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Research Article

IPoE Enhanced Reliability Model Based on SDH Optical Transmission for Intelligent Power Dispatching

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Internet of Things (IoT) technology is one of the more advanced network communication technologies at present, and the IoT-based power dispatching system can improve the operation efficiency of power system. As the number of power users increases dramatically, higher requirements are put forward for the communication and management of IoT-based devices. The authentication method of traditional network structure can no longer adapt to the huge number of clients. For the problem of insufficient reliability of IPoE authentication method at the present stage, this paper proposes a model to enhance the reliability of IPoE authentication method. First, an intelligent scheduling optimization method based on SDH optical transmission technology is designed to complete the optimization of the scheduling network. The time delay of the communication network is reduced, and the reliability of the network is increased. Second, a data online collection module is established to complete the first optimization of the communication network. Finally, SDH optical transmission technology and design communication network terminal are integrated. The second optimization of the communication network is completed. After experimental testing, the proposed model can intelligently optimize the IoT-based power dispatching network. A standardized, manageable, and secure large-scale remote dispatching solution is realized.

1. Introduction

Power dispatching is an effective management method used to ensure the safe and stable operation of the power grid, reliable external power supply, and orderly production of various types of power [1–3]. As the most direct means of power dispatching command and ordering, dispatching telephones require high reliability. Not only under normal circumstances but also in severe weather conditions, and when power system accidents occur, it is also necessary to ensure that the telephone is unblocked. The dispatching trumpet is a dispatching telephone, an important deployment method. The functional framework of IoT-based power dispatch automation system is mainly divided into support platform, real-time monitoring and analysis application layer, dispatch planning application layer, and dispatch management application layer. The application of IOT-based power dispatching automation system is conducive to improving the accuracy and automation efficiency of power dispatching. At present, it is mainly used to extend the PCM to the direct adjustment factory station [4]. But the technology also faces some problems. PCM only carries dispatch calls and faces the problems of outdated equipment, lack of spare parts, and insufficient technical support from manufacturers, which affects the safe operation of the power grid to a certain extent. NGN technology such as softswitch is a new technology for dispatching calls [5, 6], which must be carried based on IP network. The current technical system of the power dispatching and switching network is mainly circuit switching. Although the switching technology has developed into IP switching technologies such as softswitch and IMS, due to the high reliability requirements of power dispatching telephones, the dispatching and switching network based on circuit switching will still be used in power dispatching and switching networks. The industry has played a major role for a long time. The natural dependence of softswitch technology on IP bearer network has led to the unavoidable hidden danger of network security since its inception. The power integrated data network does not cover power plants and remote power stations, and the network security of the data network to carry dispatching telephones needs to be tested, and the use of IP transmission dedicated line to carry a large number of MSTP ports, and it is difficult for MSTP equipment among different manufacturers to communicate with each other [7]. This places higher requirements on IP bearer networks. The traditional PPPoE (Point-to-Point Protocol over Ethernet) access control method can no longer meet the needs of full-service operations. The introduction of the IPoE (IP over Ethernet) [8–10] access control method can make up for the shortcomings of the PPPoE method and has a good development prospect. However, there are still some problems in the reliability of IPoE [11], such as the response to some abnormal situations. This paper analyzes and discusses the reliability of the IPoE system in the network routing equipment, proposes corresponding solutions for the problems raised, and verifies the feasibility of the solution. The emergence of communication networks satisfies people's receiving and viewing of information such as images, audio, and video, but network delay has become a difficult problem in current communication. SDH optical transmission technology is the abbreviation of Synchronous Digital Hierarchy, which has the ability to reconnect, cross, and transmit lines. It is a relatively reliable and advanced communication technology and has been widely used by people. Today's communication network gaps are large, the real-time performance of the network is poor, and the stability is also a difficult problem to solve. Therefore, applying SDH optical transmission technology to communication networks [12–15] is an optimization method for today's communication networks..

In response to the above problems, we propose corresponding solutions. (1) This article uses IPoE authentication method based on SDH technology. Compared with the PPPoE authentication method, the complicated PPP session establishment process is removed. The authentication process uses Sec-Initiator to initiate authentication, so that DHCP Request packets and IP packets can create a new session when the original session is deleted, and when the session is not deleted, the normal IPoE process can solve the problem that the user cannot go online problem. (2) Based on the communication network optimized by SDH optical transmission technology, establish a data online collection module, and collect the communication data online through the network to improve the collection efficiency. (3) Integrate SDH optical transmission technology to design a communication network terminal. This terminal needs to achieve fast download speed, few network delay times, or low delay speed.

