



Intelligent Sharing Technology of Mobile Medical Dynamic Data Based on Internet of Things

Hai-bo Zhang¹(✉), Xiu-juan Duan², and Jian-mei Sun¹

¹ Dalian University of Science and Technology, Dalian 116011, China
jhj sdf89@163.com

² Financial Department, College of Humanities and Information, Changchun University of Technology, Changchun 130122, China

Abstract. In order to solve the problem of long sharing time and low efficiency caused by a large number of false data in cloud computing, the intelligent sharing technology of mobile medical dynamic data based on Internet of Things is proposed. This paper constructs a data cache model based on diagonal priority, allocates bandwidth priority to high priority data, and avoids data transmission interruption in Internet of Things. P2P algorithm is used to get the request queue length of the service node through message interface in the interactive process between the request node and the service node. Establish an intelligent sharing communication protocol for the internet of things, improve subjective and objective factors of mobile medical institutions, build a sharing constraint mechanism, and ensure that mobile medical institutions at different ends receive complete data smoothly. The experimental results show that the shortest sharing time is 2.1s, the highest sharing efficiency is 99%, and the technology has a good sharing effect.

Keyword: Internet of Things · Mobile healthcare · Dynamic data · Intelligent sharing · P2P scheduling

1 Introduction

Mobile medical care refers to the collection, reception and pretreatment of physiological parameters such as ECG, blood pressure, pulse wave and heart rate of residents on an intelligent mobile platform by using Bluetooth wireless technology to connect various household medical electronic devices [1]. Combined with the diagnosis of doctors, it can make up the defect of medical monitoring equipment. SSL and TLS are adopted to realize the security strategy of the system, and the HL7 message exchange standard is integrated with the existing medical information system to provide data support for collaborative diagnosis among hospitals [2]. Using mobile medicine, health centers can provide remote, real-time health monitoring and rapid and timely assistance in the event of an emergency. However, there are a number of security and privacy issues that need to be addressed before sharing personal health information between users. In MHSN, the

patient's PHI is privacy-sensitive, and even if the patient's identity is kept private, only patients with the same condition can view the shared information. However, because of the randomness of patient movement, this network becomes a network of opportunities [3]. Therefore, the main security and privacy challenges in current mobile medical social networks are how to achieve the secret disease matching and the security and privacy protection in the communication process. Intelligent sharing of mobile medical dynamic data based on cloud computing, with infrastructure as a service, platform as a service and software as a service, enables some specific application functions to be encapsulated as services to users through their own dynamic extension of resources and fault-tolerant management functions. [4] With the wide application of cloud computing, the security problems caused by cloud computing have become increasingly prominent, and become a key factor restricting the further development and implementation of cloud computing [5]. Specifically, because in cloud computing environment, due to hardware, software and human uncertainties, cloud servers will inevitably erroneously modify, or even erase the data of users. In the process of data use, due to the characteristics of cloud computing outsourcing, the whole process of data retrieval and retrieval is performed in the cloud. The cloud server can control the whole retrieval process and determine the final results, and the data consumer will not be able to directly verify the integrity and correctness of the data returned by the cloud server. Therefore, the intelligent sharing technology of mobile medical dynamic data based on Internet of Things is proposed.

Using centralized P2P data scheduling, a data caching model based on diagonal priority is constructed, data is allocated according to the priority level of bandwidth, and data transmission is completed in wireless cellular network by using P2P technology. Based on the Internet of Things, an intelligent sharing communication protocol of Internet of Things is constructed under constraint mechanism, which makes data communication smooth. The intelligent sharing of mobile medical dynamic data based on Internet of Things is completed.

2 Prioritization of P2P Intelligent Data Sharing Based on Internet of Things

Because of the variety of wireless channel, high loss rate of nodes and different network speed, and the small number of nodes, the quality of service of streaming media in mobile medical service is poor. In the Internet of Things, P2P network is the core architecture of data transmission, which is used by many online video and large websites. But because of the characteristics of mobile network, the traditional P2P technology can not be directly applied to mobile medical streaming media transmission. Centralized data scheduling of P2P in fixed network is the core technology. It calculates the bandwidth, delay and packet loss rate of every node in the network, and selects some nodes from neighbor set to transmit data. In order to improve the precision of mobile medical dynamic data sharing, data sharing priority is designed based on the data cache model.

2.1 Construction of Data Cache Model Based on Twill Priority

The cache model is divided into two parts in block coordinates: the decision scheduling area and the scarcity scheduling area. The scheduling algorithm of the decision scheduling area assigns an urgency degree to each block of data, which is determined by layer coordinates and time coordinates. The closer to the playback time, the lower the number of layers, the higher the urgency, and the system gives priority to dispatching the data with the higher urgency; in the scarce dispatching area, bandwidth is allocated to the scarce data first, that is, the data blocks containing the small number of nodes of the data, with the aim of reducing the probability of frequent requests to the server due to node departures, which improves the absence of scarce resources due to high node leave rates in mobile networks [6–9].

