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Microgrid Operating And Scheduling Model Based On Double-layer Blockchain

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Abstract

Blockchain is a very hot topic recently. Microgrid is also very hot. Comparing with conventional energy fluid, microgrid has the disadvantage of fluctuation, insecurity and always hard to predict. In this paper we use a double layer blockchain to implement the function of microgrid. Double layer blockchain uses mutli-blockchain technology, it can improve the transaction speed of microgrid comparing with traditional microgrid. According to the experiment, this model plays better in latency, throughout and performance.

Keywords

Blockchain, microgrid, consensus, DPOS, OPNET.

1. Introduction

Microgrid technology refers to the combination of controllable load, distributed electricity resource (DER) and energy storage system through a virtual control center, allowing them to participate in the power grid as a power district. The microgrid is commanded by the control center, and the power generation, load, and energy storage systems are uniformly scheduled through two-way information flow. It can greatly solve the problems of unstable power generation, unstable grid connection, and inaccurate prediction in distributed renewable energy sources such as wind power and photovoltaic. In Europe and the America, microgrids have become an important part of the electricity market. However, the microgrid is still in its infancy and has exposed many specific problems. For example, coordination optimization between DERs in the microgrid, control structure of microgrid, and real-time adjustment strategy of microgrid. The root cause of these problems is that the nature of microgrid transactions is decentralized, and is currently different from centralized grid planning. These problems will become more serious as more microgrids emerge in the future. It is therefore necessary to study these issues.

Blockchain technology is a very important research direction as a distributed value transmission protocol. The concept of blockchain was first proposed by Nakamoto in the "Bitcoin: A peer-to-peer electronic cash system" [6] as the underlying distributed database of Bitcoin. With the rapid development of digital currencies such as Bitcoin and Ethereum, blockchain technology is becoming more widely known. But the value of blockchain technology is far greater than digital currency. Both blockchain technology and microgrid technology have the characteristics of decentralization, intelligence, and nitelligence contraction. The combination of the two is an important research direction. According to different functions, the literature a microgrid operation model is proposed. On the basis of the literature [1], the literature [12] combines the blockchain technology and the microgrid technology to realize a blockchain-based microgrid operation and scheduling model and conducts a sample test. Literature [13] proposed a blockchain-based pricing mechanism on microgrid, which has the characteristics of supply and demand side verification, complete self-control, security

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and stability. Literature [14] constructed a large-user direct purchase electricity trading framework based on blockchain technology, which has reference significance for microgrid design. Literature [15] believes that distributed energy systems can reduce the expansion of transmission networks and centralized centralized power generation. The energy storage devices required for large power plants are also large, and distributed generation can reduce this phenomenon.

The above literature gives a detailed description of the micro-grid, micro-grid and blockchain combination possibilities. However, due to the transient nature of electricity, the time required for the internal power trading of the microgrid is also very high. The increase in transaction speed can not only directly improve the efficiency of power dispatch, but also reduce the prediction error. However, the transaction speed of the blockchain is very slow. Bitcoin, the world's largest blockchain network, trades at only one per second, and the second largest blockchain network, Ethereum, trades at only 6-7 per second. However, none of the above documents have considered this issue. This paper proposes a model based on double-layer blockchain. A tree model is adopted and this blockchain model is introduced into the operation and scheduling of the microgrid. After simulation, compared with the single-layer blockchain model in [2], this model can greatly improve the transaction speed between the internal nodes of the micro-grid on the basis of ensuring the information security inside the micro-grid and reducing the cost of trust. . Refine the power dispatching mode inside the microgrid. Improve the overall operating efficiency of the microgrid.

The second chapter of this paper briefly describes the blockchain technology and microgrid technology. The third chapter elaborates the blockchain structure, data flow and information flow of the microgrid model based on double-layer blockchain. The fourth chapter uses opnet to simulates the proposed architecture and the previous architecture respectively, and compares the delay, throughput and transaction speed, and illustrates the superiority of the proposed method. Finally, the challenges that the model may face are pointed out.