2. Related Work

2.1. IPoE Authentication Technology. IPoE is the abbreviation of IP over Ethernet. IPoE refers specifically to the technology of transmitting IP packets on the E1 link. Currently, there are two mainstream methods: dedicated chip implementation and logic FPGA chip implementation. Dedicated chips are generally used in pairs at both ends of the E1 link and use proprietary protocols to encapsulate IP packets. In this way, the product port specifications and function indexes are greatly constrained, and the cost is high, so it is not an optimal solution. The logic FPGA chip is used to implement, and the dedicated protocol is also used. On the one hand, the transmission security is guaranteed. At the same time, the subsequent protocol adjustment is relatively flexible, which can realize the expansion of the business in the future. This method can also achieve a better balance between deployment capacity and port cost and is more suitable for practical scale applications. The encapsulation definition of IPoE is given in TR101 (DSL access standard based on Ethernet), and the user interface encapsulation can be called IPoE. It omits the encapsulation of PPP in PPPoE. IPoE technology is an access authentication method introduced by the DSL Forum WT-146. It is based on the conversion of the DHCP protocol into a RADIUS authentication message to realize the user access authentication method and control. In order to obtain information such as the user's MAC address and access device port, the DHCP Option82 option is inserted into the access device, replacing the PPPoE dial-up software embedded in the user terminal, and the mechanism for obtaining the required access information is moved to the network device so that the user terminal continues to maintain its original versatility and flexibility. Therefore, compared with PPPoE, IPoE has obvious advantages in carrying services such as video and long-term online services, which provides necessary guarantees for the evolution of IP networks to multiservice bearing.

Compared with the PPPoE authentication mode, the IPoE authentication mode removes the complicated PPP session establishment process, and the rest is basically the same as the existing PPPoE authentication process, as shown in Figure 1.

First, the user's service terminal sends a DHCP Discover message carrying the corresponding Option 60 information; the message is relayed to the BRAS through the Layer 2 access device, and the Layer 2 access device can insert Option 82 into the DHCP Discover as required to provide the user line information. The BRAS receives the DHCP Discover message and extracts the relevant information and caches it. Use the RADIUS protocol to initiate authentication to the Radius Server to obtain the user's business control and QoS policy. After the authentication process is completed, the BRAS forwards the cached DHCP Discover message to the DHCP Server. After that, the DHCP server interacts with the user terminal to complete the dynamic IP address allocation process, the user terminal obtains an IP address, and the BRAS binds the user's service control and QoS policy to the IP address. When the user can start to surf the Internet, the BRAS detects that the user traffic sends a charging request to the RadiusServer. After the user goes offline, the Host sends a DHCP release message. After the BRAS receives it, it sends a stop accounting request to the Radius Server and forwards the DHCP release message to the DHCP Server.