The two regions have different scheduling algorithms, but the network bandwidth is uniformly allocated according to the priority of the entire cache, that is, all data blocks in the cache are periodically scanned and the bandwidth is allocated first to the higher-priority data [10, 11]. The build based on the twill priority data cache model is shown in Fig. 1.

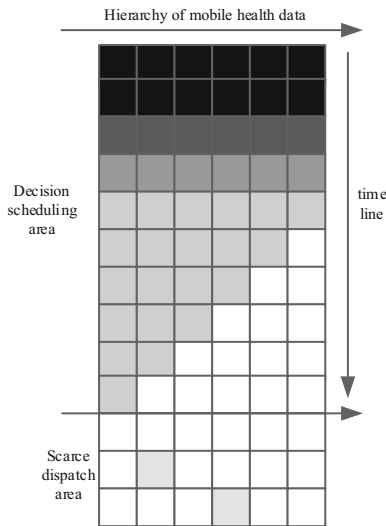


Fig. 1. Data cache model based on diagonal priority

As shown in Fig. 1, the two priority sizes can overlap, so the allocation of bandwidth is not limited to the region. The darker the color, the higher the priority, the lighter the color, the lower the priority. In the decision and scheduling area, the trend is gradually decreasing in the right direction, similar to the sub-twill. Cyclic loop computation, with each loop computing the priority of the currently available bandwidth, the decision scheduling area and the scarcity scheduling area for each data, then allocating the available bandwidth to the higher priority data, which is then allocated to the next scheduling phase until the scheduling terminates [12–14].

(1) Decision-making and scheduling area

Because of such factors as limited and drastically changing bandwidth, bad channel, and high node loss rate in mobile networks, dynamic data cannot be guaranteed to reach all at playback time [15]. Because this area is close to the playback time, the distance of playback time and the number of layers are used as the metrics of the data priority. The priority of the data in the area is allocated in the way of twill, near the playpoint, the priority of the low level data is high, far away from the playpoint, the priority of the high level data is low [16]. The strategy not only reduces the probability of avoiding data transmission interruption in the IOT, but also satisfies the definition requirement in the mobile environment, that is, to balance the data transmission fluency in the IOT [17]. The priority of the scarce data in the scheduling area is higher than that of the high-level data in the partial decision scheduling area.

(2) Scarce dispatch areas

The scheduling principle of this area is to allocate the bandwidth to the scarce data, which refers to the data blocks containing fewer nodes in the network. The aim of scarcity priority scheduling is to minimize frequent access to servers due to node departures and to reduce server load [18]. This algorithm improves the utilization of bandwidth and increases the system throughput. The principle of scarcity scheduling is that the lower the number of nodes in a region, the higher the priority. Compared with the decision scheduling area, the priority of this area will be higher than the high-level data of partial decision scheduling area [19].

2.2 Data Scheduling Algorithm Based on P2P Technology

Mobile P2P technology is the use of P2P technology in wireless cellular network for data transmission, it is P2P and mobile communication technology interdisciplinary. The current 4G technology makes the mobile P2P get the rapid development, it is widely used in the cellular network streaming media transmission and mobile network data interaction. P2P network is a kind of application layer protocol, which realizes distributed peer-to-peer relationship among peers and resources are shared by all peers and the peers can transmit data to each other. The node of P2P network is not only the data requester, but also the data provider. Peer to peer transmission is implemented between nodes, and each node acts as a server.

A P2P network is a distributed architecture that differs from a traditional client/server (Client/Server, C/S). As the center of C/S structure, the central server not only provides data resources to all nodes, but also has the basic information of nodes and networks in the system. In the traditional model, the client can only request data from the server and receive data from the server, and the server can not only receive, process and forward data, but also control the overall network situation. But the server is easy to become the network limit, when the node number increases gradually, the server's computation and the network bandwidth increase gradually, when achieves the bottleneck network efficiency to reduce suddenly. If a server is compromised by a virus or attack, the entire network faces disaster. At the same time, due to the limited single-point processing capacity of the server, the huge client requests are often not processed in time, so the network resource utilization is low, and P2P network does not have this problem.

The algorithm realizes the data communication between the request node and the service node through the interaction between the request node and the service node. The requesting node stores data such as the number of caches and historical bandwidth in the local information database, and obtains the request queue length of the service node through the message interface [20]. The peer communication in the P2P algorithm is shown in Fig. 2.

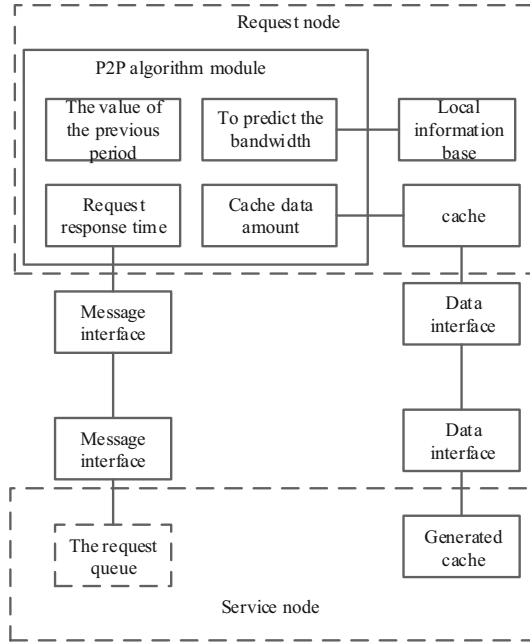


Fig. 2. Peer communication in P2P algorithm

As can be seen from Fig. 2, the algorithm dynamically adjusts the number of requests and the object of the request node by defining four variables $Q[n]$, $T[n]$, $D[n]$, and $L[n]$ to get the current network service status. $Q[n]$ represents the number of data blocks requested from node i by node k for the n th time, and the calculation formula is:

