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Research on Profibus FDL communication Based on QT software

Geng Liang[1, a, *], Xin An[1, b], Wen Li[2, c]

[1]North China Electric Power University, Beijing 102206, China;

[2]Guodian Zhishen Control Technology Co. Ltd, Beijing 100085, China;

[a]Liangeng1976@163.com, [b]ncepuax@163.com, [c]12077102@chnenergy.com.cn

Abstract

Profibus Fieldbus technology is China's first national standard for fieldbus technology in the field of industrial communications, and is also an international standard.Recently it widely was used industrial control area.It connects devices with control floor,transforms data by token transmission. This paper mainly researched Profibus data transmission in FDL based on QT software.It brought a convenient interface for easy parameter changes. Experimental simulation results verified the Profibus bus transmission characteristics,it also proved that the simulation of the bus can be realized by using QT software, which provides convenient conditions for future researchers.

Keywords

Profibus, simulation, QT software, user-interface.

1. Introduction

The Profibus (Process Field bus) bus plays an intelligent role in the industrial network control system. It is the first international open fieldbus standard. The main application areas are building automation, process automation, manufacturing automation and so on. It is a fieldbus technology used for factory automation workshop level monitoring and field device layer data communication and control. It can realize distributed CNC and field communication network from field device level to workshop level monitoring, thus achieving comprehensive automation and field equipment in the factory. It provides a viable solution for intelligent.It mainly contains Prifibus-DP , Profibus-FMS(Fieldbus Message Specification), Profibus-PA(Process Automation). Among them Profibus-DP (Decentralized periphery) devices are used for high-speed data transmission at the device level.

With the wide application of Profibus in various industries and fields, its communication performance has attracted more and more attention.At present, many scholars had studied the performance of Profibus communication.Tover et al. analyzed data input to token delay, etc. Finally, the paper given some mathematical calculation formulas of parameters.Fang H et al built an industrial control network system and simulated the bus transmission process based on MATLAB simulation software. Willig, A had compared Profibus MAC with traditional data link layer protocols and found that Profibus MAC has better performance. Lee K C et al. had proposed a mathematical performance model to calculate the communication delay of the Profibus FMS network. Ronaldo Hüsemann had also proposed the Bus Real-Time Monitoring Tool. Bao W et al. had modified the MAC layer protocol of Profibus to model the response waiting formula.The performance research of Profibus has made certain contributions. This paper was based on Profibus data link floor transmission rules.It used Qt software socket idea to simulation real field data transmission and also given some performance indicator analysis.

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2. Profibus communication control protocol

2.1 Protocol introduction

The Profibus network is a master-slave network. The master station has bus control rights. The slave station uses the polling mode to send communication requests to each slave station in turn.

In a multi-master system, a logical ring is formed between all the master stations, the token rings are arranged in ascending order of the address of the master station, and the tokens are sequentially transmitted between the master stations. When the site gets the token, it gains control of the bus and becomes the active station.Only one primary station is the active station at any time, and it can send a communication request to the secondary station or other master stations. The access mechanism of a bus is shown in the Fig. 1.

