



Data Access Control Method of Power Terminal Based on 5G Technology

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Abstract. Due to the limitation of network environment, traditional terminal data access control methods can not establish a connection channel with fast access devices, which makes the data access response time longer. Therefore, the design of data access control method for power terminal based on 5G technology is proposed. According to the classification results, the data access requests are assigned to the business areas based on 5G slicing technology, so as to improve the efficiency of data access. At the same time, build a model to ensure that the power terminal data access can be processed on time, and finally realize the power terminal data access control, improve the response performance of group mobile phone access request, and improve the power terminal data access speed. The simulation results show that the data access control method designed in this paper is obviously better than the traditional control method. Under the same thread condition, the data access response time is almost the same, and the method in this paper has a slight advantage. Under different thread conditions, with the increase of the number of threads, the access response time of the control method in this paper is significantly lower than that of the traditional method, which effectively improves the data access speed.

Keywords: Data access · 5G technology · Power terminal · Access control

1 Introduction

With the rapid development of mobile communication technology and Internet technology, higher requirements are put forward for real-time access and data response speed of terminal equipment [1]. At present, there are some problems in power terminal identity authentication and data access control. Starting from the 2G era, the access of mobile terminal equipment to the power enterprise Intranet has gradually become a demand point. With the rapid development of 3G and 4G, the transmission speed of mobile data networks has improved a lot, making the transmission of images, voice and video possible, and the user experience has become better and better [2]. With the development and popularization of 5G, a large number of mobile terminal equipment, including Internet of things equipment, have been developed, access to the enterprise Intranet has become possible [3]. The characteristics of 5G provide many scenarios and requirements for mobile terminal devices to access the enterprise intranet. With the good development of

the network environment, the power terminal equipment began to access the power grid safely, so as to facilitate people's daily life. In reference [4], the heterogeneous network (C/U) which separates the control plane from the user plane is an evolutionary method of the fifth generation (5G) network to achieve high system coverage and high capacity. In order to minimize the signaling load of the core network when a macro base station fails in the control plane, a scheme is proposed to transfer the control right of the cell covered by the faulty macro base station to the adjacent macro base station. Based on the analysis of the average handover rate between cells, the extended coverage rate of adjacent macro stations under the constraint of transmit power and the load balance index of the system, the maximum formula of macro blind source handover is constructed and further solved by convex optimization method. In reference [5] the rapid growth of the number of mobile devices, massive data and higher data rate are promoting the development of the fifth generation (5G) wireless communication. 5G network has three unique characteristics: ubiquitous connectivity, extremely low latency and high-speed data transmission through the use of new technologies to equip future nano millimeter wave wireless communication systems and large-scale multiple input multiple output (MIMO) systems with extreme base station and device density, as well as an unprecedented number of nano antennas. These 5G new technologies are introduced, especially for the nano materials used in antenna. Due to a large number of MIMO technology and ultra densification technology, traditional antennas can not provide new frequencies for smaller antennas, while nano antennas are used for 5G. Nano materials for broadband millimeter wave antennas are introduced. However, due to the limitation of the traditional network channel, it is unable to meet the centralized access of mass power Internet of things terminal equipment at the same time. Therefore, for the research of power terminal data access control, based on 5G technology, a power terminal data access control method is designed, which has a good protection and reference for the security of sensitive data of power system terminal.

2 Design of Power Terminal Data Access Control Based on 5G Technology

With the rapid development of Internet technology, the use of smart phones is becoming more and more popular [6]. Table 1 shows the survey of smart phone use rate from 2016 to 2020.

Table 1. 2016–2020 smartphone usage survey

Particular year	Utilization rate
2016	65.32%
2017	72.10%

(continued)

Table 1. (continued)

Particular year	Utilization rate
2018	90.06%
2019	97.26%
2020	98.01%

According to Table 1, more than 98% of smart phones are used, which makes more and more service projects begin to be carried out through mobile terminals, which facilitates people’s lives [7]. The same is true of power data, and the data access control of power terminal has become a problem to be solved. In order to better ensure the speed of user data access, based on 5G slicing technology, the data access area of power terminal is divided, and then the data access control model is established to control the data access direction of power terminal, and finally the data access control is realized.