2. Blockchain technology and microgrid

2.1 Blockchain technology

Blockchain technology was first proposed by Nakamoto in "Bitcoin: A peer-to-peer electronic cash system" as the underlying technology for bitcoin applications [12], with decentralized, asymmetric encryption, network internal node consensus, Features such as smart contracts. The essence of the blockchain is the p2p network. There is no central node in a traditional network, and each node has the same status. Each blockchain can be divided into two parts: block header and block body. The block header contains the hash value of the previous block and the biller node information and generation time when the block is generated. Used for fast indexing. The block header can carry a small amount of information for fast query, as shown in Figure 1, the block header information of the bitcoin bottom blockchain. The block body contains the data contained in this block. For example, the micro-grid internal node transaction information mentioned in this article. This information uses the hash hash value and random number of a node superimposed on a string to form the hash hash value of this block.

References are cited in the text just by square brackets [1]. (If square brackets are not available, slashes may be used instead, e.g. /2/.) Two or more references at a time may be put in one set of brackets [3, 4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under a heading *References*.

The blockchain is operated by a cryptographic method, and the head of each node is connected to the previous node. When the user verifies the data, the Merkel tree can be traced back to the head node. Changing a node's data not only changes the node itself, but also changes all of its successors. This is unrealistic under current computer technology. It ensures the security and non-destructive modification of the data.

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2.2 The combination of blockchain and microgrid

As mentioned above, there are currently problems in the microgrid that there is mutual trust between nodes, low communication efficiency, and serious unauthorized data calls. Blockchain has the characteristics of decentralization, intelligent contract, node consensus, security and credibility [13]. It can just solve some of the problems existing in the current microgrid.

1) Decentralization: There is no super-privileged central server in the blockchain. All participating nodes can partially back up or completely back up all the data in the blockchain. When new data is generated, the transparent rules are used for verification, and the new data is added to the database after the verification is successful. The same rules are used between nodes to securely traceable transactions without trust.

2) Smart Contract: In Ethereum, the concept of smart contracts was first proposed. A smart contract is a piece of public code in which the logic cannot be changed once it is implemented. When the input reaches the required value, the smart contract will be executed irreversibly. Since the logic of the smart contract has been confirmed at the time of deployment, the parties will not object to the execution of the smart contract, so the smart contract execution is extremely efficient. Programming can be done in smart contracts, especially for the programmed scenario of the microgrid.

3) Node Consensus: In a centralized microgrid, the central server has extremely high scheduling privileges. When an erroneous command is issued for unintentional or private interest, or the communication line fails, it may cause energy consumption inside the microgrid or even downtime of the power network. Ordinary power generation nodes can only work according to the instructions of the central server and cannot choose the operation mode that is most beneficial to them. In the blockchain-based microgrid, there is no central server, and each node uses consensus mechanisms such as pow, pos, and dpos to complete the consensus. Consensus results are confirmed by all nodes according to the same rules, and security and stability will not cause problems in the centralized microgrid.

4) Data security: At present, the data in the microgrid is uniformly stored by the centralized database. The remaining nodes use API calls. There is a call issue with unauthorized data. The data security of blockchain is based on mature encryption algorithms in dense ci-code theory, such as elliptic curve encryption algorithm and large digital decomposition encryption algorithm. The security of the data in the chain can be guaranteed. Through various methods, the data of each node in the micro grid is provided with a strong and powerful guarantee.

It can be seen that the application characteristics of the blockchain technology and the microgrid combination are similar, and the blockchain technology provides a safe and reliable solution for the Yunxing River dispatching of distributed energy.

3. A microgrid model based on double layer blockchain

With the development of the energy Internet, microgrid technology has gradually matured. With the expansion of the microgrid scale, in the design of the microgrid model, in addition to the conventional factors such as security and data privacy, the transaction efficiency of internal nodes in the microgrid model should also be considered in detail. The current microgrid model assumes that there is no problem with the network. In this section, we propose a new hybrid network architecture based on double-layer blockchain, which will be divided into four parts: the general description, the inter-node transaction flow of the model, the consensus algorithm of the nodes in the model, and the intelligent contract within the model.

