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COMPUTER HARDWARE AND NETWORK DATA TRANSMISSION BASED ON INTERNET OF THINGS COMMUNICATION TECHNOLOGY

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Abstract. In order to meet the requirements of computer hardware and network data transmission security, a research based on Internet of Things communication technology is proposed. The main content of this research is the research based on the communication technology of the Internet of Things, through the description of the communication protocol of the Internet of Things, the system hardware design and implementation methods are used, and finally the research method based on the communication technology of the Internet of Things is constructed through experiments and analysis. The core technologies of 5G connectivity are being used to construct the IOT. As a result, the IOT might gain momentum. The experimental findings demonstrate that the delays are all within 200 Ms. When the message size is short (within 1KB), the transmission of diverse hardware is average, and the transmission quality standards of QoS1 are fulfilled. The transmission quality standards of QoS1 can match the communication reliability and security needs of the Internet of Things. This article evaluates the performance of data transfers with lengths of 20 byte, 30 byte, 50 byte, and 70 byte, respectively. This paper evaluates the efficiency of Wi-Fi access configuration by sending data packets of varying sizes i.e., 10 bytes, 30 bytes, 50 bytes, and 70 bytes over a distribution network. The results show that, on average, the network takes 0.6692s, 1.3546s, 2.8600s, and 4.7319s to deliver each packet, with success rates of 100% in each case. The system's increased network distribution efficiency is observed from the experimentation. The research based on the Internet of Things communication technology can meet the needs of computer hardware and network data transmission security.

Key words: Internet of things; Communication technology; Computer hardware; Network data transmission.

1. Introduction.

With the continuous advancement of science and technology, it has greatly promoted the emergence and development of the Internet. The role of computer hardware and network data transmission is becoming more and more important. Increasing the use of computer equipment and communication technology on the Internet can improve the remote operation level of telecommunication network technology, fully evaluate the use of computer equipment and communication technology, and meet the requirements of reducing costs, meet the needs of self-improvement, the efficiency of data transmission and the level of network transmission are steadily improved, and the effective use and reconfiguration of network resources are realized [1].

The application of computer hardware in current applications is mainly reflected in the application of basic computer equipment such as cameras, RFID scanners, etc., which is done in basic hardware applications [2]. Computer terminal detectors help complete the collection and transmission of basic data. Through its application, all things can be effectively connected to the Internet, the sensor is mainly composed of power management module, sensor module and LED display. In addition, access control sensors also account for a large proportion of applications. Gateway sensors act as routers to transmit signals from network endpoints. The gateway is arguably the sensor that acts as a bridge, ensuring that the communication network can be effectively connected and ultimately feel in control.

With the continuous deepening of the application of network technology, in order to effectively improve the quality of computer network services, people's requirements for network service quality are getting higher and higher [3]. Achieve service quality improvement and standardized improvement processing, it is necessary to continuously improve various implementation conditions and implementation time, effectively improve the quality of network services. If the network is not secure, it will seriously affect the operation of the entire network, and the security of network services is an important prerequisite for network operation. In order to prevent the outside world from causing serious interference to the operation of the entire network, it is necessary to ensure the reliability of the server. For example, the servers of some enterprises are located abroad, whether

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people's private data has been protected, their security must be studied. If an operation failure occurs during the operation, the user can take timely measures to protect the information, and the monitoring system can obtain the information in time and return it to the user in real time, reducing the degree of loss. One of the IOT's initial technologies is communication technology. Dissimilar categories of communication systems can be used to connect the IOT, and the most recent advancement in 5G communication has distinct compensations.

