Scholar Publishing Group
Academic Journal of Energy
https://doi.org/10.38007/RE.2022.030105
ISSN 2790-2714 Vol. 3, Issue 1: 40-48

Energy Consumption based on Resource Allocation under Blockchain

Zhaoyang Wu*

Qinghai Normal University, Qinghai, China

williams1203@foxmail.com

**corresponding author*

Keyword: Resource Allocation, Blockchain, Energy Consumption, Edge Computing

Abstract: With the continuous progress of science and technology, mobile electronic technology has spread all over the public's vision. Countries around the world are promoting the liberalization of the energy field. First, the demand for energy in industrial production and social life is increasing day by day. Second, the goal of carbon peak and carbon neutralization has become a consensus. Distributed renewable energy sources are developing rapidly. This paper first introduces the related technical concepts of blockchain, then simulates and analyzes the algorithm of blockchain technology in resource allocation, and finally concludes in the experimental analysis that the application of blockchain algorithm technology in resource allocation can greatly reduce energy consumption.

1. Introduction

Advances in computing technology are changing the way people perform computing tasks for day-to-day applications, and the use of traditional desktop computers for large-scale computing work has expanded to various computing modalities, such as cloud computing. In recent years, with the explosion in the number of IoT devices and their demand for computing power and storage services, new computing models are emerging to overcome high cloud service costs and liquidity constraints.

With the rapid increase of wireless data transmission, the energy consumption in wireless communication networks is increasing day by day, so energy-saving technology has become particularly important for the development of wireless networks. Reducing network energy consumption, improving energy efficiency, balancing energy efficiency and spectrum efficiency have become the research focus in various fields of network communication. At present, the United States, the European Union, Japan, South Korea and other countries have launched strategies or projects such as energy-efficient network technology, green communication technology, high-energy efficiency and low-carbon emissions, promoting the transformation of existing networks to low-power, high-energy efficiency networks and the development of green and low pollution ecological communication systems. They considered four main branches, namely adaptive link rate, interface agent, energy aware infrastructure and energy aware application, and observed the root causes of energy waste in these four main branches. Blockchain technology is essentially a public ledger, which records the data related to trust management into this ledger and is jointly maintained by all participants to achieve the purpose of decentralized and trusted management of network applications, and bitcoin is one of the most successful digital currency applications. However, the research and application of blockchain technology should not be limited to this. As the research on blockchain technology is carried out more widely, there are also many researches on the application of blockchain in the field of non digital currency. At present, there are some real projects at home and abroad that have received tens of millions of dollars of investment. Most of these studies are based on existing blockchain platforms such as Ethereum. At the same time, blockchain technology itself is also constantly developing. Therefore, the following will sort out and analyze the current research on blockchain technology and resource management using blockchain technology, and summarize the existing achievements and shortcomings.

This paper efficient edge computing resource allocation method,allocation way so as to make full use of idle resources widely distributed at the edge of the network, so as to get rid of the current situation that the current computer model still depends on large data centers.

2. Overview of Related Concepts

2.1. Block Structure

In the common blockchain system represented by bitcoin system, transaction data is usually packaged and recorded in the form of blocks. These transaction information are packaged into blocks after verification, and the Merkle root value is obtained after being organized in the form of Merkle tree and stored in the block header. The unique and unchanging timestamp generated by it will ensure the tamperability of the recorded data. The only way to tamper with data controls at least 51% of the network capacity, which is manifested in the workload proof consensus mechanism. It can be said that it is almost impossible for individuals to tamper with the data recorded in the blockchain. Therefore, using the above methods to record transaction data, on the premise of having the copy information of the blockchain, all participants can reliably verify the transactions recorded in the blockchain. In fact, in the research of blockchain technology, the so-called transaction usually refers to the special operation involving asset transfer between users in bitcoin, a blockchain system for digital currency applications. In a broader application scenario, this operation can be replaced by any trust operation suitable for the needs of different applications, and the focus of the problem will shift to how to design these trusted operations to make them suitable for trust management in different application scenarios. Therefore, in the next section, we will take bitcoin as the main analysis object again to analyze the process of implementing trusted transactions.