2.1 Development of Data Access Classification Schemes

The design of data access control method for power terminal promotes the normal operation of the method by formulating data access classification scheme in the model [8]. In the control process, how to classify the data access requests of power terminals is the main problem to be solved [9]. The classification scheme includes three main parts: user (U), cloud service provider (CSP) and master certification authority (MA). The relationship between them is shown in Fig. 1.

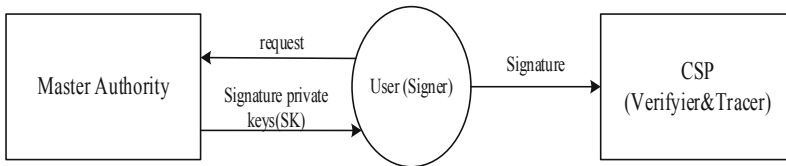


Fig. 1. U, CSP, MA relationship diagram

According to the content of Fig. 1, some problems are analyzed as follows: firstly, the existing access requests of users are classified, and the threshold access structure is a more efficient way, so this paper selects the threshold structure as the basis for data access classification [10]. Then, in cloud computing, users can protect the integrity of data in some ways [11], and a more important role is to authenticate users. The main starting point of this paper is how to make the cloud platform trace the user’s identity while verifying the user’s access request. This paper sets the symmetric traceability key TK to encrypt the user’s identity, and only after the cloud platform is verified successfully can it pass the calculation The TK is obtained by calculation, and then the user identity is obtained by decryption. One is to ensure the security of the whole scheme, and the other is to improve the computational efficiency [12]. Finally, if the user’s access request

is revoked or changed, it should be updated and classified in time [13]. In the specific operation of the scheme, it is necessary to select two multiplication groups $Q1$ and $Q2$ of prime p for MA, and set e as bilinear mapping, then the formula (1) can be obtained.

$$e = Q1 \times Q1 \rightarrow Q2 \tag{1}$$

In the multiplication group $Q1$, $g1$ and $g2$ are randomly generated, and the main key $x \in Z$, $H1, H2, H3: \{0, 1\} \rightarrow g2$ are selected as three Hash functions that can resist collision. Then for any attribute i , the random number $t_i \in Zp$ is selected, and the formula (2) can be obtained.

$$\begin{aligned} PK &= (g1, g2, H1, H2, H3, t_i)_{i \in A}, \\ MK &= x \end{aligned} \tag{2}$$

Since the threshold access structure is used for classification, the threshold access structure is defined as $T_{k,v}()$ and the relationship between this structure and attribute set ω is shown in formula (3).

$$T_{k,v}(\omega) = (v, k) = \begin{cases} 1, & |\omega \cap v| \geq k \\ 0, & \text{other} \end{cases} \tag{3}$$

In the formula (3), k is the threshold, ω is the attribute set required by the authentication request, and v is the attribute set of the access structure. The meaning of the above formula is to use (v, k) to represent the threshold policy access structure T . only when the attribute set of the user authentication request and the attribute set of the access structure T have the same attributes greater than k , then the attribute set ω satisfies the access structure T , and the access can be classified to the region, otherwise, the access can be classified not adopted [14]. In the attribute set v of access structure T , let the attribute set $\omega1$ be the same as the attribute set of access structure T and user signature, and let the attribute set $\omega2$ be different from the attribute set of access structure T and user signature. In other words, the intersection $\omega1$ of the signature attribute set and the attribute set of the access structure must be greater than the threshold k to pass the verification. Thus, the relationship among the attribute sets $\omega, \omega1$, and $\omega2$ can be obtained, as shown in formula (4).