1.1. Problem Statement. The use of Internet of Things (IoT) communication technology in computer hardware and network data transmission has introduced several research problems. One of the major issues is the reliability of network transmission in complex IoT systems. The large volume of data generated by IoT devices can cause network congestion and latency, leading to transmission errors and delays. Additionally, the use of different communication protocols and standards in IoT devices can create interoperability issues and hinder data transmission. Another problem is the security of data transmission in IoT systems. Due to the large number of connected devices and the lack of standard security protocols, IoT systems are vulnerable to cyber attacks and data breaches. Insufficient data protection, insecure communications, and data storage are some of the significant challenges for IoT privacy and security. To address these research problems, several approaches have been proposed. One approach is to use edge computing to reduce network congestion and latency by processing data closer to the source. Another approach is to develop standard security protocols and frameworks for IoT devices to ensure data confidentiality and integrity. The use of IoT communication technology in computer hardware and network data transmission has introduced several research problems related to network reliability and security. Addressing these problems requires the development of new approaches and standard protocols to ensure the secure and efficient transmission of data in IoT systems.

1.2. Motivation and Contribution. For the Internet of Things to be used on a broad scale, more study has to be done to understand its architecture, communication mechanisms, and networking methods, as well as the information interaction of the complex interactions between devices [4]. When it comes to the Internet of Things (IoT), existing communication architectures typically rely on the cloud platform, which serves as middleware and connects IoT devices together. While this solution promotes the diversity of heterogeneous devices from application developers or device manufacturers, it also increases the platform's complexity [5, 6]. In the 5G era, the national growth strategy clearly guides the development of IOT technology and applications. IoT technology should be aggressively promoted throughout a wide range of businesses, development fields, and application domains. Our goal is to increase communication, traffic, and resource pooling. We also encourage new approaches, new ideas, and new ways of integrating data. As 5G wireless networks become more widely available, the Internet of Things will evolve. As a result, we take a look at the scientific strategies that have been implemented to modernize and improve age-old industries. Meanwhile, IoT applications can boost the marketability of useful data and services.

1.3. Organization of the article. The remaining article is structures as: Literature survey of this article is presented in section 2 of the article followed by Research on Internet of Things Communication Technology briefed in section 3. Section 4 presents the analysis of results and the final conclusion is detailed in section 5.

2. Literature Review. In the current social development, the rapid development and progress of the level of science and technology, people are more and more inseparable from the use of computers in their daily lives, because computers can be used for communication to process some necessary information, moreover, daily communication can be carried out through the computer, which makes the weight of computer communication improved to a certain extent [7]. At present, precisely because of the development and progress of the communication industry, in terms of network, the situation of network saturation has gradually appeared, therefore, more and more advanced communication technology is needed to solve the current pressure of network communication, so that all walks of life can achieve smooth communication and interaction with the help of communication technology, in addition, communication interference in the service can be avoided, and the pressure on the computer in terms of communication can also be correspondingly weakened and controlled. In addition, the technology can also enable the computer to establish a more complete platform for network monitoring to realize real-time monitoring of the background work process. Under the influence of the continuous development of science and technology, the use of communication technology on the Internet is limited and the network is relatively wide. Internet communication and communication technologies can be established.

The Internet of Things is the age of applications. Today, there is a lot of attention on the Internet, and most executives use the opportunity to actively explore and discuss the Internet. The interconnection of communication technologies and mobile payments has contributed to the development of various communication industries. In short, the potential for identifying and using communication networks is relatively large, and thus can be actively promoted on the Internet [8]. With the widespread use of artificial intelligence technology, modern information technology, with the advancement of technology, the Internet of Things has been gradually introduced, so that the actual operation of the objects used in the Internet of Things can be remotely controlled through communication and information technology, use remote rice cookers and hot water at home with the help of communication technology. When you're at work, use the app on your phone to control your home remotely. When you get home from get off work, the hot water will boil in the water heater, which not only saves time, but also improves people's living standards. In view of the above problems, in order to meet the needs of computer hardware and network data transmission security, the author proposes a research based on Internet of Things communication technology [9]. The realization of the Internet of Things technology takes the Internet as the carrier, and realizes the mutual transmission of data and information through the Internet, which is no longer limited to the limited physical space, in fact, the nature of the information transmitted is mainly virtual information and analog signals, however, IoT technology can use signal transmission to control real things, build local area networks, and connect various types of computer communication networks, ensure that data transmission and signal transmission are faster and faster, expand the controllable range of IoT technology, give full play to the advantages of computer communication networks, and create a remote management and control network that integrates informatization and intelligence.

