quantity of strength, and they are managing data, which is processing and holding the data in storing devices, i.e., memory. One of the main tasks is to travel efficient data from source to destination point. Most scientists have utilized the energy to wireless sensor nodes and maximize the data transmission rate of WSN [5]. There has been an idea to allow efficient data transmission without any delay between the data transmissions. Moreover, many procedures have been proposed to utilize efficient data transmission through multichannel procedures for this purpose. Separately, different fusion channel dividing procedures are also scheduled to operate constant data slots of network-based time and frequency types for effective channel utilization [6]. Any time transaction using blockchain technology is more efficient than other ways. There is no need for a third party to conduct transactions from one point to another, which reduces the friction, time, and cost of communication. Through blockchain technology, transactions are always safe and quick. The cryptography behind the blockchain allows the transaction to be verified and helps ensure the permanency of the record [7].

Previous studies on blockchain-based IoT networks have primarily focused on static channel allocation or relied on private blockchains, which limit scalability and transparency. For instance, an energy-efficient allocation mechanism was proposed but did not address dynamic channel characteristics [8]. The proposed protocol differs by incorporating Gaussian-based multiresolution analysis, allowing real-time spectral adjustments, and leveraging a public blockchain for decentralized security. This combination ensures scalability and enhanced throughput, making it suitable for resource-constrained environments like telemedicine [9].

Yang et al. [26] examined sliding mode control for persistent dwell-time switched systems experiencing random data dropouts. Duan et al. [27] concentrate on observer-based fault detection for continuous-discrete systems, utilizing a Takagi-Sugeno fuzzy model to improve system monitoring and dependability, especially in nonlinear hybrid systems. Diao & Zhang [28] employed decision tree models to enhance management strategies for small- and medium-sized firms (SMEs), demonstrating a practical application of machine learning in corporate management. Yang et al. [29] proposed an asynchronous fault-tolerant control technique for stochastic jumping singly perturbed systems with H_∞ sliding mode control. Xing et al. [30] examined the stability and Hopf bifurcation in neural network models using time delays. Jia et al. [31] investigated finite-time synchronization of uncertain fractional-order delayed memristive neural networks by adaptive sliding mode control. Yu et al. [32] examined adaptive finite-time control for uncertain nonlinear systems with unknown control gains, suggesting a robust control method with applications in nonlinear system stabilization. Zhang et al. [33] examined observer-based sliding mode control for fuzzy stochastic switching systems subjected to deception assaults, thereby augmenting system resilience against cyber threats. Sun et al. [34] introduced sliding mode control for discrete-time interval type-2 fuzzy Markov jump systems. Duan et al. [35] proposed H_∞ control techniques for continuous-discrete systems in TS fuzzy models with finite frequency requirements. Wang et al. [36] introduced H_∞ sliding mode control for PDT-switched nonlinear systems utilizing a dynamic event-triggered technique. Huang et al. [37] proposed a rejected multi-objective grey target choice model for supplier selection, merging grey system theory with decision-making methodologies. Xu et al. [38] concentrated on data-driven optimal tracking control for switched linear systems.

There are three types of blockchain technology, "which do not include traditional databases or distributed ledger technology (DLT) that are often confused with blockchains" [10].

- **Public blockchains** like Bitcoin and Ethereum.
- **Private blockchains** like Hyper Ledger and R3 Corda.
- **Permissioned Blockchain or Hybrid blockchains** like Dragon chain.

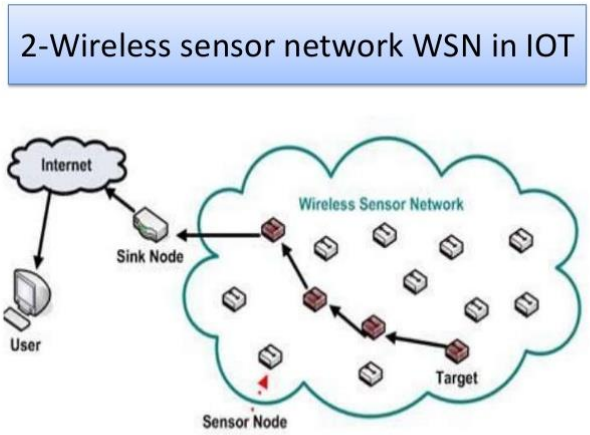

Figure 1. Proposed system model.

2. Proposed Model

The main key points of this paper are frequently summarized as follows.