3.1 Review of DB-Microgrid

DB-Microgrid is a microgrid model based on a two-layer blockchain architecture. Compared with the blockchain model proposed in [2], this model has the characteristics of fast response and more security. There are two roles of generators and consumers in the DB-MIRCROGRID model. Each character has different attributes. Generators have information such as identity ID, maximum power

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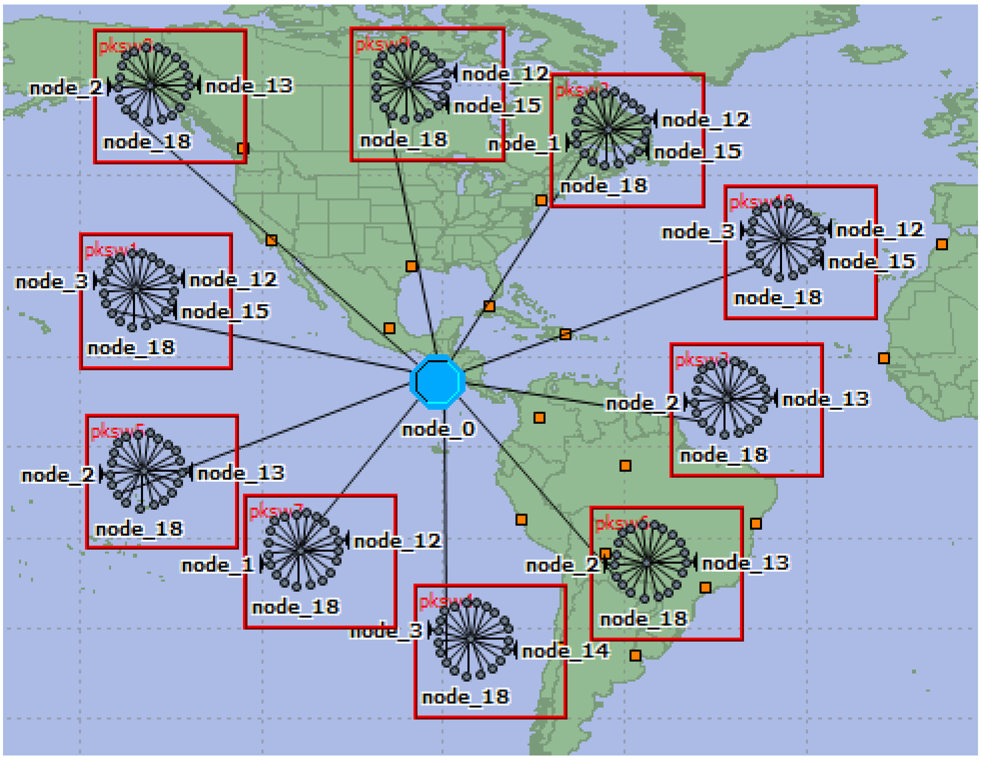
generation capacity, energy type (new energy, traditional energy), and geographic location. The consumer has information such as identity ID, power demand level, and geographic location. The same node can serve different roles. The architecture of the microgrid is as follows:



figure[2]DB-Microgrid figure

For the sake of clarity, the following concepts are defined in this model:

1) Parent chain: is a high-level blockchain in DB-MIRCROGRID. The nodes in the blockchain are elected by each sub-chain through a consensus mechanism. The main function of the parent chain is to control the access rights of the nodes in the sub-chain; to resolve the disputes between the nodes in the sub-chain; and to store complete data to enhance the block. Chain security.

2) Sub-chain: The sub-chain is a low-level blockchain in DB-MIRCROGRID. The nodes in the sub-chain are the generators and consumers who are close to each other in the micro-grid. Because the loss of low-voltage transmission is extremely high, in order to reduce losses, energy transactions cannot be performed between different sub-chains.

3) DBSCA consensus algorithm: DBSCA algorithm is a consensus algorithm between nodes in the sub-chain of DB-MIRCROGRID model. Since there are no centralized nodes in the sub-chain, the nodes are completely equal and do not trust each other. Therefore, the election of the bookkeeper is very important. In order to reach a power trading agreement and reduce misunderstandings and disputes in the shortest time, an efficient consensus algorithm is needed to elect the accountants in the model. The DBSCA algorithm is used in this model to solve this problem, and the specific algorithm is described in the next section.

The microgrid model is divided into a subblock chain and a parent block chain. Power trading is done in the sub-blockchain. The main function of the parent blockchain is to store complete microgrid transaction data and provide secondary security protection when the network is attacked. At the same time, it controls the access rights of the nodes in the sub-blockchain network (including the nodes joining the network, the nodes kicking out the network, temporarily stopping the transaction behavior of the node, etc.). In the microgrid based on the double-layer blockchain network, a certain number of nodes closer to each other form a sub-blockchain, and power transactions are performed between the internal nodes of the sub-blockchain. The sub-blockchain is negotiated by DBSCA (DOUBLE-BLOCKCHAIN-SON-CONSENSUS-MECHANISM, which will be described in detail in the next

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section), such as confirming transactions and electing billers. The accountant elected by the consensus mechanism performs the rights in the parent blockchain on behalf of other nodes in the sub-blockchain. Sub-blockchains Each node in the blockchain represents a unit. It contains three attributes: power generation, electricity consumption, and energy storage. The nodes are traded through the p2p network without scheduling and interference from the central node. Trading and judgment through smart contract logic ensures the accuracy and efficiency of the network.