$$\begin{aligned} \omega1 &= \omega \cap v = A \cap v \\ \omega2 &= v - \omega = v - A \\ \omega1 \cup \omega2 &= v \\ \omega1 \cap \omega2 &= \sigma \end{aligned} \tag{4}$$

When the cloud platform receives the verification from user U , the cloud platform needs to verify whether the request classification is correct, that is, judge whether the request s meets the access structure $T_{k,v}()$, and the judgment equation is shown in (5).

$$\frac{\prod_{i=1}^{|\omega|} e(g, s_i g_2^{q^{(i)} + t_i})^{\Delta_{i,\omega}(0)}}{e(g, s_2) e(H_2(m), s_1)} = Z \tag{5}$$

Judge whether it is true through formula 5. If it is true, it means that the intersection of attribute set ω and attribute set v of access structure T is greater than k , then accept m and request s , and the verification is passed. Otherwise, the next classification verification is refused. Lagrange interpolation theorem should be used in verification, as shown in formula (6).

$$\begin{aligned} q(x) &= \sum_{i=1}^{|\omega|} q(i) \Delta_{i,\omega}(x) \\ \Rightarrow q(0) &= \sum_{i=1}^{|\omega|} q(i) \Delta_{i,\omega}(x) = x \end{aligned} \quad (6)$$

Finally, the classification of data access requests is determined by the formula calculation results.

2.2 Division of Business Area Based on 5G Technology

After the power terminal data access classification is completed, the terminal data area is divided based on 5G technology, so that the power terminal data access classification corresponds to the corresponding slice area, so as to promote the data access speed [15]. The so-called 5G is the abbreviation of the fifth generation mobile communication technology, as a new generation of mobile communication technology after 4G system [16]. Increasing data rate, decreasing energy demand, increasing system capacity and expanding equipment connection scale are the performance goals of 5G [17].

5G has three characteristics

- (1) It is eMBB (enhanced mobile broadband), which provides ultra high speed broadband services;
- (2) Ultra high reliable ultra low delay communication (uRLLC), data communication low delay, real-time is very strong;
- (3) mMTC (massive machine communication) supports the connection of massive devices and provides the basic guarantee for the interconnection of everything.

In 5G technology, with the maturity of cloud computing and virtualization technology, network slicing mode becomes possible [18]. In 5G network environment, network slicing refers to dividing some network related resources. According to the actual needs, the network areas with different functions are set up. With 5G network segmentation technology as the core, a number of logical subnets with different characteristics are presented, and these logical subnets are isolated. Wireless network, transmission network and core network form the network slice combination. For the logical subnet formed by slicing, the slicing management system realizes the unified management. And according to the different characteristics of logical subnet, it meets the diversified needs [19]. For power terminal system, the biggest advantage of 5G network slicing technology is that it can freely choose slicing characteristics, set logical subnet to meet user access requirements, and realize data access control of power terminal through low delay, high throughput and high network efficiency. Reasonable data

access control is conducive to improve products and services, and improve user experience satisfaction. In addition, the impact of network slicing on the rest of the network does not need to be considered by operators, which saves operation time and reduces operation cost. Through the application of network slicing technology to bring better economic benefits [20]. The schematic diagram of network slice is shown in Fig. 2.

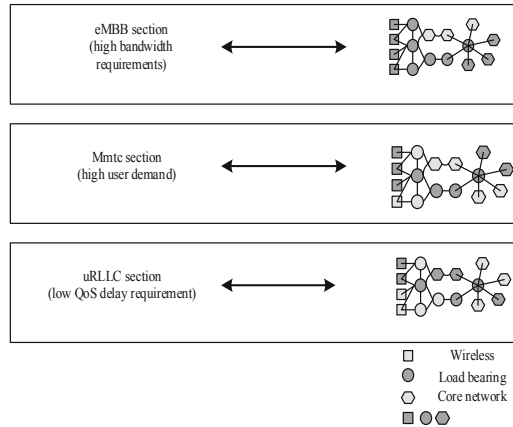


Fig. 2. Diagram of a network slice

Based on the characteristics of 5G such as high bandwidth, large connection and low latency, 5G application scenarios are mainly divided into application scenarios, application examples and network requirements, as shown in Table 2. According to Table 2, the first commercial scenario is mobile bandwidth, which is characterized by high speed. On this basis, services in the 4G era will be further improved.