- Presenting the procedure of wholly automated network-informed channel distribution protocol.
- The designed protocol checks the transmission data rate and gives a better topology to transmit the data, increasing the data rate.
- This paper uses the Gaussian Radial foundation to utilize multi-user data.
- Furthermore, this proposed model gives us a solution of a combined network channel apportioning protocol that regularly analyses a channel's varying time and spectral qualities for economic data transfer in a multiuser environment [1].
- Push data to a public blockchain like Ethereum to save it and avoid data tampering.
- Each node will be linked to a single system account, a physical blockchain account.
- Nodes will publish data to the chain via a system account.
- Data storage will be done through trisections, which system accounts will sign.
- Similarly, system accounts will be used to access data from the Ethereum chain at any point in the network.
- The system account is used for research purposes. In real-life scenarios, each node will have its account or private tags, and its data will only be accessible via its permission.
- This designed procedure is considerably the shortest path for every Transmission. We traveled the data on the transmission channel, choosing the shortest route for efficient solutions in terms of output, blocking the probability of channel fairness, and successfully increasing the achieved output from 40% to 60%.
- The designed procedure is exceedingly strong and gives a high communication speed of up to 44.5 Mbps around a single-channel solution [3].

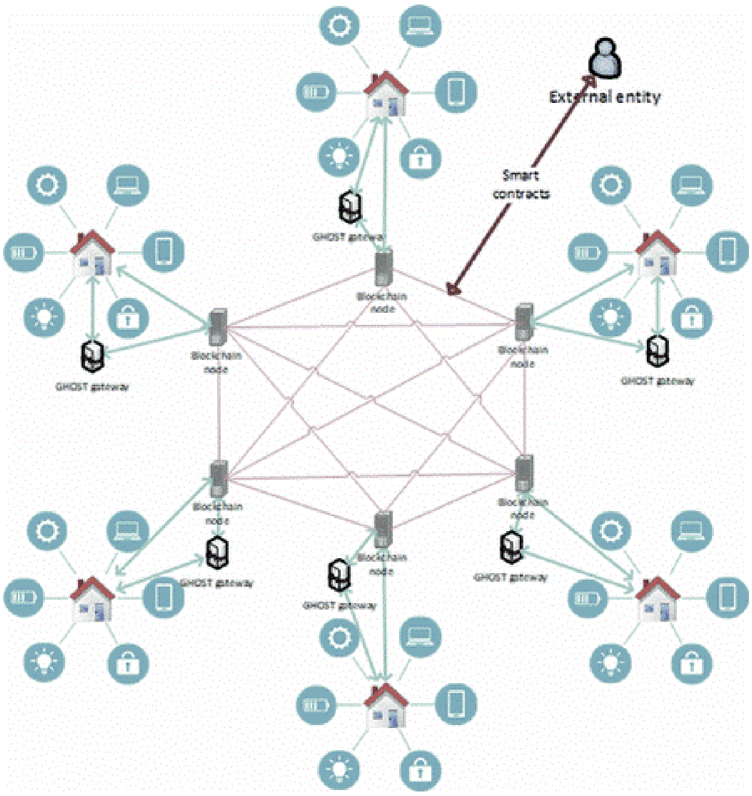

Figure 2. Blockchain-based IoT network.

3. Overview of Block Chain Technology

There are three types of chains.

- Public Blockchain
- Private Blockchain
- Hybrid Block Chain

We use the public blockchain in our research, open-source technology. They allow anyone to participate as the user's developer or community member with that user's permission. All transactions are fully transparent and take place in a blockchain network, which means anyone who examines the transaction details with the permission of the node [12]. Public blockchains are designed to be fully decentralized systems with no one individual or entity controlling which transactions are recorded in the blockchain. We can transfer data through channels using a highly secure procedure. Because the data of nodes are stored in blockchain, anyone who wants to access the data must follow the permission from that node [13].

3.1. Need for Blockchain Technology

Now that we understand what a blockchain is and the different types of blockchain used at different points, blockchain technology has many benefits. Most of the advantages of the implementation of a blockchain is security. Blockchain implementation is a very secure procedure for communication or transactions. Blockchain is a database, but it differs greatly from traditional databases [14]. In a traditional database, information stored is centralized, but in a blockchain, it is decentralized. All the participants in the chain hold a record of the ledger that can verify the provenance of all the entered data. Think of it as a database without an administrator. This means that participants don't have to rely on any single individual or entity for data integrity. Distributed Ledger Technology, or DLT, is a category of database technology that includes blockchain technology or characteristics of a blockchain [15].