$$Q[n] = Q[n - 1] + \frac{\alpha}{m}D[n] + \frac{\beta}{m}S[n] + \delta \frac{U}{L}T[n] \tag{1}$$

As shown in formula (1), $Q[n]$ is determined by the number of requests for data blocks at the previous time, the estimated bandwidth of the node, the amount of data in the cache and the response time of the node, α , β , δ being constant; m the size of the set of service nodes [21].

$S[n]$ represents the data size of the buffer for the n th request from node k , calculated by:

$$S[n] = \frac{S_m - S[n - 1]}{S_m} \tag{2}$$

In formula (2), S_m is the threshold for the cache size, and if the cache size at the previous moment was greater than this value, $S[n]$ is negative, reducing the number of data requests for $Q[n]$ and vice versa. Proportional to $S[n]$ and $Q[n]$, that is, the fewer the number of service nodes, the greater the impact of $S[n]$ on $Q[n]$, raising the priority of scarce resources, increasing system throughput.

$T[n]$ represents the response time of the n th request, including queuing delay and sending delay. The calculation formula is as follows:

$$T[n] = 1 - T[n-1] \quad (3)$$

As shown in formula (3), the current request response time is inversely proportional to the response time of the previous cycle. $T[n]$ is inversely proportional to the ring, and proportional to the queue length of the $L[n]$ -node k request service. That is, the greater the uplink bandwidth, the greater the impact of $T[n]$ on $T[n]$, and the higher the uplink bandwidth utilization; Increasing the queue length of the request service reduces the value of $Q[n]$ by $T[n]$, so the system can reduce the probability of service queue congestion.

$D[n]$ Represents the predicted bandwidth of node k n th direction node j , the calculation formula is:

$$D[n] = \sum_{i=1}^n \lambda_i D[n-1] \quad (4)$$

In formula (4), $D[n]$ records the information sent by the service node to the requesting node in the most recent m cycles, and estimates the current bandwidth based on the amount sent, thus predicting the amount requested from the service node. As shown in formula (4), n is a positive integer, and the closer the period, the greater the impact of bandwidth prediction, which follows the characteristics of network bandwidth changes. $D[n]$ is proportional to m , and the smaller the number of service nodes, the greater the impact of $D[n]$ on $Q[n]$.

3 Research on Intelligent Sharing Technology Based on Internet of Things

3.1 Establishment of Data Sharing Mechanism Based on Internet of Things

The mobile medical dynamic data sharing based on Internet of things mainly follows the intelligent sharing communication protocol, as shown in Fig. 3.

As can be seen from Fig. 3, the real-time sharing of mobile medical dynamic data based on the Internet of Things meets the following conditions: the sender and the receiver have the same purposes, and the sharing results can achieve the desired effect during the whole data sharing process [22].

Therefore, in order to improve the subjective and objective factors of mobile medical institutions, effective management and shared constraint mechanism should be established, as shown in Fig. 4.

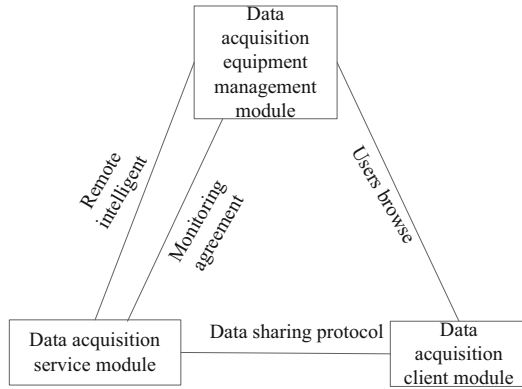


Fig. 3. Networked intelligent shared communication protocol

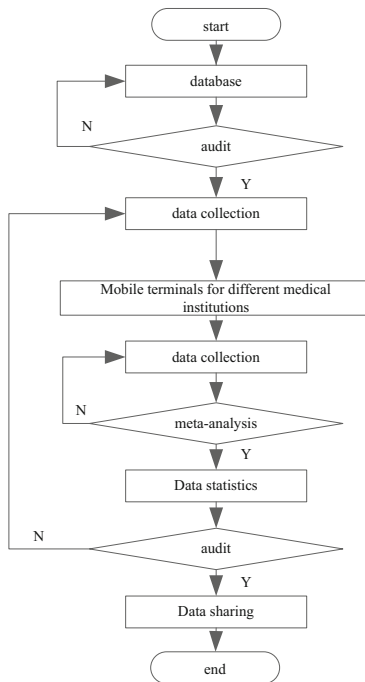


Fig. 4. Data sharing constraints based on Internet of Things

Under the constraint mechanism shown in Fig. 4, the dynamic transmission of mobile medical data based on Internet of Things needs to go through three steps: data integration, data sending and data receiving. Therefore, a constraint mechanism is needed to promote the effective sharing of data within the main transformer. Through the data sharing constraint mechanism, the mobile medical institutions based on the Internet of Things

can be urged to analyze from the common cognitive perspective, carry out reasonable transmission, and through accurate data transmission [23], the complete data can be successfully received by different mobile medical institutions, and then the dynamic data sharing of mobile medical services based on the Internet of Things can be realized.