As the Internet of Things scope and number of device accesses grow, so does the volume of data processing, which raises the threshold for system dependability, stability, and concurrent data processing [10]. It is imperative that research be conducted on the Internet of Things's design, communication, and networking techniques, as well as the information interaction of the complex relationships between devices [11], if it is to be widely adopted. Existing IoT communication architectures are typically based on cloud platforms, which act as middleware and connect IoT devices. This solution encourages application developers and device manufacturers to create heterogeneous devices due to the complexity of the platform, but a standard protocol is required for the communication of these devices. The MQTT protocol is the most prevalent among the numerous IoT communication protocols [12]. The MQTT protocol's topic subscription / message delivery method allows the monitoring centre and smart gateway to remotely manage and control papermaking equipment located in several locations through a cloud-based MQTT server. A huge amount of historical data saved on a cloud server may be mined and processed using data mining and information technology to aid in the making of scientific judgments, the improvement of production efficiency, and the reduction of expenses. The system's reliability and stability were shown by high-frequency vibrator testing [13]. Based on the MQTT protocol and the theoretical basis of Wi-Fi technology, this article provides a strategy for optimizing Wi-Fi distribution networks, a mechanism for communicating between terminals, and a platform for testing the system. As the results of the experiments show, the MQTT-based communication method for IoT terminal equipment suggested in this work can reliably and flexibly execute the equipment's communication function and fulfill the communication needs of the IoT system.

3. Research Methods.

3.1. Research on Internet of Things Communication Technology.

3.1.1. The main architecture of the Internet of Things. The realization of the function of the Internet of Things needs to rely on a perfect logical structure, which generally includes an information perception and control module, an information transmission module and an information application module [14].

Information application module. This module, also known as the IoT application layer, covers a variety of application software, because the Internet of Things system has huge data resources, combined with big data technology, cloud computer technology, etc., it can control and manage actual objects on the network platform.

Information transfer module. This module is also known as the transport layer. At this stage, the network forms used for Internet of Things information transmission include mobile communication networks, local area networks, and the Internet, data transmission between different networks relies on communication technology, connect different types of information management and sensing nodes, build an IoT information transmission and resource management and control platform, inorderto ensure the stability and security of the information transmission of each module [15].

Information perception and control module. This module, also known as the perception layer, is composed of different types of controllers and sensors, its main function is to perceive the target object information within the scope of the Internet of Things, at the same time, the acquired data information is converted into a common communication format, and then data transmission is completed based on wired or wireless networks [16].

The perception layer is one of the important components to ensure the normal operation of the IoT system, its function is to perceive and collect data information in the area, and use the IoT control box to complete the data information transmission between different gateways, establish a stable connection relationship with multiple local area networks, exchange information with each sensor, execute professional program algorithms in the system to analyze data information, and complete the processing of related data. The data information acquired by the perception layer is the basis for the operation of the computer network, and many tasks need to be based on this, because the acquired data information has good accuracy and comprehensiveness, and the network control box completes data transmission, protocols and groups. network transformation, etc., further expand the information surface that the computer network can cover [17]. The system can select corresponding analysis methods according to different data types, which makes data processing work smoother and more efficient, and effectively improves the processing speed of system data information, in the actual use of the Internet of Things, a reasonable method is adopted to allocate limited Internet resources, relying on the current communication network, with the continuous improvement and development of the Internet of Things technology, more and more functions and scope of application can be realized, especially in the field of logistics, the IoT perception layer can identify huge logistics data information, and it is transmitted to the computer communication network system, which can complete the processing of huge data information in a relatively short period of time, effectively improve the work efficiency in the field of logistics, and promote the further development of the logistics industry.