However, not every blockchain is a distributed ledger. In the Dragon chain case, there is no single blockchain. On the Dragon chain, there is also no need for proof of work or proof of stake, like distributed ledger technology. See how easy it is to get confused?

- The terms are sometimes synonymous, but other distributed ledgers are structured differently from blockchains.
- Examples include Iota and Hash graphs, more accurately described as DAGs or Directed Acyclic Graphs.
- While blockchain was the first distributed ledger technology (DLT), it is not the only type of DLT one can consider.

3.2. Overview of Channel Allocation Technique

A cellular network in deep space is divided into smaller parts known as small cells. The cell image is placed on the base station with a hexagon of the whole thing suitable for the rays of a directional antenna. For each mobile station in the cellular base station, a channel allocation is requested. And allocate a base station and a mobile station using channel allocation for customers [12]. The art stipend is acceptable to the main runners and tries to reduce the possibility of blocking calls. Three allocation methods exist for a specific channel distribution channel (CAF), DCA, and HCA [16].

Depending on the channels, how these methods are used. Predetermined Price Allocation (CAF) in CAF channels is initially assigned to cells. The main reason is related to the stream's source; from there, the branch is available for the entire cell. Thus, all cluster cells outside the cell of the same channel are displayed in a uniform current distribution. FCA has a very simple design and an even efficient distribution of channels. These are not, however, conditions for the distribution of goods to adapt to the evolution of the user and CAF. Providing advice to each other, there is an uneven distribution of traffic channels in the FCA [18].

The SVM classifier categorizes channel states based on spectral and temporal features. Inputs include signal-to-noise ratio (SNR), bandwidth, and time allocation metrics. The model achieves nonlinear classification by utilizing a Gaussian Radial Basis Function (RBF) kernel, allowing accurate prediction of optimal channels for dynamic allocation. Parameters such as regularization strength and kernel coefficients were tuned using cross-validation to enhance predictive accuracy [16].

4. System Model

The reliability verification of IoT system devices refers to the approval that the destination device has the attribute, for example, position and functions [22]; these are called in the examination center, and all the information transmitted and received is not secure from network attackers. The old-style security and privacy strategies based on irregular or asymmetric encryption are very problematic to implement in an IOT atmosphere for two reasons.

- Encryption is based on a centralized key-based management system, which is why a decentralized system is preferred to meet the growing IoT technology.
- The current generation market is consumer-extensive, which is why price matters a lot in every aspect of the design of IoT; decentralized methodology not only provides the best possible security but is the best option for price that meets the needs of current market trends.

Blockchain technology pretty much solves the problem, but the IoT network still faces some challenges in the application. The following are some major problems I have shortlisted in my research [15].

- The Products of IoT require a low latency transmission as the blockchain is calculation intensive, giving a hard time for IoT Applications.
- The number of static hash records of the blockchain requires more time, which is unsuitable in IOT as the network is rapidly increasing.

- The pre-transmission traffic is more substantial than the concerned data flow, affecting proper communication.

The research proposes the credibility of the verification methods of the blockchain. I tried to work on credibility for IoT device verification based on hashing methodology. To illustrate the difficulties faced in the application of IoT with the blockchain for verification.

4.1. Algorithm Depth First Search DFS

The DFS is a recursive method that gives us a backtracking idea of a loop. Firstly, it searches all nodes in the future track. It selects the perfect path if it finds the possible search path of a finite loop. Otherwise, it goes back to backtracking to find the ideal path for data transmission. For this purpose, when you go forward to see the path, but there are no possible nodes in your track, go back for backtracking to find the possible node of the perfect path. In this procedure, all nodes will be visited [17].

This procedure continues until all the nodes have been finished. After visiting all the nodes, select the path which will be the perfect path. This recursive loop of DFS is applied through the stack. Push the node first in the stack, and then pick the node from the stack where you want to start and push all neighboring nodes. Now, pop a new node from the stack and push and pop continually. Pop a node from the stack to choose the next node to visit and push all its neighboring nodes into a stack. Repeat the procedure again and again until all nodes are [9].