Because of the large amount of mobile medical dynamic data based on Internet of Things, the sharing mode should be selected. For the complementary judgment matrix under different modes, in order to obtain the optimal shared results, the following steps are required:

Step 1: Set thresholds and iteration parameters before data is shared;

Step 2: According to the complementary judgment matrix to obtain the minimum deviation and the optimal weight vector;

Step 3: according to the following formula to obtain complementary judgment matrix consistency index;

Step 4: Output complementary judgment matrix that is the optimal weight vector, according to the vector of data security sharing mode to sort, in order to get the best sharing results.

3.2 Shared Process Design Based on Internet of Things

In this paper, a medical information sharing system is proposed, which can realize the information sharing by using the cloud to store the patient's diagnosis and treatment data, and allocating and managing the related authority of the institution. The sharing process based on the Internet of Things is shown in Fig. 5.

Under the constraint mechanism shown in Fig. 4, the dynamic transmission of mobile medical data based on Internet of Things needs to go through three steps: data integration, data sending and data receiving. Therefore, a constraint mechanism is needed to promote the effective sharing of data within the main transformer. Through the data sharing constraint mechanism, the mobile medical institutions based on the Internet of Things can be urged to analyze from the common cognitive perspective, carry out reasonable transmission, and through accurate data transmission, the complete data can be successfully received by different mobile medical institutions, and then the dynamic data sharing of mobile medical services based on the Internet of Things can be realized.

Because of the large amount of mobile medical dynamic data based on Internet of Things, the sharing mode should be selected. For the complementary judgment matrix under different modes, in order to obtain the optimal shared results, the following steps are required:

Step 1: Set thresholds and iteration parameters before data is shared;

Step 2: According to the complementary judgment matrix to obtain the minimum deviation and the optimal weight vector;

Step 3: according to the following formula to obtain complementary judgment matrix consistency index;

Step 4: Output complementary judgment matrix that is the optimal weight vector, according to the vector of data security sharing mode to sort, in order to get the best sharing results.

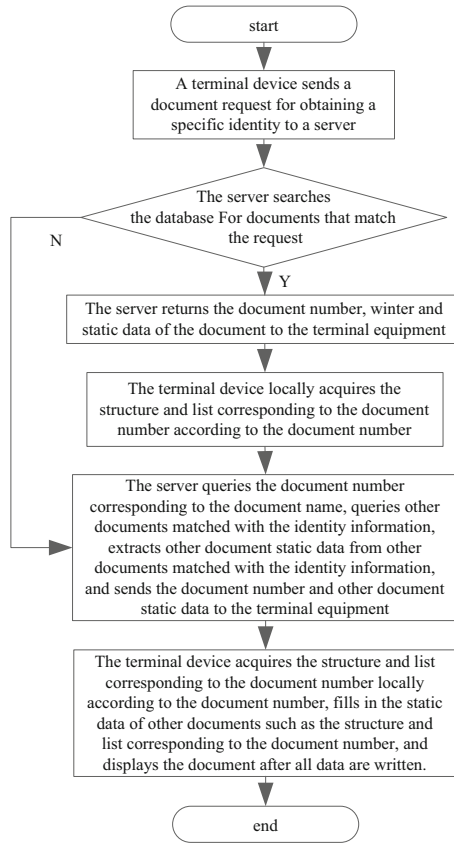


Fig. 5. Data sharing constraints based on Internet of Things

3.3 Shared Process Design Based on Internet of Things

In this paper, a medical information sharing system is proposed, which can realize the information sharing by using the cloud to store the patient's diagnosis and treatment data, and allocating and managing the related authority of the institution. The sharing process based on the Internet of Things is shown in Fig. 6.