The Internet of Things transport layer relies on the existing communication network to strengthen the connection with the information perception network, communication network and broadband through computer communication methods in the form of optical fiber width and wireless network. With the continuous improvement of the level of modern science and technology, the Internet of Things technology has also achieved greater breakthroughs. On the one hand, it promotes the further improvement of existing related technologies, on the other hand, some communication nodes with strong independence and extensibility have also been produced, and these new communication nodes are fundamentally different from general computer network communication nodes, which brings huge challenges to the operation of computer network communication systems [18]. In addition, the computer communication network mainly uses the Internet of Things to realize the management and control of each node, which can significantly improve the speed of the Internet of Things. At present, during the joint operation of multiple computer networks, there will be problems of mutual influence. In order to speed up data processing, it is necessary to create a sound operation platform and fully understand the needs of different industries, actively carry out the development of computer communication network monitoring functions, build a reasonable industrial development system, set up cloud integration connection ports, and complete the disclosure and sharing of information in various fields on the operating platform, create a complete Internet application platform based on cloud computing technology, and further strengthen the operation effect of computer communication network.

3.1.2. IoT Communication Protocol. The MQTT protocol is one of the earlier communication protocols of the Internet of Things, it is a lightweight transmission protocol based on a subscription and publishing mechanism to solve the communication between devices in poor network conditions [19]. Under a topic that publishes a message to the server through an MQTT client, any MQTT client that subscribes to the topic can receive the message, and the client can receive messages under multiple topics by subscribing to multiple topics. MQTT is a TCP-based communication protocol and supports TLS/SSL encryption, and its minimum packet size is only 2 bits. Due to the complexity of the industrial site environment, the instability of the network and the need to access a large number of local sensors, a high-quality, dependable, and low-bandwidth data exchange protocol is required for the industrial application scenario of cloud-side communication. Due to its

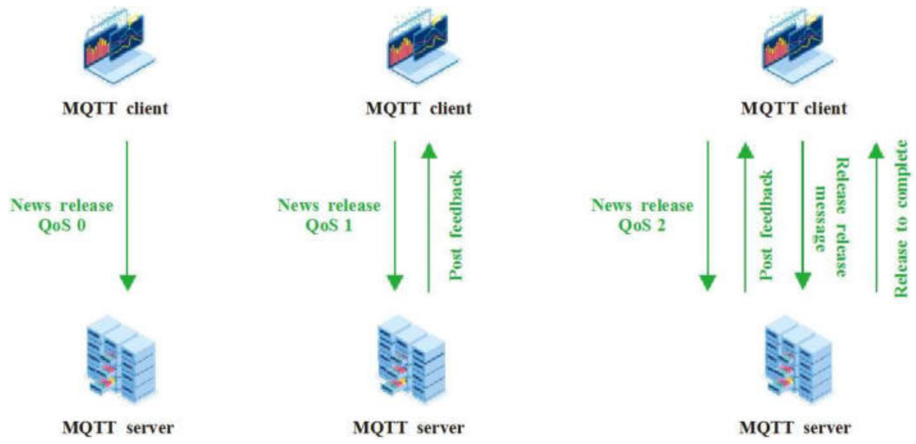

Fig. 3.1: MQTT protocol working mechanism

small message size, publishing and subscription-based decoupled communication modes, extensive QoS options, and LastWill mechanism, the MQTT protocol is highly suited for application scenarios with limited hardware resources and bandwidth. Therefore, the MQTT protocol has become a viable option for the industrial IoT communication system.

MQTT provides a will mechanism and three flexible mechanisms to meet varying data transmission quality requirements. In the Internet of Things, QoS 0 or QoS 1 can be used for uploading and analyzing sensor data to the cloud. QoS 2 can be used to guarantee the accuracy and timeliness of transmitted data for vital parameters and sensors. As depicted in Figure 3.1, when the sensor or gateway is abnormally offline, other clients can also be notified in a timely manner via the will mechanism. Commonly used IoT information and communication technology (ICT) protocols, compared to other IoT ICT protocols, the MQTT protocol provides more quality-of-service choices in the service mode that supports publish and subscribe, and because of its smaller message size, it has lower requirements for bandwidth [20]. At the same time, the TCP-based message transmission of the MQTT protocol ensures the reliability of the message transmission process. Therefore, the author uses the MQTT protocol as the on-site cloud-side communication protocol to build the system.