4.2. Blockchain Technology

It is a technology that enables digital data transfer with highly sophisticated encryption and in a completely secure manner [3]. This transfer does not require a centralized intermediary to identify and certify the information; instead, it is distributed in multiple independent nodes that register and validate it without the need for trust between them. Our research uses the public blockchain, which is an open-source technology. They allow anyone to participate as a user's developer or community member with that user's permission [12]. All transactions are fully transparent and take place in a blockchain network, which means anyone who examines the transaction details with the permission of the node. Blockchain implementation is a very secure procedure for communication or transactions.

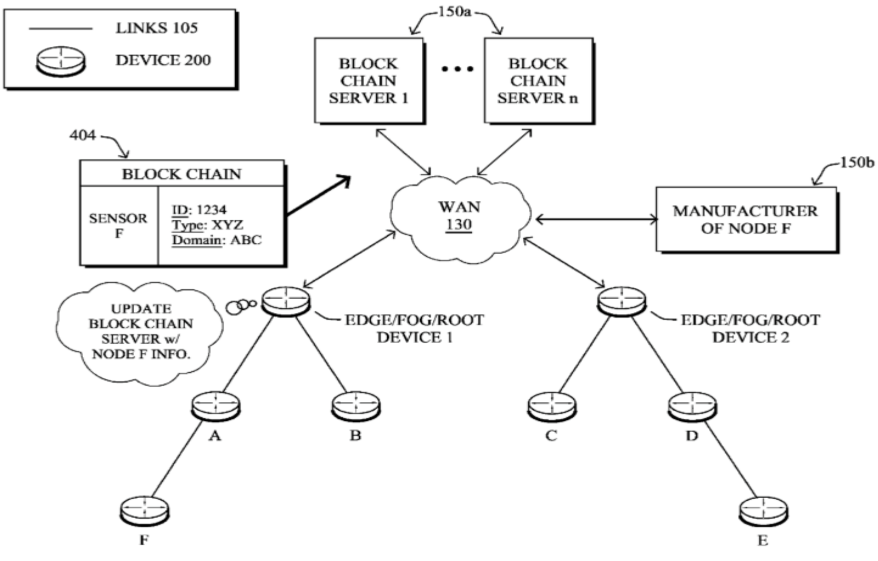

Figure 3. Database of Blockchain IoT Net.

Blockchain is a database, but it is very different from traditional databases. In a conventional database, information stored is centralized, but in a blockchain, it is decentralized. All the participants in the chain hold a record of the ledger that can verify the provenance of all the entered data. Think of it as a database without an administrator [14].

4.3. Proposed

This is for verification of proposed data models based on original IOT data communication. I designed a model for device verification. These IoT devices included IDs and private data communication keys. This ID was used to identify the IOT devices. That is why all devices are different from each other. All keys used for the asymmetric encryption were used for the verification [19].

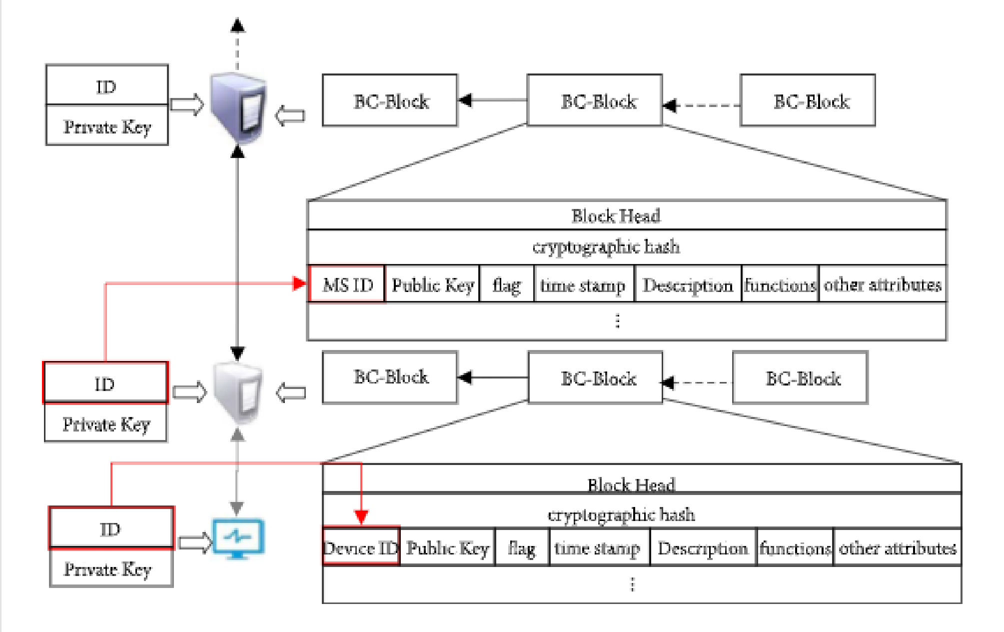

Figure 4. The data model for verification.