3.2 Tradings in DB-Microgrid

The main function of the microgrid is to efficiently complete internal transaction behaviors under the premise of safe and reliable output and controllable, and achieve the goal of mutual benefit between internal nodes and external power grids. The electricity price of electric energy in the microgrid changes with the criticality of the demand for electricity and the amount of demand. The internal electricity price is based on the distributed energy feed-in tariff and the national grid electricity price, which guarantees the profitability of all participants.

When the number of transactions reaches a certain value, the biller node in the micro-grid packs all the transaction information in the period into blocks, and propagates in the sub-block chain and the parent block chain. The sub-blockchain then re-elects the biller. When the biller is selected, the one-wheel blockchain transaction process ends. Similar to the sub-blockchain, the nodes in the parent blockchain are generated by the consensus algorithm by each sub-blockchain. There are also trading behaviors in the parent blockchain, but not the trading of electrical energy, but such as participant rights management. The parent blockchain stores all the data in the subblock chain. Although no participant has all the data of the overall network due to the frequent replacement of the participants, the complete sub-network transaction data can still be obtained by indexing the block header. Since most nodes in the blockchain are assumed to be justice nodes, the accuracy of the data can be guaranteed.

3.3 Consensus in DB-Microgrid

The consensus mechanism is an important part of the blockchain. At present, the popular blockchain consensus mechanisms include POW, POS, DPOS, and PBFT. The POW consensus mechanism is the workload proof mechanism. It is a blockchain consensus method for mainstream digital currencies such as Bitcoin and Ethereum, which is applicable to the public chain without identity verification. However, there is a problem of consuming too much power resources in the consensus process. The POS consensus mechanism is called the equity proof mechanism, similar to stocks. Use the set share ratio to determine the bookkeeping rights. The complicated decryption operation in the POW mechanism is avoided, and the energy consumed is reduced. However, the implementation of centralization in the public chain is likely to cause the stocks to get together. Therefore, it is more suitable for a coalition chain with a barrier to entry.

The DB-MIRCROGRID neutron network and the parent network can be controlled by rights and belong to the alliance chain. Therefore, this DB-MIRCROGRID uses the DBSCA consensus algorithm based on the POS method. The consensus algorithm is used to select sub-network registrants, record transaction information of the sub-network, select parent network registrants, and record transaction information of the parent network. The specific implementation is as follows:

(1) Selecting the subnet's biller

1) When the parent system blockchain passes the consensus mechanism to confirm that a subnet needs to re-elect the biller, the subnet biller election begins.

2) Power generation nodes in all sub-networks can nominate themselves as billers in the subnet. Information about various attributes of the node, including identity ID, maximum power generation capability, and geographic location, is sent as a transaction information to the sub-blockchain. Each node first uses the RSA algorithm to identify the authenticity of the message. After identification, each attribute is weighted and added using the DBSCA algorithm. The weight of each attribute can be changed according to the specific circumstances at the time. When the weighted sum of the nodes

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in the new message is greater than the sum of the rights of the current account in the current node, the node identifies the node in the new message as a temporary biller node. When the weighted sum of the nodes in the new message does not have the weight of the current account in the current node, the node does not change.

3) After receiving the message and calculating it, regardless of whether the stored biller is changed, the node receiving the message should forward a transaction message of the currently identified biller node to the network and sign with its own private key. In this way, when a node receives a sufficient percentage of confirmation messages, it can prove that the new biller has been generated. The old bookkeeper sends a message of change of the biller information in the parent chain. After the parent chain is confirmed, the new bookkeeper begins to perform the work and the consensus is completed.

(2) Recording transaction information of the subnet

1) The nodes in the sub-network distribute the power generation demand information to the network, including the required amount of power, the type of power required (whether new energy), the demand price, and the demander ID.

2) All subnet nodes listen for information on the network. When a node thinks that it can accept the offer itself, it spreads the message of agreeing to the offer to the neighboring nodes.