The detailed steps are:

Step 1: The terminal device sends a document request for obtaining a specific identity to the server. The request includes: identity identification information and document name;

Step 2: The server searches the database for documents matching the request. The technical solution provides a complete way of data sharing. No matter what system the operating system of the terminal device belongs to, it can automatically generate the corresponding document structure and list and display them, which makes it convenient for users or doctors to query historical medical data. Specifically, because the documents are generated by the terminal according to the document number, and the information data is filled by the terminal device itself according to the received data content in the

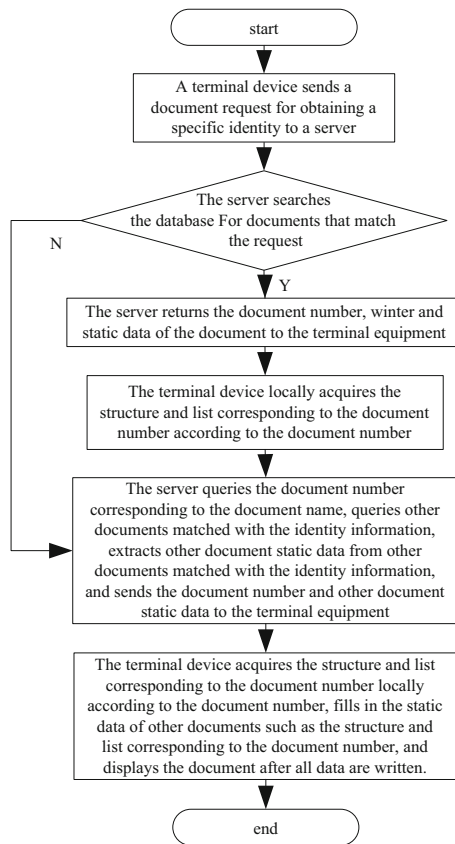


Fig. 6. Sharing process based on Internet of Things

corresponding document, so it will not be incompatible with the system. In addition, the locally generated documents also reduce the problem that the documents do not match with the terminal device. For example, the document interface displayed on the PC is displayed on the mobile phone, and it is easy to cause the problem of mismatch due to the size of the display screen, while the locally generated documents only extract the local documents corresponding to the document number according to the document number, so it will not cause such problem, and the system does not need to distinguish the application system of the terminal device and uniformly issue the document number. In addition, the static data of other documents can be invoked from other documents that match the identity information, even if no matching document can be queried in the above way. For static data, because of its stability and the characteristics of only matching the identity information, it can become the static information of other documents instead of the static information of this document, so that the operators such as doctors do not have to re-enter the user's static data during this operation, thus saving doctors' time and improving their work efficiency.

Step 3: The server returns the document number, static data and dynamic data to the terminal device;

Step 4: The terminal device acquires the structure and list corresponding to the document number locally according to the document number; fills in the static data and dynamic data of the document into the structure and list; for example, there are many rows of data in the dynamic data of the document, the server extracts the description of each row of records according to the structure of many rows of records, forms a list of row of descriptions, sends the return data ID into a list of row of descriptions to the terminal device, and the terminal device writes the list of row of descriptions into the document structure and list line by line, and displays the document when all data are written;

Step 5: The server inquires about and obtains the document number corresponding to the document name, inquires about other documents matching the identity information, extracts other static data of other documents matching the identity information, and sends the document number and other static data of documents to the terminal device;

Step 6: The terminal device obtains the structure and list corresponding to the document number locally according to the document number, fills in the static data of other documents into the structure and list corresponding to the document number, and displays the document after all data is written.

4 Experiment

In order to ensure the reliability of the experiment, we set up a fixed experimental device to verify the rationality of the research on the intelligent sharing technology of mobile medical dynamic data.

4.1 Construction of Network Open Source Simulation Platform

OverSim is an open source P2P network simulation framework based on OMNeT++ (Objective Modular Network Testbed in C++). It supports many P2P protocols, including not only structured overlay network but also unstructured overlay network. OverSim platform has three layers, which are application layer, coverage layer and foundation layer from top to bottom.

(1) Application layer

The application layer is a P2P application development system for developers. The platform provides a number of perfect application APP instances, which send detection information periodically, obtain the data of the protocol bottom layer through the basic layer or the overlay layer, and record the information delay and hops in the overlay layer. The application layer provides the perfect system simulation index for developers to use together.

This level provides a data sharing system for communication terminals in a medical system, as shown in Fig. 7.

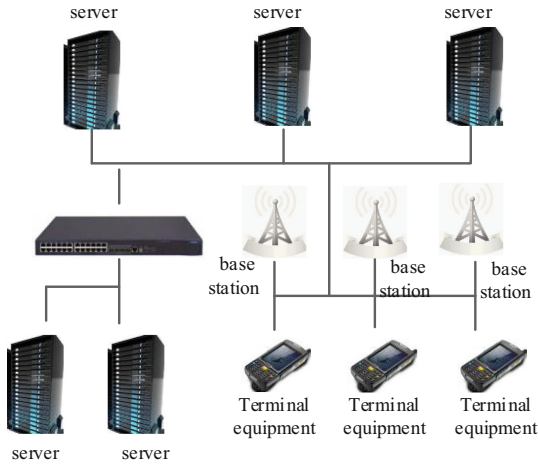


Fig. 7. Data sharing system

As can be seen from Fig. 6, the system is composed of two parts, the terminal device and the server. The terminal device is used for sending a document request to the server for obtaining a specific identity, including identity information and document name, and is used for obtaining the structure and list corresponding to the document number locally according to the document number. The static data and dynamic data of the document are filled in the structure and list, and the document is displayed when all the data is written; the server is used to retrieve whether there is a document matching the request in the database, such as query for a document matching the request, and return the document number, static data and dynamic data of the document to the terminal device. The server is used for querying documents without the requested match, querying for the document number corresponding to the document name, querying for other documents matching the identity information, extracting static data of other documents in other documents matching the identity information, and sending the document number and static data of other documents to the terminal device.