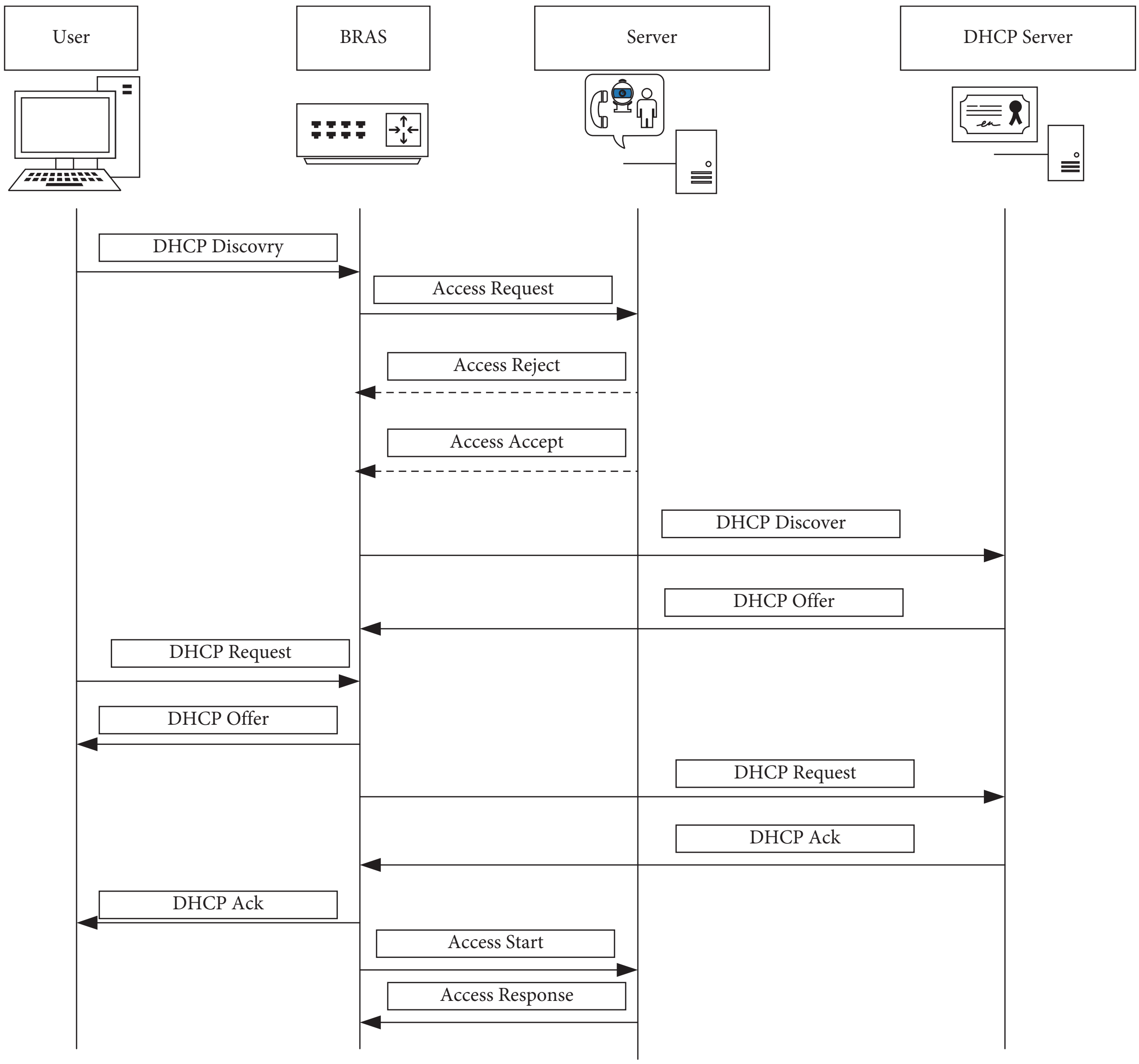

Figure 1: IPoE certification process.

In this process, the corresponding security detection and protection basically meet the needs of refined operations. However, IPoE is still insufficient in reliability, and there will be client exceptions, IPoE service exceptions, and so on. There is still a need to strengthen the handling of exceptions on the client and server sides.

2.2. Optical Transmission Technology Based on SDH in Power Grid Dispatching. SDH optical transmission technology is the abbreviation of Synchronous Digital Hierarchy. It has the ability to reconnect, cross, and transmit lines. It is a relatively reliable and advanced communication technology [16, 17]. SDH technology has many advantages: (1) unified bit rate and unified interface standard; (2) using byte multiplexing technology, the upstream and downstream signals in the network become very simple; (3) SDH equipment can accept various new; (4) rich overhead ratios are arranged in the SDH frame structure, which greatly strengthens the operation, maintenance, and management functions of the network and facilitates centralized management. Figure 2 shows how SDH works.

SDH protection methods are divided into two categories: channel protection and multiplex section protection. In channel protection, service information is protected on a per-channel basis. In normal times, service signals are also transmitted in the protection section, that is, dual transmission and selective reception. In industrial production applications, the common channel protection mechanisms mainly include two-fiber single-phase channel protection and two-fiber bi-directional channel protection. In another method, the inverted ring is based on the signal quality of the multiplex section between nodes. When a fault occurs in the protection ring, the service information of the multiplex section between the entire nodes is turned to the protection ring. Doing so saves the bandwidth occupied by the service transmission.