Table 2. 5G application scene division

Application scenarios	Application cases	Network demand
Mobile broadband	4K/8K Ultra HD video, holography, AR/VR	High capacity, high storage
Massive internet of things	Mass sensors: related sensors such as power, agriculture, family, smart city, etc.	Large scale connection, mostly static
Mission critical internet of things	Unmanned driving, intelligent industry, smart grid	Low delay, high reliability

5G will bring great changes to the mobile terminal equipment access to the intranet of the enterprise. Through the previous dedicated physical network providing services for different vertical applications, it will be transformed into “network factory” [21–23].

The network slice can be customized by software to provide guaranteed service quality for different mobile terminal equipment and scenarios. It is based on the same set of physical infrastructure equipment (wireless network, bearer network and core network) Generate logical isolated, independent running network slices from different business requirements. 5G will create a new mobile Internet. Through 5G slicing technology, the access area of mobile terminal equipment is divided according to the diversified target. The main business characteristics of grid company include high real-time requirements, long data connection and high bandwidth. Therefore, the network of power grid needs to ensure absolute security, and mobile terminal equipment is connected to the internal network.

The realization of network slice is based on network virtualization, the essence of virtualization is mapping and the form is encapsulation. The problem of network slicing is to solve the mapping problem, which aims to allocate network resources. Data needs to be sealed to achieve the isolation between network slices, and the isolation mechanism will be the key to the implementation of network slicing. For the application of network slicing, whether it is a special line of enterprise, SLA with low delay service or independent control of vertical industry, it is essential that the network slicing be rigid or elastic isolated to a certain extent. Because 5G architecture is still developing, it brings new requirements and challenges to the isolation of network slice, especially in the case of end-to-end security, and the end-to-end 5G network Slicing Based on slicing isolation is the first step to realize user security. After studying the mechanism of network slice isolation, some isolation mechanisms and technologies are pointed out, and the latest trends and challenges of slice isolation are analyzed. Generally speaking, compared with the existing network isolation technology, 5G network needs to integrate and manage various isolation mechanisms on different levels of network, and provide end-to-end isolation that meets the requirements. These technologies may not be new, such as sandbox based isolation, virtual machine based isolation and VLAN. Generally speaking, there are several aspects of network slice isolation:

Traffic isolation: when multiple network slices share network resources, it is necessary to ensure that the data flow through one slice does not flow to other slices.

Bandwidth isolation: any given slice and data flow through a slice will be allocated a certain bandwidth resource, and other slice bandwidth resources should not be encroached on. CPU resources on the node are similar.

Processing isolation: when network resources are shared between network slices, the processing of packets on the slice shall be independent of other slices. If on the same physical server, packet processing for multiple slices must be run independently by virtualization, container environment separation.

Storage isolation: slice related data should be stored independently.

In order to provide guaranteed performance services for multi tenants on the general physical network, network slicing needs data/control/management/service plane isolation. From the effect of isolation, there are two layers of isolation: hard isolation and soft isolation.

Hard isolation is achieved by providing independent circuit switched connections, dedicated to a virtual network. Circuit switched connections can be provided by flex, dedicated wavelength or dedicated TDM slots.

Soft isolation is realized by using packet technology to multiplex traffic statistics from two or more virtual networks to common circuit switched connections. Nvo3, MPLS and deterministic networks are typical soft isolation technologies, but slices isolated by soft isolation technology may still compete for underlying resources in extreme cases.