3.2. System Design.

3.2.1. System Hardware Design and Implementation. According to the architecture of the IoT system, the author designs and implements the IoT communication system of MQTT. The system includes perception layer, transport layer, platform layer and service layer. The perception layer includes on-site vibration sensors and video image collectors, data collectors and intelligent gateways; Sensors and data collectors in the perception layer form edge nodes, and edge gateways form the edge of the system, which communicates data with the cloud through the MQTT protocol through the transport layer, among them, the transmission layer adopts 4G network to realize the data communication between the field and the cloud; The platform layer adopts Alibaba Cloud server, deploys server application software, realizes data storage, analysis, processing and forwarding on the edge site, and analyzes user subscription services; The service layer is based on technologies such as Qt and Paho, and develops application software on the PC client to realize user theme service subscription and data visualization [21].

The ZM-YB40-V/A sensor is a three-wire instrument that can produce either an analogue voltage or current signal, making it a prototypical vibration sensor [22]. In order to gather sensor data, the author used the low-power, multi-functional acquisition board's central CPU and the analog-to-digital conversion module. Figure 3.2 depicts the three components that make up this system's software architecture: an edge data collection module, a cloud-edge collaborative communication module, and a user subscription service module.

The edge data acquisition subsystem includes on-site data acquisition and data processing and analysis modules, the data acquisition of the vibration sensor is realized by using the STM32 on-chip AD function [23].