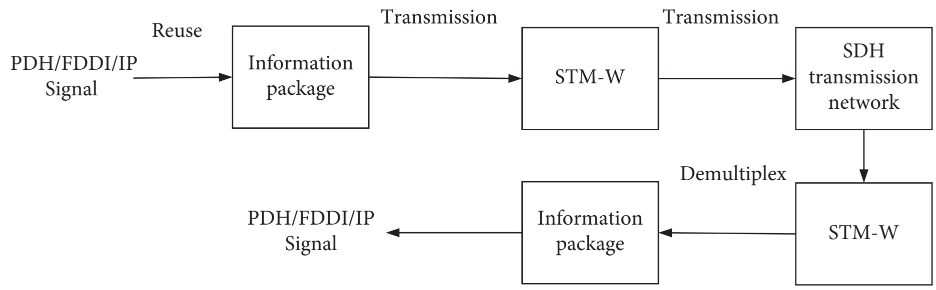

FIGURE 2: Schematic diagram of how the SDH system works.

3. Method of This Article

This chapter mainly introduces the IPoE enhancement method proposed in this paper and the grid trumpet scheduling method based on SDH technology.

3.1. IPoE Authentication Method Applied in Power Grid Dispatching. In the daily dispatching process of the power grid, there is a problem that the client cannot go online due to the abnormality of the client. Mainly because the server deletes the session, the message sent by the client cannot create a new session. For the two cases of abnormal client, there will be two kinds of packets, namely DHCP Request packet and IP packet. It is only necessary to allow these two packets to create a new session when the original session is deleted and to follow the normal IPoE process when the session is not deleted to solve the problem that users cannot go online. The DHCP Request message and IP message that create the Session at this time are collectively referred to as Sec-Initiator.

3.1.1. DHCP Request Trigger. There are two ways to trigger the creation of a Session by a DHCP Request message. First, you can use the Mac address as a keyword to search for a list of existing sessions and create a new session if not found. However, when the number of user sessions is large, it will take a certain amount of time to search once. Second, by summarizing the scenarios in which Request packets are generated, it can be found that there are three situations in which DHCP Request packets are generated: (1) Request packets in the normal process; (2) Request packets in the renewal process; (3) Sec-Initiator in the Request message. For the first and second cases, the Session is generated by the Discover message, and the Request here does not need to generate the Session again. When the first situation occurs, the user has not applied for a legal IP and has not specified the applied IP; that is, the Request IP field and SrcIP in the DHCP Request message are both 0.0.0.0. The second case is when the contract is renewed, the user already has a legal IP; that is, the SrcIP field is not 0.0.0.0. When the Request message in the third case is generated, because the user knows that he is disconnected, he is still in the state of no IP, but if he wants to continue to use the IP used before, he must fill in the disconnection in the Request IP field. The IP is used before the line, and the SrcIP field is still 0.0.0.0. After analysis, it can be seen that whether a new session needs to be created can be determined through the comprehensive judgment of the Request IP field and the SrcIP field in the DHCP Request message, thus saving the trouble of finding the entire Session list. The process is shown in Figure 3.

3.1.2. IP Triggering Method. Consistent with the idea of creating a Session with a Request message, if you directly use IP as a keyword to find a Session, the efficiency will be low. According to the analysis, in the normal IPoE process, in addition to the user's voluntary offline, the DHCP lease expires, and AAA forces the user to log off, which will delete the session. The text cannot pass normally. You can make a cached record every time you delete a session, and only record basic information such as IP and Mac for the session with IP, and then delete it completely after a period of time. In this way, when searching by IP, only the IP on the cache needs to be searched, and the efficiency can be greatly improved. Obviously, the abnormal disconnection of the user does not follow the normal offline process, so it is only necessary to delete the lease expiration and AAA forcibly offline and record the cached session of the IP. When the IP packet received by IPoE is found in the cache deletion record, a new session will be created with IP as the keyword and then entered the process of authentication to the AAA Server, but the application for IP is less than that triggered by the DHCP packet. The process is shown in Figure 4.

3.2. IPoE Authentication Method Reliability Scheme Design. According to the design of the above-mentioned enhanced reliability scheme, some adjustments need to be made to the original IPoE system. First, in the process of message processing, add the processing of messages in the Sec-Initiator phase according to the above scheme. When processing the IP in the Sec-Initiator phase, the cache list of the deleted session needs to be used. This list needs to be generated when the original IPoE system deletes the session, and the steps of adding and deleting the cache list are added to the process of deleting the session except the user's active application to go offline.