(2) Overburden

The overlay layer is based on the basic layer, which provides the support of P2P protocol for the application layer. This layer has the following four functions:

First, information processing of statistical data in overburden layer. The layer provides an RPC (Remote Procedure Call) interface to handle packet timeout and packet retransmission caused by packet loss. The interface can also count the data sent, received, forwarded and lost by nodes.

Second, visualization of topology structure;

Thirdly, the function of node lookup is provided, which is to find the corresponding node according to the node behavior in the topology.

Fourthly, the layer provides API protocol support for the application layer. Each layer protocol must provide at least one kind of keyword -based routing interface. For the distributed hash table based protocol, the same service can be provided to

realize the communication between the two layers. For the protocol that does not support distributed hash table, the key word based routing interface can also be used to realize the communication.

(3) Basic layer

This layer has three network models: iNET(integrated Network Enhanced Telemetry), simple and singleHost. The base layer provides routing table, IP address assignment and MAC communication for network simulation. It is the bottom layer of OverSim module.

4.2 Experimental Results and Analysis

The sharing effect is mainly from the sharing time and the sharing efficiency two angles to carry on the experimental verification analysis.

Shared Time Experiment Analysis

Based on the generation stage data, operation and maintenance stage data and scrapping stage data, the training set boundary decision graph is analyzed, and the result is shown in Fig. 8.

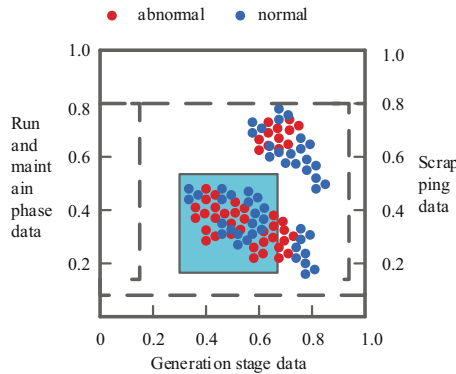


Fig. 8. Training set boundary decision graph

As can be seen from Fig. 8, the data in the boundary of the training set is the normal operation of mobile medical institutions. When the monitored data is beyond the boundary, the data can be identified as normal data and need maintenance. Cloud-based and IoT-based approaches are used to compare anomaly and normal data sharing, and the results are shown in Fig. 9.

As can be seen from Fig. 8, the abnormal data: when the data amount is 0.21×10^4 bit, the sharing time consumed by the traditional method is 20 s, while when the data amount is 0.62×10^4 bit, the sharing time consumed by the method studied is 18 s; when the data amount is 0.21×10^4 bit, the sharing time consumed by the method studied is 24 s, and when the data amount is 0.42×10^4 bit, the sharing time consumed by the method studied is 20 s. Once the shared data is found to be abnormal using the method

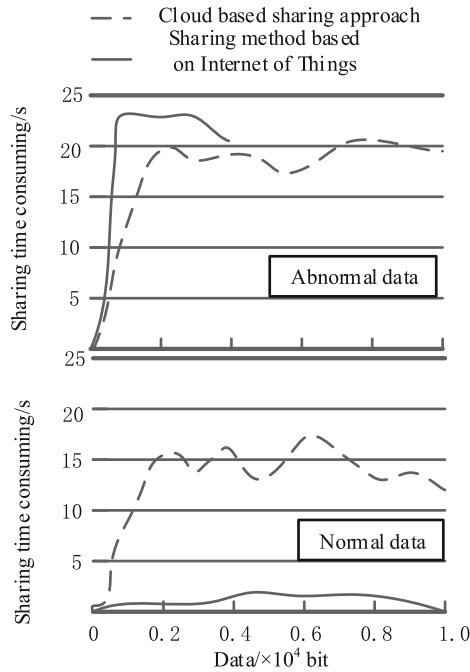


Fig. 9. Comparison of time-consuming results between the two methods

studied, the sharing is stopped immediately. But the cloud computing takes a long time to share the abnormal data. Normal data: when the data quantity is 0.21×10^4 bit, the sharing time consumed by the traditional method is 15 s, while when the data quantity is 0.62×10^4 bit, the sharing time consumed by the method studied is 19 s; when the data quantity is 0.21×10^4 bit, the sharing time consumed by the method studied is 2.1 s, and when the data quantity is 0.42×10^4 , the sharing time consumed by the method studied is 3.0 s.

Experimental Analysis of Sharing Efficiency

(1) Comparative analysis of sharing efficiency under data interference

①Creating false information

Create false information to cause some interference to data sharing, based on this situation, respectively, using cloud -based and IoT -based approach to analyze the efficiency of data sharing, the result is shown in Fig. 10.