3) Each node verifies the authenticity of the message. When the confirmation message is true, the information is stored in its own message store. When receiving a confirmation that the different nodes have confirmed the offer, the node with the early time stamp shall prevail. The biller node records information at the same time. When the number of messages reaches a certain level, the packed blockchain spreads into the network. The consensus is completed.

(3) Electing the accountant of the parent network

(4) Recording the transaction information of the parent network

3.4 Smart contract in DB-Microgrid

In DB-MIRCROGRID, each node's own logic is implemented through smart contracts. The concept of smart contracts began with Ethereum [14]. Ethereum is currently the world's second largest virtual currency trading platform after Bitcoin. The code logic in the smart contract is visible to all members of the blockchain and is automatically executed when the trigger condition is reached. No one can stop the execution of the contract. Therefore, it has higher execution efficiency and execution power than human transactions. In DB-APP, the attribute authentication and access authority authentication of the nodes in the sub-blockchain of the parent blockchain are implemented by smart contracts. It can guarantee the absolute fairness of logic execution. The authentication of the nodes in the sub-blockchain by the parent blockchain mainly includes accessing, assigning the sub-blockchain network and kicking out. When a node requires access to a sub-blockchain network. The sub-blockchain first votes for consensus. After the consensus is completed, the application is submitted to the parent blockchain, and the nodes in the parent blockchain vote. When the number of votes in the proposal exceeds a certain percentage, the smart contract automatically performs the assignment of the sub-blockchain to the new node according to various current factors. The new node joins the corresponding blockchain. The transaction can be performed after the block is synchronized. Because of the continuous silence or the transmission of false information and other information, the nodes in the sub-blockchain are kicked out of the network by the sub-blockchain proposal, and the parent blockchain still needs to be decided by smart contract voting. First, the nodes in the sub-blockchain pass the consensus mechanism for consensus consensus. When the opinion is reached, the accountant node proposes to the smart contract of the parent blockchain, and the nodes in the parent blockchain vote. When the proposal wins more than a certain percentage, the smart contract automatically performs the kick-out node operation. Cancel all permissions for evil nodes.

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4. Experiment analysis

This paper simulates the proposed DB-MIRCROGRID model using simulation software. In this chapter, we will analyze and discuss the experimental results after changing various indicators.

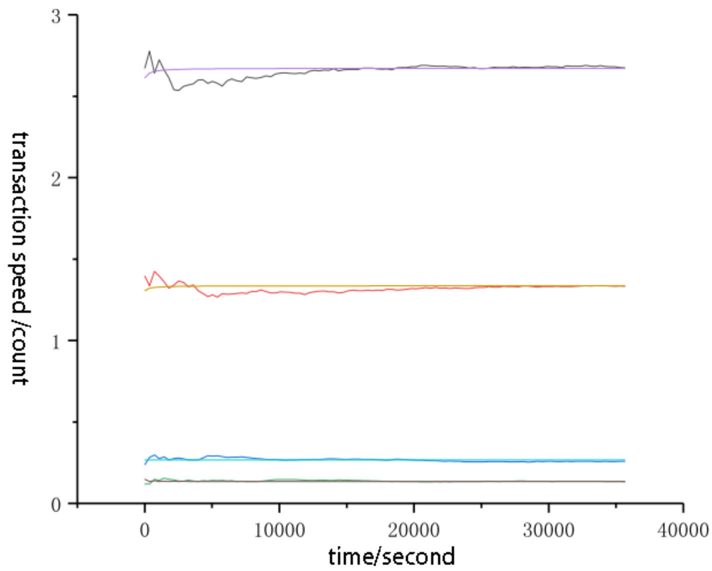
I simulated the proposed model on opnet14.5 software. Use a custom Model to simulate a microgrid. Use the xmt module in the model to simulate the nodes in the microgrid to issue transaction data, use the rcv module to simulate the nodes in the microgrid to receive transaction data, and use the proc module to simulate the microgrid to make decisions. Data is obtained by changing different network topologies and network traffic for the same node, and then analyzing.