Second, it is necessary to store the original Session structure into two parts: user-mode Session and kernel-mode Session. The main storage contents of Session include SessionKey, AuthInfo, State, ProfileId, and OptionInfo. SessionKey, as the name suggests, is a key feature that can uniquely identify a Session information, which can be

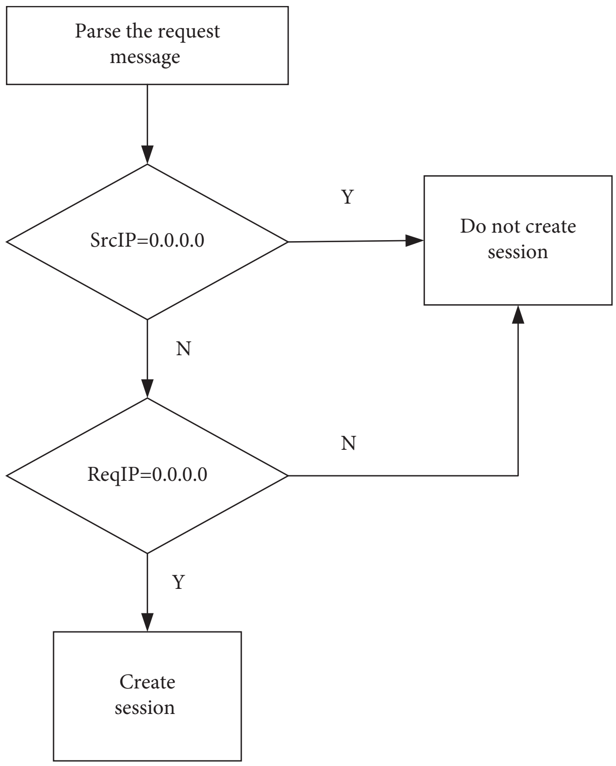

Figure 3: The Request message triggers the creation process.

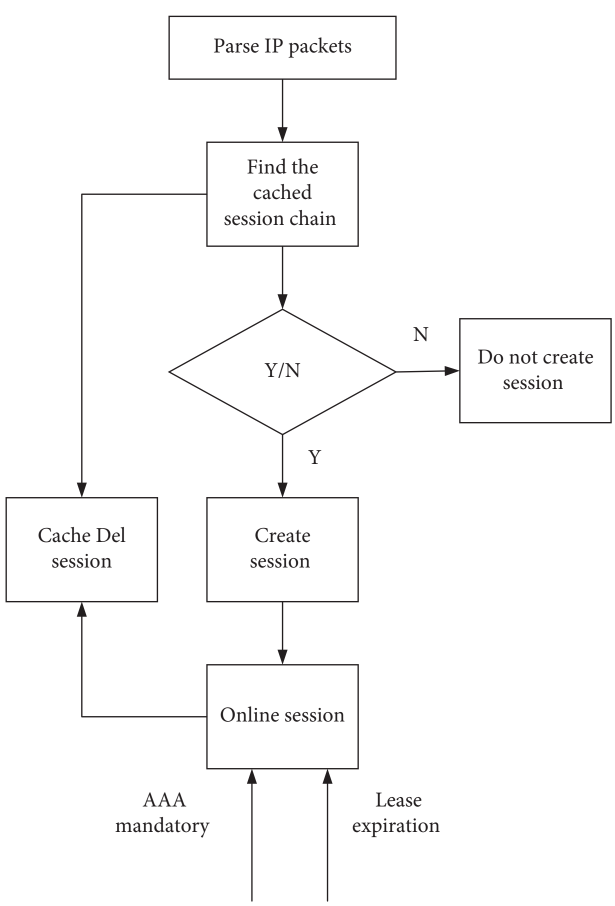

Figure 4: IP packet creation flowchart.

composed of one or several features. In the IPoE system, the SessionKey undoubtedly needs to be stored in both the kernel and user mode. It is defined as EDHCP_SESSION_KEY_S, including interface index, client IP, client Mac, and client VlanID. AuthInfo is the username and password that records the user's authentication to AAA. State identifies the authentication state a user is currently in. ProfileId records the user policy ID issued by the session after successful authentication. OptionInfo records Option82 or Option60 information in DHCP packets.