As can be seen from Fig. 9: when the data volume is 10×10^4 bit, the sharing efficiency of the method based on cloud computing is 43%, and the sharing efficiency of the method based on Internet of things is 88%; when the data volume is 30×10^4 bit, the sharing efficiency of the method based on cloud computing is

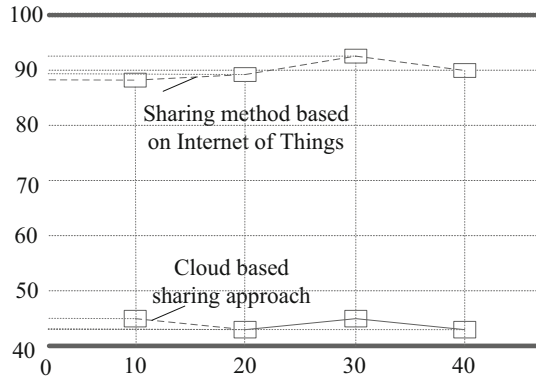


Fig. 10. Comparison of sharing efficiency of two technologies in case of creating false information

43%, and the sharing efficiency of the method based on Internet of things is 94%. Therefore, the method based on Internet of things is more efficient.

②Multiple attack points

Because the shared system is composed of a large number of data collected and processed, it is easy to be attacked by multiple attack points, resulting in more data interference. Based on this situation, the sharing efficiency of the two technologies is compared and the result is shown in Fig. 11.

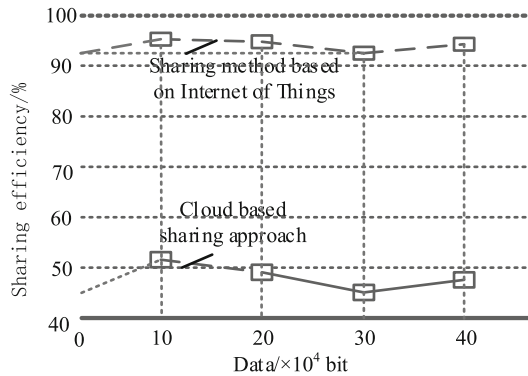


Fig. 11. Comparison of the sharing efficiency of the two technologies for multiple attack points

As can be seen in Fig. 11, both sharing efficiencies are on the rise compared with disinformation creation, and the efficiency of data sharing using the IoT-based sharing approach is consistently above 90%. When the data volume is 10×10^4 bit, the sharing efficiency based on cloud computing method is 52%, and the sharing efficiency based on IoT method is 95%; when the data volume is 30×10^4 bit, the sharing efficiency based on cloud computing method is 45%, and the sharing efficiency based on IoT method is 92%,

The results show that the sharing method based on Internet of Things has higher sharing efficiency in the case of data interference.

(2) Comparative analysis of sharing efficiency under normal circumstances

In order to further verify the rationality of this method, the interference data are eliminated, as shown in Fig. 12.

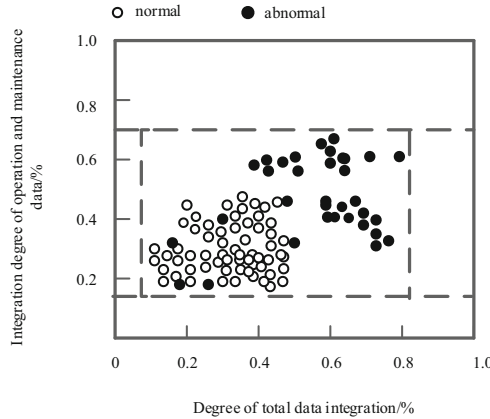


Fig. 12. Eliminating interference data

As shown in Fig. 11, the data works fine within the range of the host training set. If the monitored data is abnormal, it indicates an attack. If the monitoring data is correct, it needs to be corrected. On this basis, the sharing efficiency of the two sharing technologies is compared and analyzed, as shown in Table 1.

Table 1. Comparison and analysis of sharing efficiency of two technologies under elimination of interference data

Mobile medical data number	V2	V3
#1	82%	99%
#2	82%	99%
#3	81%	98%
#4	78%	98%
#5	78%	98%
#6	75%	97%
#7	75%	97%
#8	72%	98%
#9	70%	98%

From the Table 1, we can see that the efficiency of the two technologies is higher than 70% in the case of no interference data, which has good sharing efficiency.

5 Concluding Remarks

Due to some shortcomings of mobile medical network, such as high dynamic of nodes and poor channel quality, the data scheduling algorithm in P2P can achieve good results in mobile medical data intelligent sharing. Combined with the new data scheduling algorithm to overcome these shortcomings effectively in the mobile network, the experimental results show that the sharing time and sharing efficiency has higher advantages.

With the further development of mobile medical care, the intelligent sharing technology of mobile medical dynamic data based on Internet of Things will develop in the direction of integration. This technology will integrate all kinds of scene applications, so the data scheduling algorithm needs to be switched according to different applications. Since the proposed scheduling algorithm is based on the priority caching model, the future work will focus on the P2P algorithm, so that the series of algorithms can adapt to the needs of the integrated platform. Because this algorithm uses priority caching model, it has certain research value and research foundation.