4.1 Network performance

In the subnet, I used the DBSCA algorithm based on the proof of interest (pos) mechanism as a consensus mechanism between nodes. The various equity coefficients of the DBSCA algorithm can be dynamically changed in real time using smart contracts based on actual requirements. An example is described in the following table:

Influence	Percent
If Renewable	20%
If Environmental	30%
Cost	40%
If Stable	10%

I tested the volume per second for different block sizes (ie, packing blocks with different transaction counts). By comparing the scheduling model data in the literature [2] under the same conditions and bitcoin (using the pow proof mechanism). The results show that this model can achieve better performance than any other model, regardless of the block size.



The above figure shows that the microgrid transaction package is 4 per unit time (0.2 is my model, 0.35 is the model of literature 2) and 8 (1.4 is my model, 2.7 is the model). Comparison of the amount of node data sent out and the amount of data received in the microgrid network. It can be seen from the experimental data that the transaction efficiency between the nodes proposed in this paper is higher than that of the microgrid scheduling and transaction model proposed in [2].

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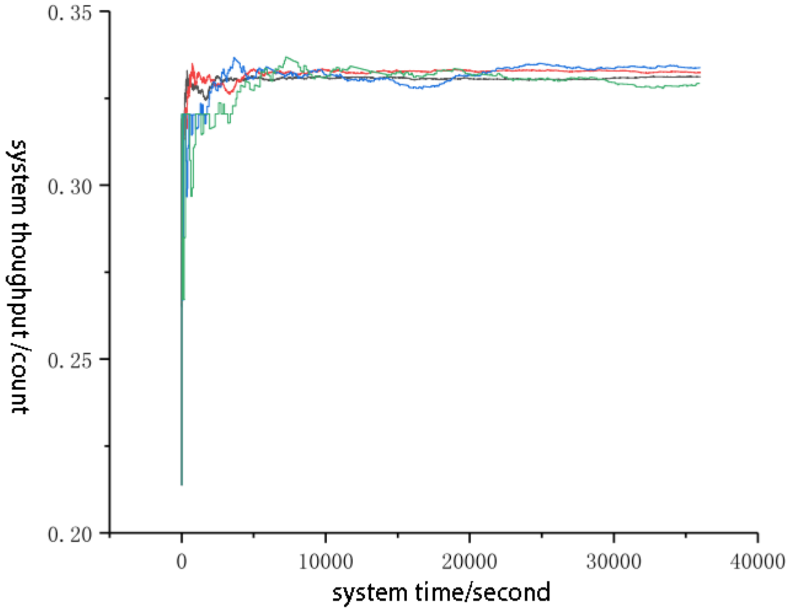
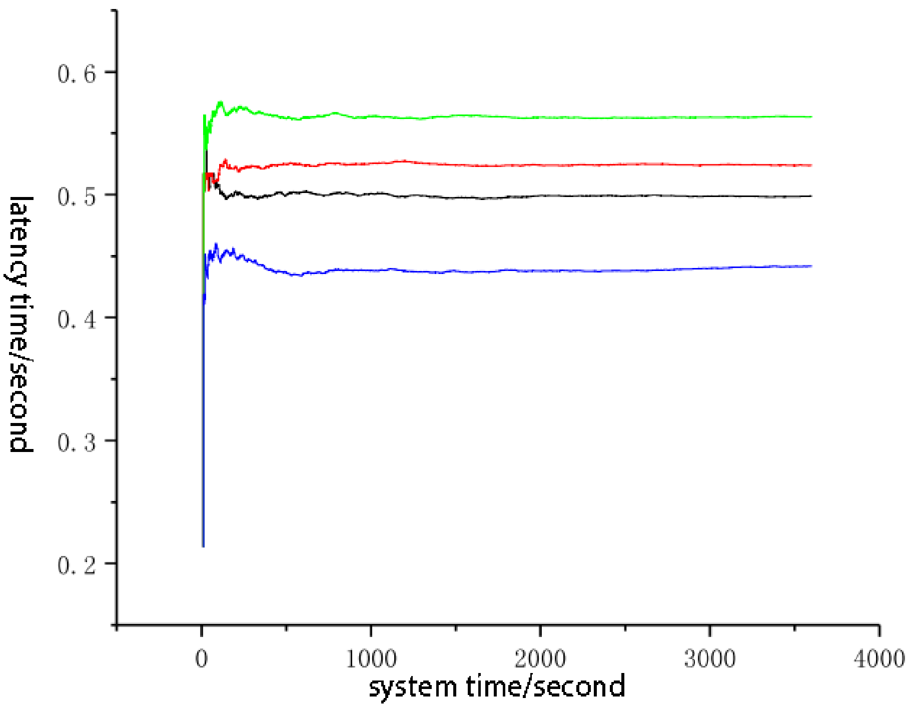


The above figure shows the throughput data of a single node under different models when the microgrid transaction package is sent in unit time. It can be seen from the figure that although the speed of consensus is much improved, the single-node throughput in the DB-MIRCROGRID model is almost the same as the microgrid scheduling and transaction model proposed in [2]. Does not add extra stress to a single node.