Compared with the previous smart grid technology, it can provide more security and flexibility for the development of 5G wireless network. According to the research on network slicing, it is still at a higher level of architecture and requirements. The specific implementation of network slicing is mainly formulated by 3GPP. According to the definition of network slicing in 3GPP, network slicing is a logical network that provides specific network capabilities and network characteristics. Network slicing includes core network and access network slicing, covering slicing architecture, slicing selection, slicing roaming, etc. The research on network slicing in 3GPP is shown in Table 3.

Table 3. 3GPP research on network slice

Project	Function
SA1	The demand principle of network slicing is proposed
SA2	Research the architecture and scheme of network slicing
SA3	Study the security and isolation scheme of slice
SA5	This paper studies the arrangement management of network slice

In addition, based on the service gateway, combined with 5G slicing technology, 5G slicing isolation at the service level can be achieved. Different business scenarios use different slices. For example, powerful Internet of things devices use the characteristics of the massive Internet of things to divide slices and connect a large number of devices to the enterprise intranet. Each slice and network channel pass through the security access area. After passing the authentication, it can easily and freely access to the enterprise intranet. Effectively improve the power terminal data access speed.

2.3 Construction of Data Access Control Model for Power Terminal

Mobile terminals need to consider real-time and concurrency when accessing background data. In single thread data communication, there can only be one thread in a process, and the rest of the process must wait for the current thread to finish. As a result, it takes a long time for the system to complete a very small task, and this way is not strong enough to deal with emergencies. If a connection is different often, it will cause the whole program to crash. 5G slicing technology is used to make better use of system resources. In practical application, how to ensure that the user access requirements are correctly assigned to the sliced area has become a difficult problem. In order to realize

the information exchange between mobile terminal and server, a data access control model based on socket communication mechanism and Java multithreading method is designed and implemented, as shown in Fig. 3. The data access control model runs on the server, and a main thread control program responds to the request of the mobile terminal in real time. The application of socket communication mechanism is the basis of the normal operation of the model. Socket is a socket specification based on transport layer protocol. It defines three types of sockets: streaming socket, datagram socket and original socket. They support TCP/IP and UDP protocols respectively. Socket is independent of the application layer protocol and consists of two main components: socket server and socket client 3. When the client establishes a connection with the remote host application layer server, the client first establishes a connection with the proxy server, and the address and port of both application layer servers will be passed to the proxy server. In the socket protocol system, when the client wants to establish a connection with the application layer server, it first establishes a connection with the socket proxy server, and the relevant address and port of the application layer server will be passed to the socket proxy server in this process. After authentication and negotiation between the client and the socket server, the socket server will establish the corresponding TCP or UDP connection with the remote server according to the request of the socket 'client, so as to realize the corresponding application protocol.