2.2. Consensus Mechanism Selection for Edge Networks

At present, according to the design of different consensus mechanisms, the definitions and utilization methods of these resources are also different. Generally speaking, it can be divided into two categories, namely, the consensus mechanism based on physical resources and the consensus mechanism based on virtual resources. Workload proof requires participating nodes to prove their honesty by consuming computing resources to solve mathematical problems, because it is not profitable to spend a lot of computing resources to destroy the stability of the system. Similarly, the consensus mechanism based on virtual resources turns the target to other valuable entities, such as the most common proof of interest. Because people usually think that people with more assets prefer the stable operation of the system to ensure the value of their money. Of course, there are also space-time proofs that take storage and memory space and usage time as physical resources, proof of entrusted rights and interests that realize the utilization of virtual resources by means of entrustment, and proof of activities that mix two ways.

Based on the above analysis, it can be found that to design a consensus mechanism suitable for different systems and solutions, the first thing is to select the appropriate value entity for voting. In the design of this scheme, because most of the participating devices are edge devices, most of the resources are limited, and the purpose of this scheme design is to coordinate the resources between the participating devices for processing computing intensive tasks. Therefore, it is inconsistent with the original intention of the scheme to use the scarce physical resources for the operation of the consensus agreement. In the design of this scheme, it is more suitable to adopt the consensus mechanism based on the voting type of virtual resources, and the common consensus mechanisms of this type are POS and dpos.

In traditional dpos, the so-called equity is the cryptocurrency held by each participating node. Obviously, this definition of "equity" is dedicated to the cryptocurrency system and cannot be directly applied to the design of this scheme. Therefore, in order to design dpos suitable for resource allocation applications, it is necessary to define the so-called "equity" according to the characteristics of the application of this scheme, and further discuss the appropriate allocation of "equity" in the operation of the formula.

2.3. Definition of "Equity" Oriented to Resource Allocation

"Network contribution" as a measure of the "equity" of nodes in the consensus process, its quantitative method also needs to be considered, and appropriate incentive factors should be added to the calculation of "network contribution". However, as mentioned above, in this paper, we assume that the capacity of resources provided by resource providers can be simply quantified. Therefore, we will simply put forward the design idea of the measurement method of "network contribution" in this scheme based on this assumption. For the first type of "network contribution", it can be directly expressed by the amount of resources contributed by the resources owned by the node to the network. Specifically, after a resource request is approved and recorded in the blockchain, based on the data structure design of the resource request, the "network contribution" made by the provider of the requested resource can be expressed as the product of resource capacity and usage time, that is

$$\mathrm{CTRB}'_{\mathrm{Usri}} = \sum_{j=1}^{n} \mathrm{Cap}^{j}_{\mathrm{REQ}_{\mathrm{StsfByUsri}}} * \mathrm{duration}^{j}_{\mathrm{REQ}_{\mathrm{StsfByUsri}}} \tag{1}$$

For the second type of "network contribution" mentioned above, that is, the contribution made by nodes participating in blockchain network maintenance and completing the "uplink" of relevant data, it can be measured by the total amount of computing capacity contained in all resources or resource requests in the block generated by the user node. Therefore, the "network contribution" that each building block can make can be expressed as

$$CTRB_{\mathrm{Block}i} = \begin{cases} \sum_{j=1}^{n} (Cap_{Block_i}^{j} * duration_{Block_j}^{j}) * \delta \\ \sum_{j=1}^{n} (Cap_{Block_i}^{j} * (ET - ST)_{Block_j}^{j}) * \vartheta \end{cases} \quad (2)$$

In order to encourage nodes to make more contributions to the network, resource requests from nodes with a higher level of "network contribution" should also be responded to first. Therefore, the "network contribution" made by the requester who participates in the formulation of resource allocation schemes should be affected by the "network contribution" of the requester who handles the resource requests. Specifically, processing resource requests from nodes that hold more "network contributions" means that the higher the evaluation of the network contributions made. Thus, in order to obtain more "network contributions", the outbound node gives priority to processing resource requests from nodes that contribute more to the network history. Such an approach can provide positive incentives for the participation and positive contribution of nodes, so as to promote the normal operation of the network. For this setting, we mainly refer to the "transaction fee" setting in the digital currency system such as bitcoin. In each transfer "transaction", the input amount can be higher than the output, and the difference is the "transaction fee", which can be collected by the "miner" himself. In this way, the "transaction" of the participant who pays more "transaction fees" is naturally easier to be verified by the "miner" and packaged into the block. To sum up, the quantification of "network contribution" can be expressed by the following formula:

$$CTRB_{\mathrm{Usr}_i} = CTRB'_{Usr_i} + \sum_{j=1}^{n} CTRB_{Block_j}^{Usr_i} \quad (3)$$