3.3. Power Grid Dispatching Network Terminal Based on SDH Optical Transmission Technology. The function of establishing an information online collection module is to improve the communication speed of the communication network. Therefore, it is necessary to break through the traditional way of collecting information, not limited to independent collection and solidified collection, and combine the advantages of both. To establish a parallel or series collection line, keep the collected information in a state of mutual connection, and ensure that the communication network avoids lines that may cause network congestion in the process of collecting information, and the network flow control function can be realized from the entire communication network. The online acquisition module also needs to have the ability to optimize the communication efficiency. When receiving information, according to the collected information, it will mark out the communication congestion section, avoid or transfer the communication section, and connect to the other side of the communication at the fastest speed. The establishment of the information online collection module is to combine the communication services of the communication network to divide different network traffic. The network layer module, the middle layer module, and the sink layer module are connected to the 30 kV network layer receiver under different operating traffic, and it is connected with the 100 kV middle-layer receiver through the F interface, and the middle-layer receiver is merged into the 220 kV sink-layer receiver through the G interface. According to different communication forms, different collection flows are designed. Increase the flow voltage, and reduce the network delay.

Based on the information acquisition module established above, it can be analyzed that the current communication network terminal functions are relatively simple, and the SDH optical transmission technology stands out in the transmission technology due to its unique advantages of reconnecting lines. Therefore, when optimizing the communication network, it is necessary to integrate SDH optical transmission technology. Transmission technology, a new type of power grid dispatching communication network terminal, is designed.

First, using SDH optical transmission technology, the communication network terminal is designed to add the function of a small processor in addition to the functions of making calls, watching videos, and downloading audio, which can communicate without interrupting the purchase of goods. SDH optical transmission technology can break through the influence of the CPU, and the phenomenon of communication interruption due to network delay or network instability will no longer occur. Second, it is necessary to have the function of distinguishing information and multimedia processing, and application software is connected through the network to make the communication network more diversified, and the network speed and communication environment are improved for different communication conditions. With the popularization of intelligence, communication network terminals need to be further optimized. On the basis of independent operation, the communication platform should be improved to make the communication process private. Finally, based on SDH optical transmission technology, by changing the network line, the communication network terminal can be effectively connected with external equipment, realizing the exchange of component functions, improving the singleness of the previous communication network terminal, and developing in a more intelligent direction.

In the optimization design of network core performance, the optimization of destructive resistance and delay is very important. In terms of optimizing the core performance of the communication network, the communication delay is one of the key factors for the poor core performance of the communication network. Considering the requirements of network invulnerability and delay, the communication network speed should be balanced as much as possible. If there are too many communication devices between points, the communication speed will be relatively reduced. Especially when the information passes through a relatively congested network path, the communication time increases, and the communication quality deteriorates. The delay in the communication network is eliminated, which not only improves the delay performance of the communication network but also the core performance of the communication network. In order to ensure the optimization of the core performance, it is necessary to control the communication network resources, and at the same time, the sender and the receiver at both ends of the communication need to cooperate with each other to predict the hidden dangers of the communication network path and ensure the smooth application of the core performance.

4. Simulation Results and Analysis

4.1. IPoE Enhanced Method Reliability Verification. In order to verify the validity of the two reliability schemes, the Sec-Initiator packet triggers the user to go online, and the session recovery when the IPoE service is abnormal, the verification is carried out in the networking model. The networking model is shown in Figure 5.

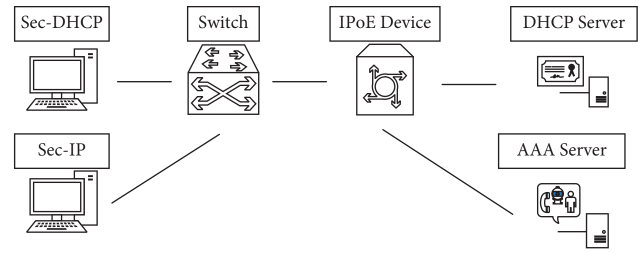

Figure 5: Schematic diagram of the networking model for verifying the IPoE enhanced reliability solution.

4.1.1. Functional Test. First, verify the DHCP Request message. Through Sec-DHCP, enter 10 Request IP fields to carry valid IP and the SrcIP field is 0.0.0.0 DHCP Request message. Check the Session information of the IPoE Device, you can see that these 10 packets are all online, and the IP address is the IP address carried in the Request IP. Then, enter 10 RequestIP and SrcIP fields through Sec-DHCP, both of which are 0.0.0.0, and the RequestIP field is 0.0.0.0. The SrcIP field is a DHCPRequest message with a valid IP. Checking the IPoE Device does not generate relevant Session information. Then, verify the IP packets. Enter 10 valid IP packets through Sec-IP, check the session information of the IPoE Device, and show that 10 sessions are generated, and all are online. Finally, verify the session recovery scheme during IPoE soft restart. In order to verify the recovery of the session after the IPoE soft restart, it is necessary to input 10 packets through Sec-DHCP first, and check that the packets are all online at the IPoE Device. Then, kill the IPoE process on the IPoE Device, and check that the Session information does not exist. Restart the IPoE process, and check the session information after 30 seconds. All 10 sessions have been restored and are online.