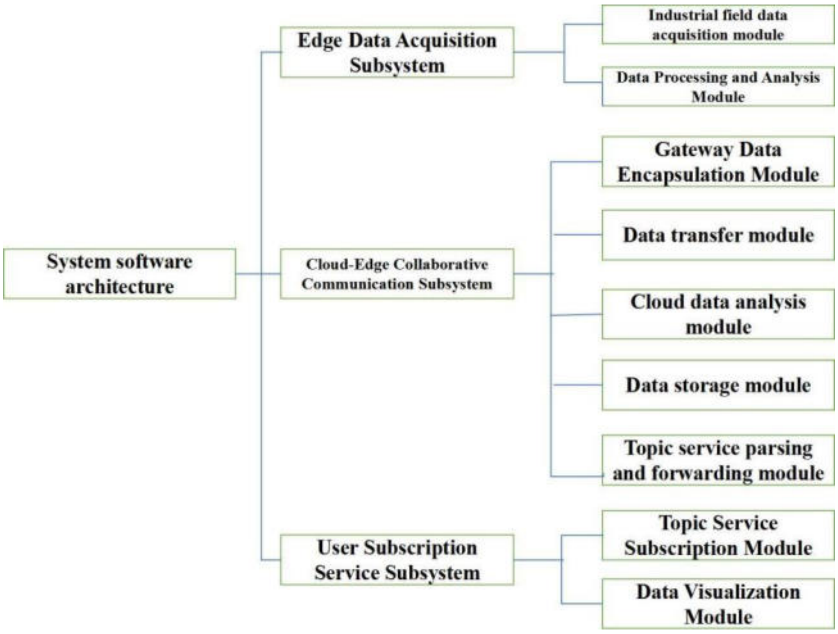

Fig. 3.2: Functional system software architecture

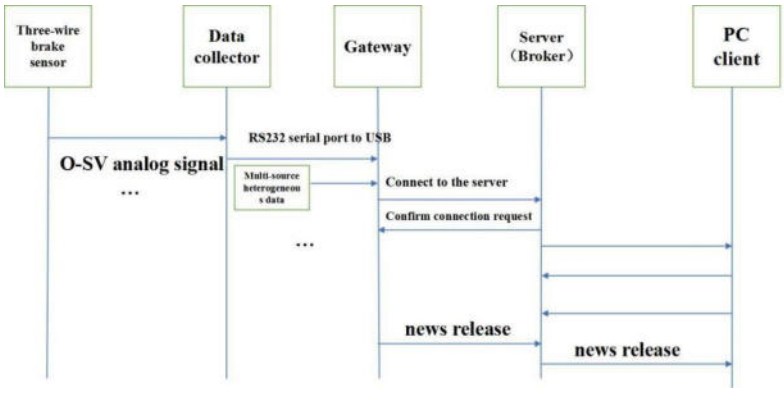

Fig. 3.3: Information flow

The data collector is connected with the gateway through RS232, and transmits data by serial communication. Figure 3.3 depicts the informational flow throughout the system. Images and data from vibration sensors are taken at the test location, but only the images are sent. The system's features include cloud data analysis, subject subscription services, and the collecting, processing, and transmission of multi-source heterogeneous data from industrial locations.

3.2.2. System Testing and Analysis. In the delay test, the time for data transmission from the gateway to the cloud is t_1, and the time for the cloud server to parse, store, and queue the message is Δt, the time of transmission from the cloud to the subscription client is t_2, and the total time t_3 for the message to be transmitted from the gateway to the subscription terminal can be obtained from formula (3.1):

$$t_3 = t_1 + \Delta t + t_2 \tag{3.1}$$

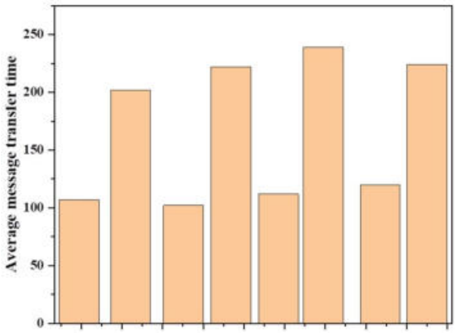

Fig. 3.4: Average delay in sending data packets on PC

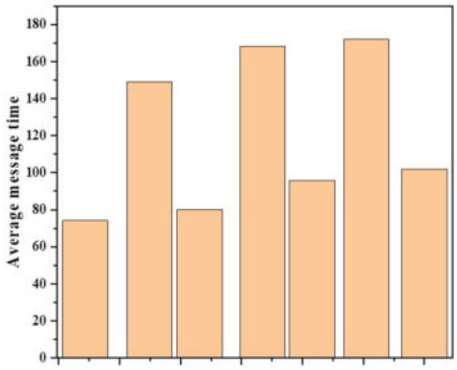

Fig. 3.5: Average delay in sending data packets on Raspberry Pi

Taking into account the actual situation, the time data obtained by the author's test are the total time (i.e. t3) of data transmission from the gateway to the subscriber, and the standard deviation of the data can be obtained by formula (3.2):

$$std.Deviation = \sqrt{1/n\sum_{i=1}^{n}(t_i - t_\mu)^2} \tag{3.2}$$

Among them, n is the total number of tests in each group, t_i is the single measurement delay of each group, and $t_\mu$is the average delay of the group. In order to determine the latency performance of the server when the client node and message load volume gradually increase, a latency test needs to be performed, the test tool is an open-source script, the script can simulate a large number of clients connecting to the server concurrently, and can set parameters such as QoS and packet volume [24,25]. Figure 3.4 depicts the mean time taken to transmit 10 data packets with varying client counts and quality settings. Figure 3.5 displays the median time taken for transmitting 10 data packets with varying client counts and quality settings on a RaspberryPi.

4. Analysis of results. Table 4.1 shows the average delay, minimum delay and maximum delay of 10 packets tested by a single client under different quality requirements and different packet volumes under different hardware terminals [22, 23].