3. Design and Implementation of Resource Allocation Based on Blockchain

3.1. Geth Client

Geth client is a way to connect with Ethereum main network. In the simulation experiment based on Ethereum, we rely on the interaction with Ethereum through the geth client, including the deployment of smart contracts, the release and storage of resource provision and resource request information, as well as the query and verification of relevant information. In order to carry out the simulation experiment, this paper builds an Ethereum private chain in the local network through the geth client.

3.2. Traffle Framework

Truffle is a popular development framework for smart contracts and decentralized applications (DAPP). Specifically, the development environment based on truffle framework is shown in Table 1.

Table 1. Truffle configuration table

File name	Effect
App	As the default directory for the entire application file, it usually includes javascript and css file directories
Contract	Store the written contract file (.sol)
Build	Store the compiled contract file (.js)
Migrations	Save the deployed script file (.js)
Test	Store test files for testing applications and smart contracts(. Js/. Sol)
Truffle.js	Configuration file

4. Energy Consumption Analysis Based on Resource Allocation under Blockchain

4.1. Determine the Total Number of Time Slices T

In Figure 1 and Figure 2, in order to obtain a reasonable total number of time slices, this paper simulates the time energy diagram (average per bit) of a cognitive user network with t=50 to 600 and spacing of 50 or 70. When the total number of time slices t<200, the average energy consumption per bit of the system decreases rapidly, while when t>400, it tends to converge. Therefore, the total number of selected time slices t=400 in the later simulation experiment of comparison of different methods.

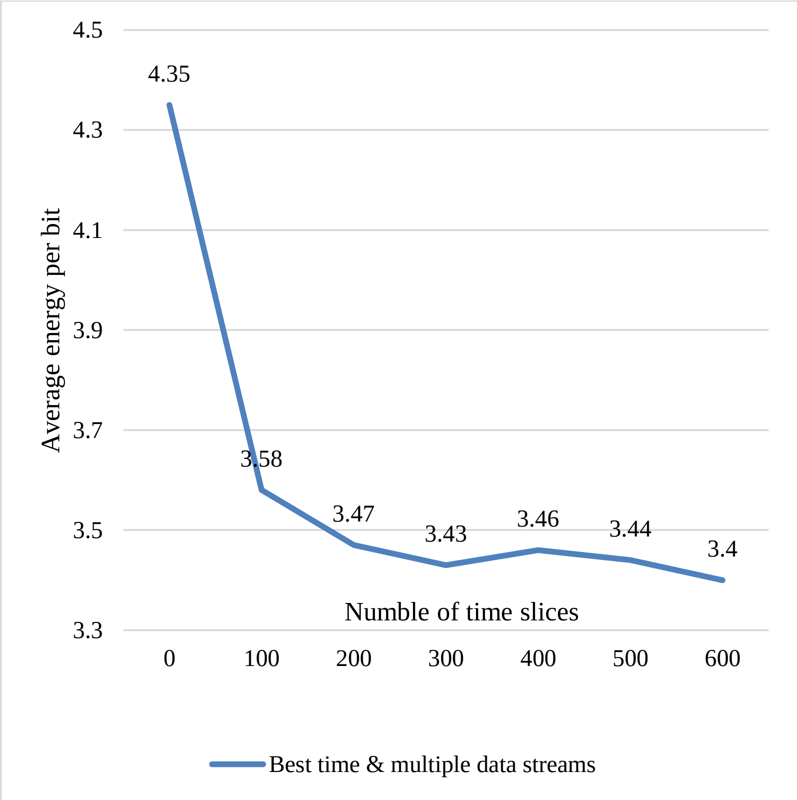

Figure 1. Average energy consumption per bit of cognitive system under different T