4.4. Method of Multi-Solution Network

We utilized multi-resolution channels in the IoTs wireless network where our designed procedure has worked. This spectrum will show the classic idea at two levels of cerebral radio networks in which clients can release secondary lines with the amount of one leg in the absence of the primary customer [20]. Automatically distributes channel structure or spectral characteristics all over the network's nodes.

$$\emptyset_0 = \alpha\, cos\theta\ (\, 2\pi \textstyle\sum_{p=0}^{n-1} (f_a + \Delta_0 x_0(p))) \quad (1)$$

To

$$\emptyset_{i-1} = a_{i-1}\, cos\theta\ (\, 2\pi \textstyle\sum_{p=0}^{n-1} (f_a + \Delta_{i-1} x_{i-1}(p))) \quad (2)$$

From

$$\emptyset_0 = \emptyset_0 + \frac{1}{\sqrt{2\pi\sigma_0}} e^{\frac{\emptyset_0}{2\sigma_0{}^2}} \quad (3)$$

To

$$\emptyset_{i-1} = \emptyset_{i-1} + \frac{1}{\sqrt{2\pi\sigma_{i-1}}} e^{\frac{\emptyset_{i-1}}{2\sigma_{i-1}{}^2}} \quad (4)$$

And

$$\emptyset_0 = \frac{1}{2}\log\left(1 + \frac{\frac{1}{n}\sum_{p=0}^{n-1} |\emptyset_i(p)|^2}{\sigma_{\emptyset_i}^2}\right) \quad (5)$$

The essential benefit of employing multi-solution channels is that they offer the least dishonesty and improved transmission proportion due to their capability to produce the best time and frequency localization (the representation that at what time the frequency happens and in what way the data at a specific time example is programmed in the frequency field) as presented in the given figure. This method developed each multi-solution network implied by ϕ applying (AWGN) as indicated across [1-4].

Where xi (p) is the baseband indication signal of sensor node i, αi is the amplitude signal of IOT network i. ϕi is the modulated signal of IoT node i, ϕj is the adjustment of capacity on channel j, and ϕj is the output of the transmission channel j by the channel power ϕj. Resolution analysis of ϕ is achieved through the designed protocol. There is greater decomposition of the channel from smaller spectral [5-6]:

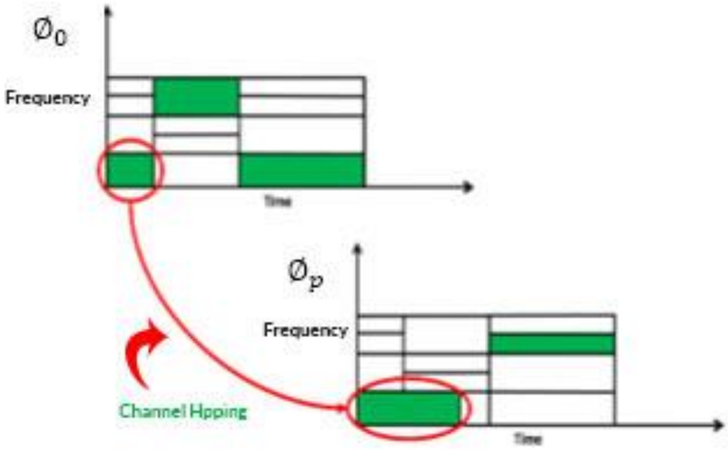

Figure 5. Received Signal Power from different Spectral bands. IoT receivers are Organized at Numerous Geographical Locations.

Table 1. Symbols and notations.