It can be seen from the results that when the network conditions are good, the message is successfully transmitted, and the proportion of successful transmission is also 100%, that is, there is no information loss phenomenon. When the message size is small (within 1 KB), under the quality requirements of QoS1 and QoS2, the average transmission delay of different hardware is within 200 ms. When the message size exceeds

Table 4.1: Message volume test data

Message volume	Hardware	QoS	Average transmission (delay ms)	Standard deviation (ms)	Minimum transmission (delay ms)	Maximum transmission (delay ms)
10Byte	PC	QoS1	100.18	52.84	59.35	216.43
10Byte	PC	QoS1	164.38	49.82	117.91	260.81
10Byte	Raspberry Pi	QoS1	86.49	25.59	62.19	135.15
10Byte	Raspberry Pi	QoS2	153.70	31.85	123.59	219.31
1KB	PC	QoS1	95.424	57.72	61.91	302.49
1KB	PC	QoS2	162.83	42.49	124.861	250.97
1KB	Raspberry Pi	QoS1	89.23	29.19	59.98	159.01
1KB	Raspberry Pi	QoS2	169.59	49.58	127.75	281.54
500KB	PC	QoS1	246.55	156.16	158.99	652.61
500KB	PC	QoS2	376.20	115.69	189.37	759.82
500KB	Raspberry Pi	QoS1	1602.88	1222.36	398.61	3211.97
500KB	Raspberry Pi	QoS2	2679.88	1797.99	419.97	5983.95
1MB	PC	QoS1	487.96	203.48	326.9	957.18
1MB	PC	QoS2	733.58	224.59	377.67	1136.05
1MB	Raspberry Pi	QoS1	4078.30	1869.05	792.10	6883.91
1MB	Raspberry Pi	QoS2	5630.02	3167.08	831.82	11533.821

Table 4.2: Test outcomes of proposed method

Performance parameter	20 Bytes Message length	30 Bytes Message length	50 Bytes Message length	70 Bytes Message length
Average time	0.67	1.4	2.9	4.8
Shortest time	0.48	1.3	2.2	2.2
Longest time	0.83	2.4	3.5	8.9
Success rate	98.56%	97.08%	99.76%	99.54%

1 KB, the communication delay performance of Raspberry Pi deteriorates rapidly, and it is also significantly better than QoS2 in the case of QoS1. The change of the communication delay under the PC side is small, which has a great relationship with its hardware resources. When the message size increases to 500 KB and above, the transmission time increases significantly, and the transmission delay under QoS2 quality on the PC reaches 600-800 ms. For Raspberry Pi with poor hardware resources, it takes an average of 5.6s to transmit 1 MB of data under QoS2, and according to Table 4.1, in the whole test process, the standard deviation of communication delay with larger message volume is larger, indicating that the transmission speed is unstable. The worst case in the test, where the Raspbery Pi transfers 1MB of data with QoS 2, took 11.5s.

The results of the proposed configuration's performance tests are shown in Table 4.2 and Figure 4.1. In order to evaluate the efficacy of the setup technique proposed in this paper's terminal apparatus, the supply time of the transmitted information is 20, 40, 50, and 70 bytes. In all four test groups, the configuration success rate for the IoT terminal equipment devised in this study approaches 100 percent, demonstrating the method's high success rate. The average time is only 0.78 seconds for 20 bytes and 4.9 seconds for 70 bytes, resulting in a significant decrease in distribution time, an increase in distribution efficiency, and the ability to meet the requirements of rapid and stable distribution. The performance of the proposed system is also evaluated with increasing bytes, namely 25, 40, 60, and 70 bytes, as shown in Figure 4.2. Observations indicate that as bytes increase, the success rate increases to 100 percent. In conclusion, under identical hardware conditions, the number of consumers has little influence on the communication delay of the system. However, under the same hardware resources, increasing the packet size will substantially increase the system's communication latency (especially when the packet size is greater than 1 KB), so this system is suited for the transmission of small