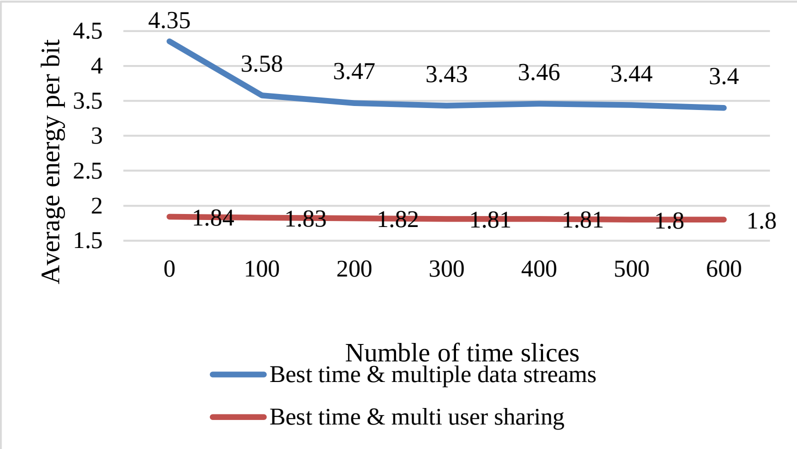

Figure 2 .The average energy consumption per bit of the two methods in the blockchain under different T

4.2. System Energy Consumption Analysis

In the simulation experiment in Figure 3, the average energy per bit diagram of the system is simulated according to the "maximum rate" method, the "best time multi data flow" method and the "best time multi-user sharing" method proposed in this paper. It can be seen from the figure that the average energy consumption per bit of the system increases with the increase of the load (or the number of cognitive nodes) in the network.