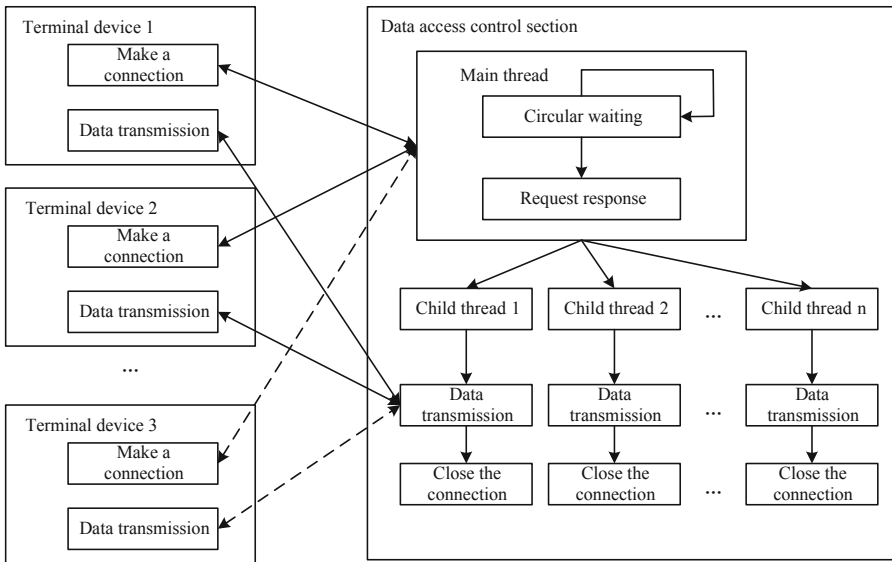


Fig. 3. Data access control model of power terminal

In the data access control model of power terminal, the server is always in the waiting state when no connection request comes, and is ready to provide services at any time. When a terminal sends a connection request to the server, the main process of the server immediately establishes a new server Socket connection, according to the type of request to find the corresponding 5G slice for sub area, at the same time, a sub thread in this

area to process the request of the mobile terminal, when the server starts the sub thread, it immediately returns to the listening state, waiting for the next connection request. After each sub thread starts, it completes the data transmission with the terminal device independently. The design of data access control model uses concurrent service mode to work, and each mobile terminal is processed by an independent thread. Because the main thread hardly communicates with the sub thread, the system overhead is small, and the resource utilization efficiency is high. Because different threads are associated with different objects and handle their own abnormal events, the software has strong robustness. What's more, each sub thread receives data synchronously, which ensures the real-time requirement of data transmission.

2.4 Implementation of Data Access Control

According to the classification of data access of power terminal, the access request is classified, and the corresponding access area is replaced according to the classification results. Finally, the access control model is used to realize the overall control of access. When the server application starts, the monitoring status is triggered. There are two options for initialization and destruction of the monitoring interface at the server. Through monitoring the servlet container, call the `startTpdaserver()` method to start a main thread, which will be in the listening state after the main thread is created. At the same time, it has its own stack, and can derive multiple sub threads according to the needs. However, after listening and receiving the request, the dynamic call creates the sub thread function, derives independent sub threads, and processes the requests with different port numbers. After the main thread is sent, the sub thread is not controlled and scheduled. The sub thread connects with the client and handles the exception. After the data access control model is started, the request from the terminal is received by listening to the specified local port. Every time a request is received, a thread is used by implementing the Java runnable interface. A `run()` method is defined in the runnable interface. When instantiating a thread object, an object implementing the runnable interface can be passed in as the parameter. The thread class will call the runnable object `run()` method then executes the contents in the `run()` method to start the new mobile terminal thread, and completes the request and response of the mobile terminal. After each sub thread is started, it can get the request content from the mobile terminal and submit it to the XML parsing class for processing. The XML document is parsed and encapsulated into Java object, passed to the background processing business logic and interacted with the database. After each sub thread is started, a deadlock detection thread is designed, which is a separate thread for handling deadlock.

3 Simulation Experiment

In order to verify that the terminal data access control method designed in this paper can effectively improve the user access speed in practical application, a simulation experiment was carried out. In order to ensure the scientificity of the experiment, the design method is taken as the experimental group, and two traditional terminal data access control methods, cloud based data resource context aware access control method

in reference [7] (traditional method 1) and edge computing based access control method in reference [8] (traditional method 2), are selected as the control group. Under the same experimental conditions, three methods are applied to access control, and the experimental data are analyzed to verify the application effect of this method. Before the start of the experiment, the running environment required for the simulation experiment is set. The development machine is Mac OS X 10.11.4. The computer parameters used are shown in Table 4 below.

Table 4. Computer parameters used

Serial number	Name	Parameter
1	Computer name	Mac mini
2	Operating system	Windows 10
3	Processor	2.80 GHz
4	Monitor	21 in.
5	Memory	8 GB
6	Hard disk	1867 MHO DDR3

Several computers with the same parameters as those in Table 4 are selected to implement three kinds of terminal data access control methods respectively. Taking threads as experimental conditions, this paper analyzes from the same thread and different threads to clarify the effect of power terminal data access control methods.