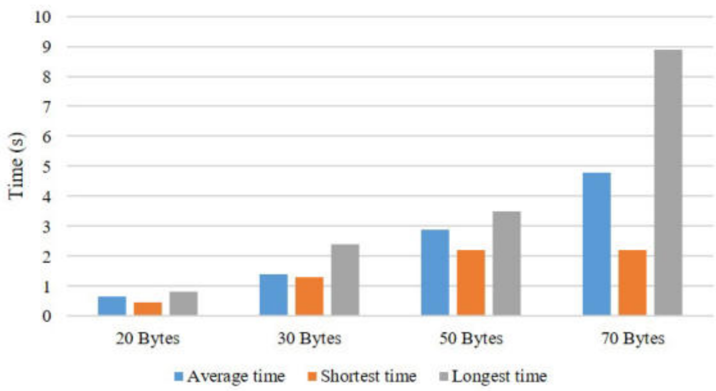

Fig. 4.1: Performance test outcomes of proposed method

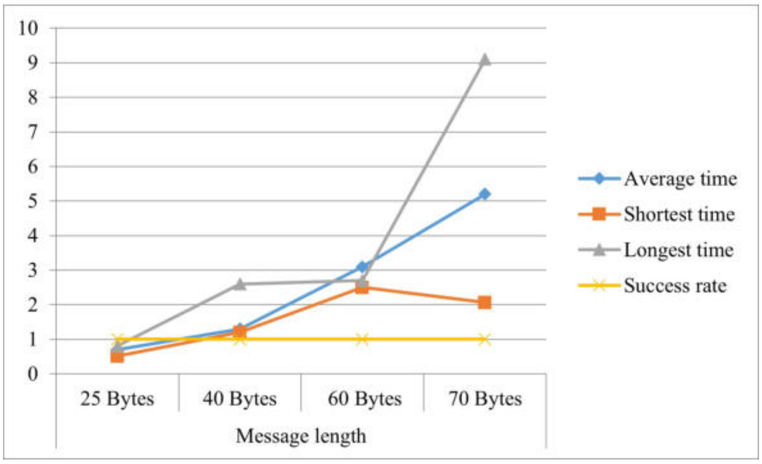

Fig. 4.2: Performance evaluation of proposed method for 25 bytes, 40 bytes, 60 bytes and 70 bytes

data packets and scenarios with high concurrent access. Similarly, the QoS1 transmission quality requirements can satisfy the IoT communication reliability requirements.

5. Discussion. This study investigates the means through which IoT terminal devices can connect to cloud platforms. The suggested method involves the device's domain name first connecting to the cloud platform for identity authentication, and then using that information to connect to the MQTT proxy server. Research the HTTP protocol's data format thoroughly, build an HTTP client within the terminal, and provide a request interface so that the device may connect to the cloud. In this post, we take a look at how Wi-Fi networks are set up and how they code their data. The UDP multicast addresses and data length are developed to facilitate easy, quick, efficient, and inexpensive network connectivity for the device. We have finished the specific implementation on the setup tool and terminal equipment, and have developed a coding network distribution mechanism and a coding protocol. This article establishes a system test platform and finishes testing the terminal device's network access setup technique for functionality and performance. Based on the findings, it is clear that the terminal equipment's suggested way of accessing the network and exchanging data is both practical and effective in meeting the Internet of Things' communication requirements.

6. Conclusion. In order to meet the requirements of computer hardware and network data transmission security, the author proposes a research based on Internet of Things communication technology. The application of Internet of Things technology can realize the information exchange between people and objects, objects and objects, and then realize the management and control of related objects. The Internet of Things mainly includes three parts: information application module, information transmission module, information perception and control module. With the continuous development of the Internet of Things technology, the perception layer, the transmission layer and the application layer have an increasing impact on the computer communication network, continuous technological innovation must be carried out on the basis of full analysis of market demand, only then can we ensure the perfect integration of IoT and computer communication network. In this article, we take a closer look at the suggested method's underlying coding mechanism and network distribution strategy. Network communication is simplified, accelerated, maximized, and reduced in cost when a multicast address and data length are generated for the device. Based on the results, it is clear that the proposed network access strategy and communication strategy for the terminal equipment is feasible and can meet the communication needs of the Internet of Things system.

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