It is concluded that the intelligent sharing technology of mobile medical dynamic data is suitable for the development of mobile medical platform, intelligence and diversification, and has far-reaching application value. In addition, the follow-up research can focus on the mobile medical dynamic data sharing mechanism, and improve the quality of mobile medical data transmission from many aspects.

References

1. Cheng, H., Shi, Y., Wu, L., et al.: An intelligent scheme for big data recovery in internet of things based on multi-attribute assistance and extremely randomized trees. *Inf. Sci.* **557**(4), 66–83 (2021)
2. Toh, S.: Analytic and data sharing options in real-world multidatabase studies of comparative effectiveness and safety of medical products. *Clin. Pharmacol. Ther.* **107**(4), 834–842 (2019)
3. Cole, C.L., Soumitra, S., Sarah, R., et al.: Ten principles for data sharing and commercialization. *J. Am. Med. Inform. Assoc.* **3**(3), 646–649 (2020)
4. Oliveira, J.L., Trifan, A., Silva, L.B.: EMIF Catalogue: A collaborative platform for sharing and reusing biomedical data. *Int. J. Med. Inform.* **126**, 35–45 (2019)
5. Elizabeth, F., Malcolm, O., Lamiece, H., et al.: Should free-text data in electronic medical records be shared for research? a citizens' jury study in the UK. *J. Med. Ethics* **46**(6), 367–377 (2020)
6. Dubovitskaya, A., et al.: Applications of blockchain technology for data-sharing in oncology: results from a systematic literature review. *Oncology* **98**(6), 1–9 (2019)
7. Chandrasekaran, R., Sankaranarayanan, B., Pendergrass, J.: Unfulfilled promises of health information exchange: what inhibits ambulatory clinics from electronically sharing health information? *Int. J. Med. Informatics* **149**(1), 104418 (2021)
8. Bahr, B., Cunningham, W.J., Dittrich, B., et al.: Data on sharing data. *Nat. Phys.* **15**(8), 724–725 (2019)

9. Saito, M.A., Bertrand, E.M., Duffy, M.E., et al.: Progress and challenges in ocean metaproteomics and proposed best practices for data sharing. *J. Proteome Res.* **18**(4), 1461–1476 (2019)
10. Du, M., Chen, Q., Chen, J., et al.: An optimized consortium blockchain for medical information sharing. *IEEE Trans. Eng. Manag.* **68**(6), 1677–1689 (2020)
11. Fylan, F., Fylan, B.: Co-creating social licence for sharing health and care data. *Int. J. Med. Informatics* **149**(4), 104439 (2021)
12. Dexheimer, J.W., Greiner, M.V., Beal, S.J., et al.: Sharing personal health record data elements in protective custody: youth and stakeholder perspectives. *J. Am. Med. Inform. Assoc.* **26**(8–9), 8–9 (2019)
13. Kalkman, S., Delden, J.V., Banerjee, A., et al.: Patients’ and public views and attitudes towards the sharing of health data for research: a narrative review of the empirical evidence. *J. Med. Ethics, medethics-2019–105651* (2019)
14. Shortreed, S.M., Cook, A.J., Yates, C.R., et al.: Challenges and opportunities for using big health care data to advance medical science and public health. *Am. J. Epidemiol.* **188**(5), 851–861 (2019)
15. Shu, D., Yoshida, K., Fireman, B.H., et al.: Inverse probability weighted Cox model in multi-site studies without sharing individual-level data. *Stat. Methods Med. Res.* **29**(6), 096228021986974 (2019)
16. Spector-Bagdady, K., Hutchinson, R., Kaleba, E.O., et al.: Sharing health data and biospecimens with industry — a principle-driven, practical approach. *N. Engl. J. Med.* **382**(22), 2072–2075 (2020)
17. Timothy, B., Yan, Y., Thomas, S., et al.: Piloting a model-to-data approach to enable predictive analytics in health care through patient mortality prediction. *J. Am. Med. Inform. Assoc.* **27**(9), 1393–1400 (2020)
18. Sheehan, M., Friesen, P., Balmer, A., et al.: Trust, trustworthiness and sharing patient data for research. *Journal of Medical Ethics*, (3):medethics-2019–106048 (2020)
19. Kuo, Y.F., Raji, M.A., Lin, Y.L., et al.: Use of medicare data to identify team-based primary care. *Med. Care* **57**(11), 905–912 (2019)
20. Fritz, Z., et al.: Patient engagement or information overload: patient and physician views on sharing the medical record in the acute setting. *Clin. Med. (Lond.)* **19**(5), 386–391 (2019)
21. Liu, S., Liu, G., Zhou, H.: A robust parallel object tracking method for illumination variations. *Mobile Networks Appl.* **24**(1), 5–17 (2018). <https://doi.org/10.1007/s11036-018-1134-8>
22. Liu, S., Bai, W., Liu, G., et al.: Parallel fractal compression method for big video data. *Complexity* **2018**, 2016976 (2018)
23. Liu, S., He, T., Dai, J.: A survey of CRF algorithm based knowledge extraction of elementary mathematics in Chinese. *Mobile Networks Appl.* **26**(5), 1891–1903 (2021). <https://doi.org/10.1007/s11036-020-01725-x>