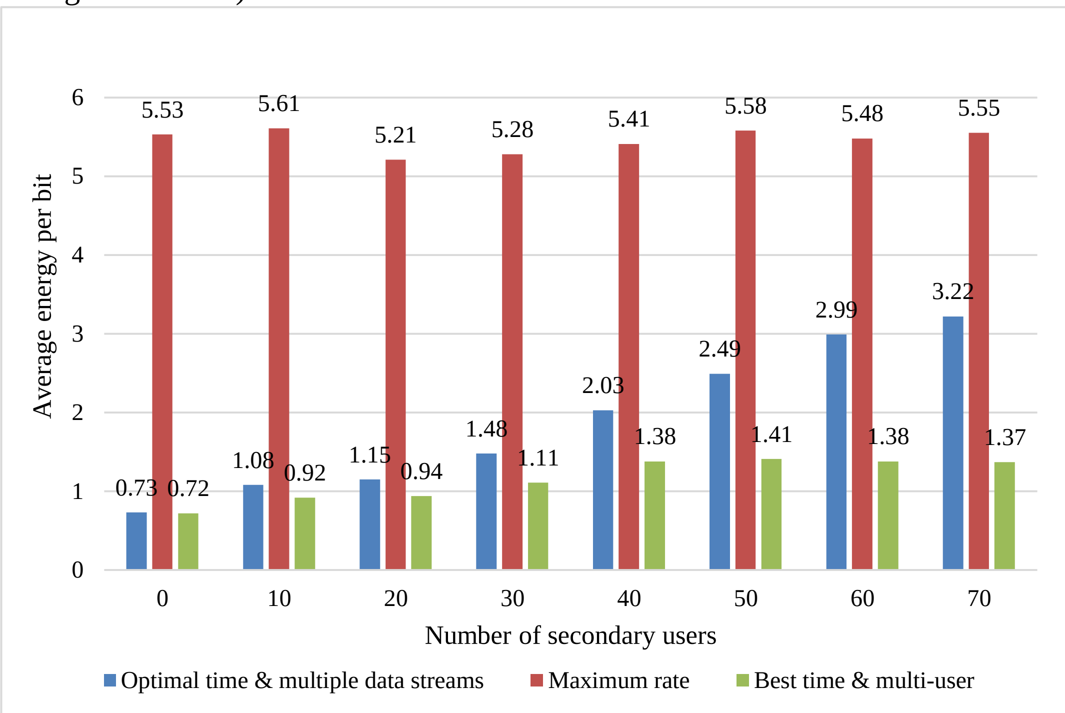

Figure 3. Average energy consumption per bit of secondary users in blockchain

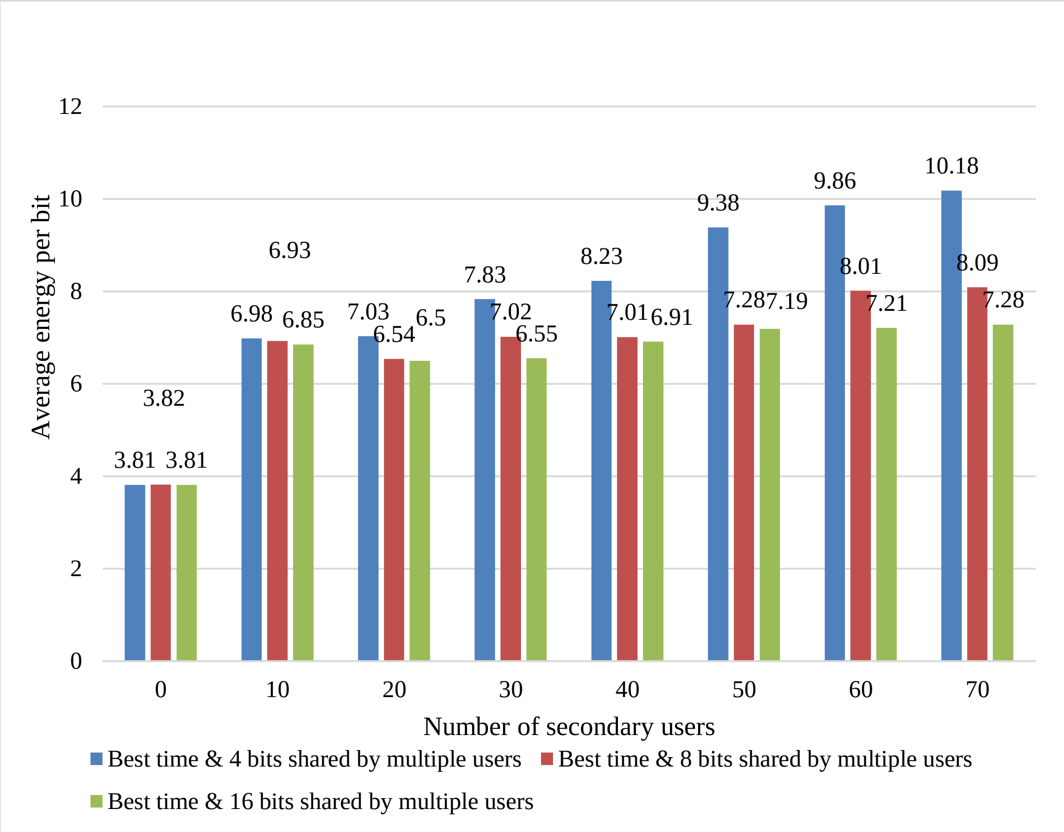

Figure 4. Average energy consumption per bit of next users in different M

In Figure 4, this paper simulates the energy efficiency of users in the system under different conditions (m=4,8,16) according to the method of "best time multi-user sharing". The analysis shows that the average energy consumption per bit of the system increases with the increase of the load, but decreases with the increase of the spread spectrum code. It can be concluded that on the premise that the time resources are not saturated, the shared time resources that users do not interfere with each other will reduce the average energy consumption per bit of the system.

5. Conclusion

With the development of Internet of things technology and the increase of all kinds of Internet of things and intelligent terminal devices, more and more data are generated at the edge of the network, which brings about the change of computing mode. Edge computing is becoming a good supplement to cloud computing, bringing more resources closer to the edge of the network where data is generated. However, the current management and allocation of edge computing resources are still mostly based on the traditional centralized mode, which violates the original intention of network computing and cannot adapt to the highly decentralized and heterogeneous characteristics of edge computing resources. This paper mainly proposes a decentralized edge computing resource allocation mechanism based on blockchain, which aims to realize decentralized trusted computing resource allocation in edge networks. Under the guidance of this overall goal, the research is carried out from three aspects: credible resource information disclosure, credible resource allocation and credible resource use. At the same time, the energy consumption under the distribution system is significantly reduced.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Kostmann M , Sciubba E . Forecasting in Blockchain-Based Local Energy Markets. IRTG 1792 Discussion Papers, 2019(3):1-3.