4.1.2. Stress Test. In order to verify the reliability of the scheme, a stress test was carried out on the above scheme. Through the tester, the IPoE Device has been injected with the full specification of 32 k traffic for a long time. The result shows that only a few sessions fail to go online, and the rest of the sessions can go online normally, and the online rate can reach 98.6%. The reason why a few sessions fail to go online may be due to router packet loss and other reasons.

4.1.3. Performance Test. In addition to functional test and stress test, the performance of the IPoE system in this solution was also tested. The results show that on the IPoE Device, there can be an average of 450 sessions going online per second, which is acceptable.

Through the verification of the above two reliability schemes, it is confirmed that the scheme in this paper is feasible, and it can be seen from the verification that the effect of this scheme is relatively ideal, which can effectively enhance the reliability of the IPoE system.

4.2. Power Grid Scheduling Simulation Based on SDH Optical Transmission Technology. Establish a communication network model based on SDH optical transmission technology, connect 3 devices on the network cable, fold the network cable into 3 segments, and design the traffic of 5 Mb/s and 15 Mb/s for the network cable through OPEN software. The same design of the network is made, and simulation experiments are carried out to verify whether the optimization method designed in this paper is feasible.

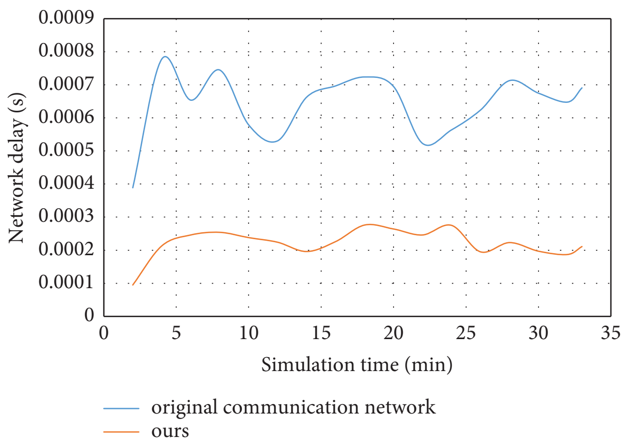

Figure 6: Simulation effect of grid dispatching network delay based on SDH technology.

After the simulation experiment, the simulation results obtained are shown in Figure 6. The simulation results are the network delay comparison diagram, the abscissa is the simulation time, and the ordinate is the network delay at different simulation times. It can be seen from Figure 6 that the original communication network is within half an hour, the network delay at different simulation times is more than 0.00040 s, and the fluctuation range is relatively large, which is basically maintained at about 0.0070 s. The communication network designed in this paper is under the same conditions. The delay is about 0.0020 s, and the fluctuation range is small. In the scenario of power grid dispatch simulation, the overall delay of the method in this paper is low, and the fluctuation is small. Therefore, the communication network designed in this paper is more real time.

To sum up the simulation results, the model proposed in this paper achieves smaller network delay, smaller network fluctuation, and more real-time performance in power grid dispatching.

5. Conclusion

Internet of Things (IoT) technology is a professional network technology with strong advancement at this stage, and its joint application with power system can improve the operation efficiency of power network and provide better guarantee for operation quality. In this paper, an enhanced model of IPoE authentication method based on SDH optical transmission technology is proposed for the application of IoT in power network. First of all, based on the authentication method for the IPoE system, improve the reliability of the network. On this basis, the SDH data acquisition module is designed to optimize the network. Finally, the SDH technology is integrated to complete the optimization of the system to achieve the purpose of reducing delay. In this paper, a simulation experiment is carried out on the above method. Experiments show that the model proposed in this paper can effectively solve the above problems and enhance the reliability and low delay of the power dispatching network. It can intelligently optimize the energy consumption of the power industry and achieve standardized, manageable, and secure scale remote dispatch. The model proposed in this paper is currently used in the power grid dispatching scheme, and the method of this model is similar to the dispatching system in the railway network. In the future, based on this model, further research can be carried out in the railway scheduling problem, so that the model has a wider range of applications.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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