Symbols	*Description*	*Symbols*	*Description*
θ	Multiresolution Channel	f2	Number of Messages
Φ	Channel Capacity Multiresolution	f3	Channel Load to Throughput Ratio
K	Number of Multiresolution Channel	f4	Channel Blocking probability
N	Number of IOT Nodes	θT	Total Channel Width
x	IoT Nodes Baseband Signal	θN	Channel θ utilized by N IOT Devices
ϖ	Modulated Signal	K	Depicts the Number of Folds during cross
θL	Lower Decompused Channel band	α	Classification Accuracy
θH	Higher Decomposed channel band	T1	True Positive Rate/ Sensitivity
f	Fused Feature Vector	T2	True Negative Rate/ Sensitivity
f1	Number of Nodes	Ʊ	Channel Variance

5. Experimental Analysis

An investigational analysis of the designed IoT primarily based on wireless sensor communications in the direction of channel hopping and time synchronization has been calculated using the required ecosystem [10]. The affected surroundings are defined in detail, and the overall system of the paraphrase is computed on several performance metrics defined in addition. The recommended model makes networks' data sets where all channels have their data for Transmission. If there is more data for Transmission, it allows the equal bandwidth and swap the channel with an equal amount of data undertaking minimum output of data as defined within the diagram [11].

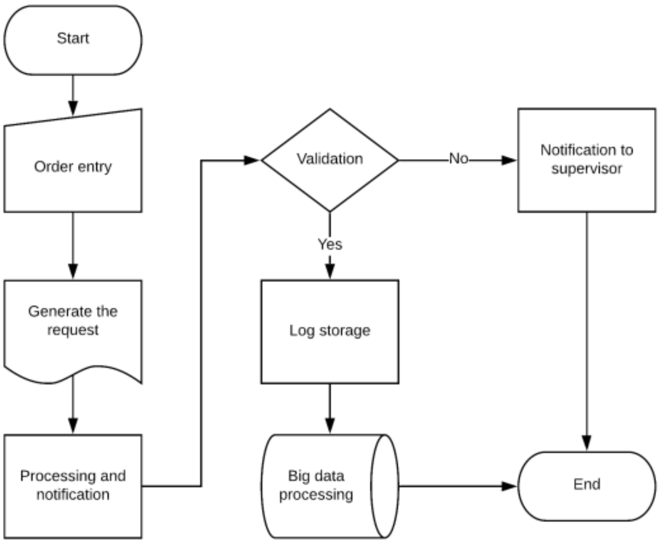

Figure 6. Flow Chart of IoT Network-Based Blockchain.

5.1. Storage Evaluation

In my research methodology, the overall storage capacity of nodes is KS [16]. Where the value of K and n is different for storage capacity's graphical pattern is shown in the figure. The greater the value of K, the greater the storage space required. For this purpose, the nodes of the IOT pattern are given. These nodes are random and transmit the data from one node to another using blockchain technology rather than traditional storage procedures [17]. Store the data across every node through a private ID assigned to every IoT node.

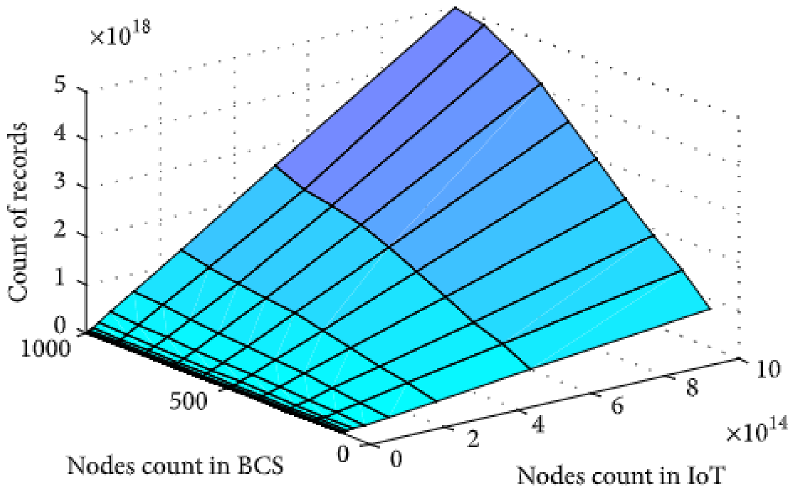

Figure 7. Storage capacity measurement with different K (node count in BCS) and N (node count in IoT).