3.1 Data Access Response of Same Thread Power Terminal

For the computer that implements the data access control method of power terminal, 300 threads are opened to simulate the data access of power terminal. Each thread automatically performs 15 million addition calculations by computer. Repeat the simulation experiment for 7 times, and finally make statistics on the access response time. The results are shown in Fig. 4.

According to Fig. 4, it can be found that under the application conditions of two traditional power terminal data access control methods, the response time of access is between 2 s–2.5 s. After the application of the design method in this paper, the longest data access response time is only 1 s, and the response time of most experimental results is less than 1 s. Through the analysis of the data access response results of the same thread power terminal, the conclusion is that although the response time of the three methods is almost the same, the method in this paper has a small advantage.

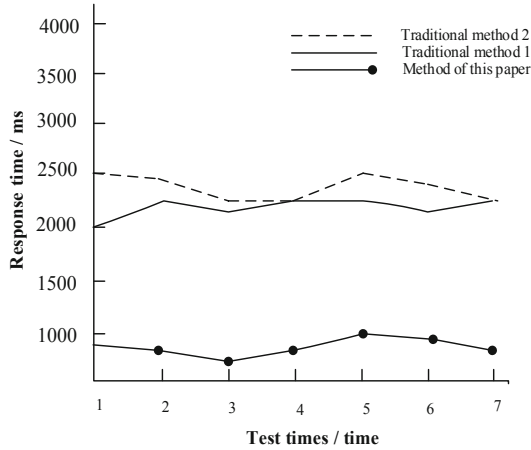


Fig. 4. Data access response of same thread power terminal

3.2 Data Access Response of Different Threaded Power Terminal

In order to show the effect of different power terminal data access control methods more clearly, 100, 200, 500, 1000, 2000, 5000 threads are opened respectively, each thread carries out 10 million times addition calculation, and finally, the average response time is counted. The statistical results are shown in Fig. 5.

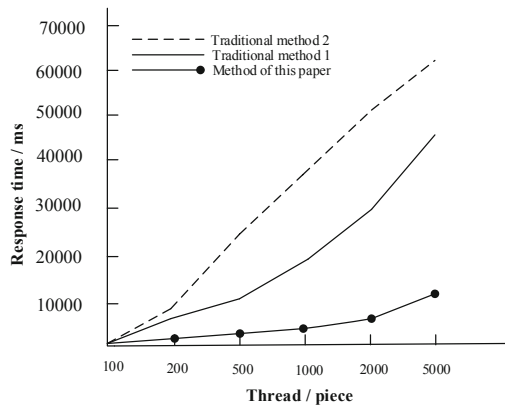


Fig. 5. Data access response of different threaded power terminal

Compared with the experimental results of the same thread, the data access response results of different threads shown in Fig. 5 show the effect of different data access control methods of different power terminals. The response time of the data in this paper increases with the increase of the number of threads, but the overall growth trend is relatively slow. When 2000 threads are opened at the same time, the response speed is about 3.12 s, which can meet the data access requirements of power terminals. The response time of the two

traditional methods increases with the increase of threads. When 2000 threads are opened simultaneously, the response time of the traditional method reaches 30.08 s and 51.35 s, which greatly affects the data access effect. In conclusion, the method designed in this paper has good effect on data access control of power terminal. It can better meet the needs of users.

4 Conclusion

In this paper, 5G technology is the core, and a data access control method of power terminal is designed. Through the application of 5G chip technology and the establishment of data access control model of power terminal, the data access control of power terminal is realized finally. The speed and efficiency of power mobile terminal equipment accessing the intranet of enterprises under 5G environment are improved, and the response time of data access is reduced. Although the data access control method designed in this paper improves the response speed of data access effectively in practical application, the research results are not perfect because of the insufficient research time and the limited of the environment. In the future, this will be the focus of in-depth research.

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