[2] Hukkinen T . Reducing blockchain transaction costs in a distributed energy market application. 2018(4):16-18.

[3] Waal M , Carolina D , Moses M , et al. Blockchain-facilitated sharing to advance outbreak R&D. Science (New York, N.Y.), 2020,368(6492):719-721. https://doi.org/10.1126/science.aba1355

[4] Timothy M , Serge U . Method Of Matching Renewable Energy Production To End-User Consumption Via Blockchain Systems:, EP3459038A1. 2019(13):56-58.

[5] Ysx A , Yl A , Xqc A , et al. Research on the transaction mode and mechanism of grid-side shared energy storage market based on blockchain - ScienceDirect.2022(4):109-111.

[6] Brousmiche K , Menegazzi P , Boudeville O , et al. Peer-to-Peer Energy Market Place Powered by Blockchain and Vehicle-to-Grid Technology// 2020 2nd Conference on Blockchain Research & Applications for Innovative Networks and Services (BRAINS). 2020(3):369-370.

[7] Sedlmeir J , Buhl H U , Fridgen G , et al. Recent Developments in Blockchain Technology and their Impact on Energy Consumption. 2021(4):4-7.

[8] Zhang Y , Shi Q . An intelligent transaction model for energy blockchain based on diversity of subjects. AEJ - Alexandria Engineering Journal, 2020, 60(1):6-9. https://doi.org/10.1016/j.aej.2020.10.005

[9] Mihaylov M . NRGcoin—A Blockchain-based Reward Mechanism for Both Production and Consumption of Renewable Energy. 2018(3):111-131.

[10] Imbault F , Swiatek M , Beaufort R D , et al. The green blockchain: Managing decentralized energy production and consumption// 2017 IEEE International Conference on Environment and Electrical Engineering and 2017 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe). IEEE, 2017(31):1-3. https://doi.org/10.1109/EEEIC.2017.7977613

[11] Nair R , Gupta S , Soni M , et al. An Approach to Minimize the Energy Consumption during Blockchain Transaction. Materials Today: Proceedings, 2020(5):6-7. https://doi.org/10.1016/j.matpr.2020.10.361

[12] Sikorski J J , Haughton J , Kraft M . Blockchain technology in the chemical industry: Machine-to-machine electricity market. Applied Energy, 2017, 195(JUN.1):234-246.

[13] Dinh T , Liu R , Zhang M , et al. Untangling Blockchain: A Data Processing View of Blockchain Systems. IEEE Transactions on Knowledge & Data Engineering, 2017, PP(99):1-1.
[14] Kang J , et al. Enabling Localized Peer-to-Peer Electricity Trading Among Plug-in Hybrid Electric Vehicles Using Consortium Blockchains. IEEE Transactions on Industrial Informatics, 2017, PP(6):1-1. https://doi.org/10.1109/TII.2017.2709784
[15] Kshetri, Nir. Can Blockchain Strengthen the Internet of Things?. It Professional, 2017, 19(4):68-72. https://doi.org/10.1109/MITP.2017.3051335
[16] Dayarathna M , Wen Y , Fan R . Data Center Energy Consumption Modeling: A Survey. IEEE Communications Surveys & Tutorials, 2017, 18(1):732-794. https://doi.org/10.1109/COMST.2015.2481183
[17] Salim R , Yao Y , Chen G , et al. Can foreign direct investment harness energy consumption in China? A time series investigation. Energy Economics, 2017, 66(aug.):43-53. https://doi.org/10.1016/j.eneco.2017.05.026
[18] Haustein,H, Neuwirth,E. Long Waves in World Industrial Production, Energy Consumption, Innovations, Inventions, and Patents and Their Identification by Spectral Analysis : Technological Forecasting and Social Change. Journal of Science Policy & Research Management, 2017, 2(1):53-89. https://doi.org/10.1016/0040-1625(82)90028-2