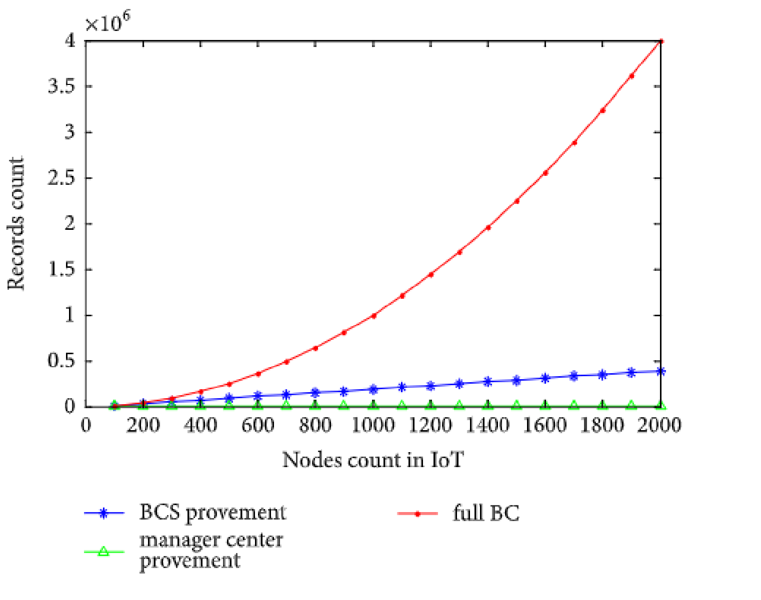

Figure 8. Comparison of storage efficiency.

5.2. Performance Evaluation

In my research methodology, much research proves the performance of IoT nodes. Some aspects affect the performance of these nodes.

- Several probabilities of forged nodes FP.
- The degree of these Tree K.
- The number of samples for solution of forged node T.

There are lots of nodes that randomly determine the average path [15]. The tree's gradation strongly minded the node pair's average path length. The prospect of forged nodes determined the probability of a forged node appearing on the path. Hence, these two facts decide the probability of forging [15]. We simulate the situation with ten million IoT entity nodes and select one million node pairs randomly for each restriction grouping. The arithmetical results are shown in Figure 9.

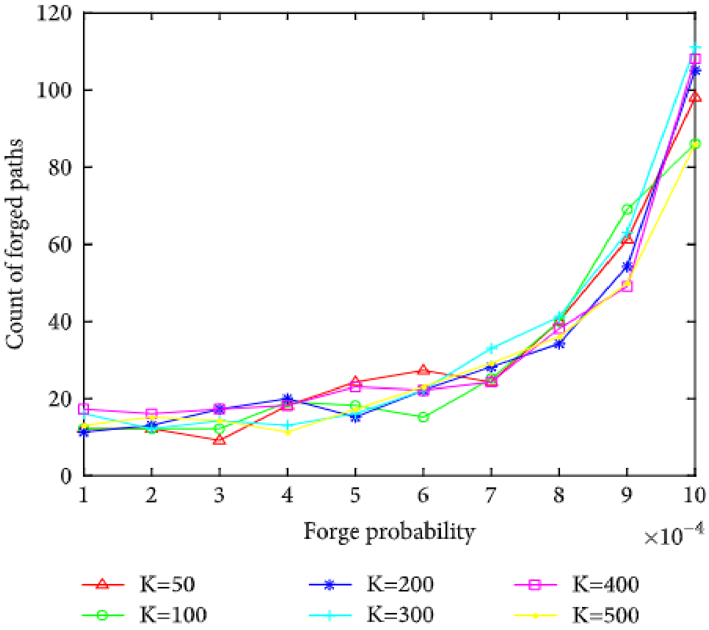

Figure 1. Experiment result of IoT path.

The proposed design is a completely automatic channel recognition and allocation procedure that automatically discovers channel characteristics. For high-speed data transmission, follow the channel allocation procedure for efficient data. Moreover, the recommended procedure utilizes the multiresolution channels and gives us efficient localization of wireless network channels for effective time and frequency features. The proposed procedure is an automatic network that provides the user with an automatic service to send the data from the source to the destination point. It automatically selects the channel to see the bandwidth and time allocation. If there is more data in one channel, then transfer some of the data to another channel for better transmission speed.

The proposed protocol achieved a data transmission rate of 44.5 Mbps, a 60% improvement over static allocation methods. Simulations using NS-3 demonstrated enhanced throughput under dynamic node conditions, with a 40% reduction in channel blocking probability. A public blockchain (Ethereum) added a secure layer to data storage and retrieval, albeit with increased computational overhead. Future work could explore lightweight consensus mechanisms to mitigate this limitation.