The figure above is a network delay test diagram of DB-MIRCROGRID under different node conditions. Since the double-layer blockchain is used in the MIRCROGRID model, the number of nodes in the sub-chain is exponentially decreased. Under the same conditions, the consensus time of the system will not increase due to the large increase of nodes in the network. As can be seen from

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the figure, even if the number of nodes in the network is expanded by 40 times, the consensus time is only increased from 0.45 seconds to 0.56 seconds.

4.2 Scheduling performance of DB-Microgrid

In order to test the performance of DB-MIRCROGRID in the actual production environment, I conducted a simulation using real data after consulting the literature. The indicators for 100 nodes are as follows:

Number	If Renewable	Environmental	Cost	If Stable	Count
1	1	0.99	0.166	0.6	0.538232
2	0	0.39	0.208	0.6	0.356497
3	1	0.16	0.407	0.6	0.505266
4	1	0.30	0.040	0.3	0.361345
5	1	0.45	0.253	0.2	0.482081
6	0	0.23	0.196	0.7	0.302989
7	1	0.98	0.275	0.1	0.494186
8	0	0.85	0.160	0.3	0.335182
9	0	0.82	0.248	0.1	0.281013
10	1	0.96	0.175	0.0	0.490179
11	1	0.04	0.473	0.4	0.500117
12	1	0.24	0.390	0.3	0.388878
13	0	0.14	0.214	0.8	0.276848
14	1	0.91	0.456	0.4	0.571269
15	1	0.46	0.450	0.3	0.578667
16	1	0.84	0.476	0.6	0.586885
17	0	0.92	0.030	0.1	0.352244
18	0	0.96	0.117	0.0	0.357685
19	0	0.33	0.148	0.0	0.264036
20	1	0.81	0.117	0.6	0.456695
21	1	0.83	0.327	1.0	0.568909
22	1	0.83	0.416	0.4	0.627855
23	1	0.73	0.093	0.4	0.490729
24	1	0.46	0.478	0.6	0.594121
25	0	0.35	0.108	0.8	0.232722
26	1	0.14	0.287	0.7	0.449559
27	0	0.01	0.206	1.0	0.311368
28	0	0.86	0.130	0.8	0.400609
29	0	0.90	0.268	0.8	0.395435
30	0	0.55	0.042	0.3	0.278238
31	0	0.86	0.064	0.8	0.420319
32	1	0.48	0.118	0.6	0.439806

ISSN: 2414-1895 DOI: 10.6919/ICJE.201909_5(10).0001

33	1	0.63	0.334	0.1	0.479069
34	1	0.76	0.332	0.4	0.479059
35	1	0.13	0.418	0.1	0.393187
36	0	0.88	0.440	0.5	0.444288
37	1	0.06	0.046	0.8	0.320183
38	1	0.77	0.317	0.6	0.591038
39	1	0.12	0.424	0.8	0.486947
40	1	0.93	0.427	0.1	0.545342
41	0	0.82	0.252	0.0	0.302715
42	0	0.52	0.167	0.7	0.255909
43	1	0.89	0.094	0.6	0.500321
44	1	1.00	0.027	0.9	0.472231
45	1	0.48	0.221	0.1	0.347593
46	1	0.71	0.433	0.7	0.561445
47	0	0.39	0.001	0.5	0.200344
48	0	0.86	0.007	0.9	0.332557
49	0	0.90	0.121	0.4	0.338724
50	0	0.36	0.320	0.0	0.248793
51	1	0.11	0.178	0.7	0.375476
52	0	0.73	0.023	1.0	0.381816
53	1	0.75	0.054	0.0	0.336257
54	0	0.62	0.248	0.6	0.345776
55	0	0.13	0.258	0.5	0.223979
56	1	0.46	0.044	0.6	0.464962
57	1	0.45	0.113	0.1	0.470417
58	0	0.64	0.277	0.4	0.315761
59	0	0.82	0.209	0.5	0.445364
60	0	0.71	0.109	0.3	0.322588
61	1	0.18	0.255	0.2	0.420778
62	1	0.42	0.409	0.8	0.531115
63	1	0.70	0.187	0.3	0.437196
64	0	0.51	0.462	0.8	0.50115
65	1	0.65	0.414	0.4	0.51308
66	0	0.04	0.347	0.7	0.249063
67	0	0.68	0.367	0.1	0.354506
68	0	0.14	0.238	0.1	0.213699
69	1	0.41	0.396	0.4	0.541323
70	1	0.23	0.343	0.2	0.434984