5.3. Future Research Directions

To advance the research on IoT networks and blockchain technology using fuzzy sets and their extensions, we can include fuzzy logic systems to address uncertainties and imprecise information within IoT networks. The volatile characteristics of IoT environments, characterized by noisy, incomplete, or unclear data, render fuzzy logic an appropriate instrument for decision-making, optimization, and control [39-44]. Rather than employing deterministic approaches for channel allocation, we can represent the problem using fuzzy sets. Fuzzy membership functions may delineate various channel states (e.g., overloaded, underutilized, or idle). By integrating fuzzy rules, the system may render more adaptable decisions regarding the timing and method of data reallocation across channels based on these ambiguous conditions. The system can employ fuzzy inference algorithms to determine network topology, data transmission routes, and channel allocation, particularly in the presence of uncertainty related to network congestion, device status, or resource availability.

Fuzzy sets can be employed to model and evaluate the probability of different attacks or data integrity concerns within the security realm. The system can adjust its security measures depending on real-time assessments of the network's current condition by employing fuzzy security levels (e.g., low, medium, and high-security risks). These sets facilitate the modeling of membership and non-membership degrees, offering a more nuanced depiction of uncertainty [45-51]. For example, invalidating IoT device authenticity and intuitionistic fuzzy logic can represent confidence and skepticism, enhancing decision-making in device authentication and data verification procedures. These sets facilitate the modeling of membership and non-membership degrees, offering a more nuanced depiction of uncertainty. For example, invalidating IoT device authenticity, intuitionistic fuzzy logic can represent confidence and skepticism, enhancing decision-making in device authentication and data verification procedures [52-60].

Future studies may investigate the creation of fuzzy-based dynamic resource allocation models for IoT networks, especially those utilizing blockchain for secure data management. Integrating fuzzy logic with blockchain enables the dynamic allocation of resources (e.g., bandwidth, energy, storage) while maintaining security and efficiency [61-66]. Integrating fuzzy logic with alternative decision-making methodologies, including multi-criteria decision analysis (MCDA) or machine learning algorithms, may yield a potent hybrid strategy. This will facilitate enhanced uncertainty management in intricate IoT networks and optimize decision-making in real-time scenarios [67-71].

6. Conclusion

The research proposes the credibility of blockchain verification methods. I tried to work on credibility for IoT device verification based on hashing methodology. To illustrate the difficulties faced in the application of IoT with the blockchain for verification, although the proposed method has some advantages, some problems still need to be resolved. For example, an attack on the MS cannot verify the credibility of all the nodes under it, which does not achieve complete decentralization. 51% of the computation problems are still not effectively addressed and threaten the entire network under such an attack. In addition, for a large-scale IoT environment, determining how to choose the number of BCS nodes and how to control the tree's height is still a problem requiring further study. The designed protocol uses the Gaussian radial function to transmit the data on a hybrid channel for checking the channel time and spectral characteristics for a high speed of transmission data using the nonlinear SVM classification model. For high-speed Transmission, swap the channel for a self-directed channel while transferring the data to the network channel. The planned design has also been associated with state-of-the-art solutions against different metrics where the proposed solution significantly outperforms them against different performance metrics.

This design and application of the Internet of Things (IoT) built a wireless sensor network that has been offered for efficient data transmission to meet the application of its requirements. To boost the channel's throughput, construct the channel using a time spectral technique and operate the channel swapping within the time needed. The adaptive channel distribution and excellence measurement protocols within multichannel sensor networks have been adopted. The proposed protocol is exceptionally robust, giving high data for an IoT net rate of up to 43Mbps. This designed network is used in telemedicine and hospital industries where remote work requires highly fast data transmission. This network sends the patient history and diagnostic report between the remote laboratory and the hospital. Also, the proposed protocol can be utilized in the defense sector to provide high-speed data transmission between the high command and the army.

Declarations

Ethics Approval and Consent to Participate

The results/data/figures in this manuscript have not been published elsewhere, nor are they under consideration by another publisher. All the material is owned by the authors, and/or no permissions are required.

Consent for Publication

This article does not contain any studies with human participants or animals performed by any of the authors.

Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare no competing interests in the research.

Funding

This research was not supported by any funding agency or institute.

Author Contribution

All authors contributed equally to this research.

Acknowledgment

The author is grateful to the editorial and reviewers, as well as the correspondent author, who offered assistance in the form of advice, assessment, and checking during the study period.

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Received: 05 Aug 2024, **Revised:** 30 Oct 2024,

Accepted: 21 Nov 2024, **Available online:** 23 Nov 2024.