ISSN: 2414-1895 DOI: 10.6919/ICJE.201909_5(10).0001

71	1	0.91	0.082	0.6	0.497525
72	1	0.57	0.111	0.9	0.444753
73	1	0.18	0.061	1.0	0.424238
74	1	0.43	0.346	0.8	0.512613
75	0	0.23	0.303	0.8	0.378052
76	1	0.10	0.487	0.6	0.459877
77	0	0.98	0.441	0.0	0.517405
78	0	0.67	0.206	0.1	0.328053
79	1	0.01	0.166	0.2	0.368778
80	0	0.03	0.122	0.6	0.215145
81	0	0.50	0.075	0.7	0.332844
82	0	0.95	0.178	0.9	0.404777
83	0	0.44	0.233	0.4	0.266711
84	0	0.95	0.306	0.1	0.358013
85	1	0.90	0.482	0.9	0.729324
86	1	0.78	0.080	0.4	0.390143
87	1	0.64	0.466	0.4	0.592145
88	1	0.88	0.483	0.7	0.672031
89	0	0.32	0.373	0.8	0.376159
90	1	0.01	0.184	0.9	0.409431
91	0	0.10	0.057	0.8	0.16099
92	0	0.98	0.472	0.2	0.430798
93	1	0.44	0.415	0.3	0.51696
94	1	0.89	0.485	0.9	0.751901
95	0	0.87	0.247	0.8	0.379537
96	0	0.70	0.287	0.5	0.378146
97	0	0.87	0.188	0.5	0.422653
98	1	0.49	0.249	0.4	0.48635
99	1	0.37	0.184	0.3	0.325916
100	0	0.60	0.341	0.9	0.449266

The election of the biller node in the network uses the DBSCA algorithm. Due to the dynamic changes in the weight of each indicator. For the convenience of calculation, the formula for calculating the tentative biller node score is:

$$Count == (R*0.2+C*0.3+M*0.4+S*0.1).$$

The microgrid model proposed in the literature [2] is available from calculations. The accountant node should be node 53. The score is 0.752. For the model proposed in this paper, the microgrid is divided into 10 groups by serial number, and the accountant nodes of each group are:

Number	Order Number	Node count
1	1	0.538

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2	16	0.586
3	22	0.628
4	38	0.591
5	46	0.561
6	57	0.470
7	69	0.541
8	77	0.571
9	85	0.729
10	94	0.751

In order to make the test results more realistic, we set the delay to the total time from when a microgrid node sends a packet to when it is received by the router, the microgrid node, and the biller node records the information in the transaction packet to the block. This article uses opnet for simulation with a simulation time of ten minutes. It can be seen from the experimental results that the model [2] completes the consensus (that is, the transaction information is written into the blockchain of the accountant node) 223 times, and the total weighted score according to the DBCSA algorithm is 0.458 points. The DB-MIRCROGRID microgrid model proposed in this paper has a total of 431 consensus, and the total weighted score is 0.572. Because of the instantaneous nature of electricity. The improvement of the internal transaction speed of the microgrid model based on the blockchain is more conducive to the maximization of economic benefits and the correct decision of the grid.

5. Summary

With the booming energy Internet, the level of the microgrid is getting lower and lower. Achieving rapid decision making and improving the security, privacy and scalability of microgrid systems are major challenges for the development of microgrids. This paper proposes a hybrid microgrid operation and scheduling model based on double-layer blockchain to try to solve these problems. Experiments show that the proposed model will greatly shorten the time for reaching consensus among microgrid nodes while giving up the optimal solution. However, the model still has some limitations. For example, the parent blockchain does not consider the control of the sub-block link-in permissions, and the low number of nodes in the sub-blockchain may affect the overall security and privacy of the system. We will continue to work in this area in the future.

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