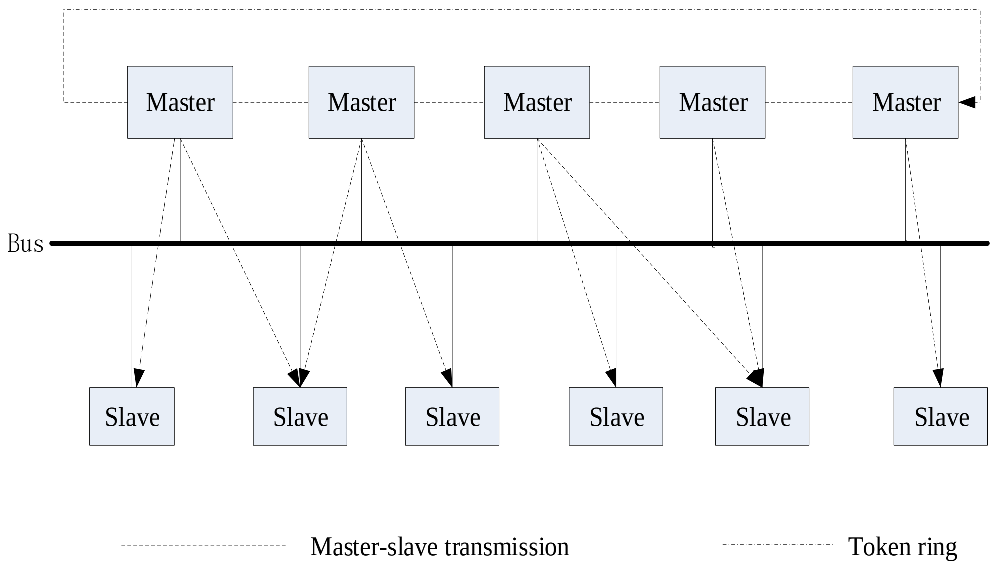

Fig. 1 Profibus bus transmission characteristics schematic diagram

2.2 Parameter analysis

There are two main parameters in the performance analysis of Profibus . One is the target token cycle time, which is a set value before the start of field communication. It refers to the full time of the token received from the current node until the next token arrives at the node. The other parameter is the actual token cycle time. It is consistent with the meaning of target token cycle time, which refers to the token rotation time of the actual site polling of the main station. The difference between the target token rotation time and the actual token rotation time is called the master token holding time. During the target token cycle time, each node performs data transmission in the order of address value. The site receiving the token preferentially transmits high priority data, and after transmitting a high priority data, if real token cycle time is less than setting time, current master continues transmitting date. The next high-priority information of current node is transmitted (if the node has one), after all the high-priority information of current node is transmitted, and the time is still remain, the low-priority information is transmitted. The detailed transmission principle is as Fig. 2 showed. Since the time judgment is completed before the information is transmitted, once the information is transmitted, the transmission must be completed. Even if during the transmission, the token cycle time is equal to 0. This is called time overflow. At this time, information transmission may be disordered or information transmission may be delayed. Therefore, the bus access mechanism has a direct impact on the delay of network transmission.

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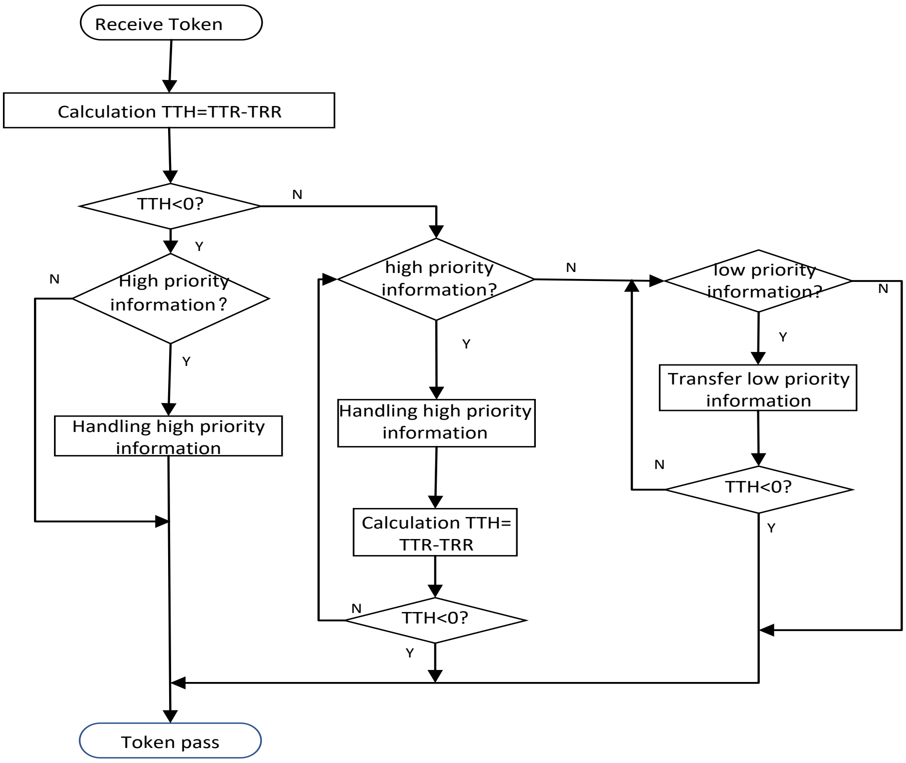

Fig. 2 Schematic diagram of Profibus single master station information transmission process

3. Simulation platform construction

3.1 Qt introduction

Qt is a cross-platform C++ graphical user interface application framework developed by Nokia.It provides the functionality that application developers need to build a state-of-the-art graphical user interface.Qt is fully object-oriented, easy to operate, and allows for true component programming.It has excellent cross-platform features, rich calling class functions, convenient file reading and so on.

Qt interface design

In the Qt development environment, this software design adopted lots of socket association,and slot function plays a central role in network communication. The interface designed is showed as the Fig. 3

It contains input and output area. In the input area, operator can set parameters.

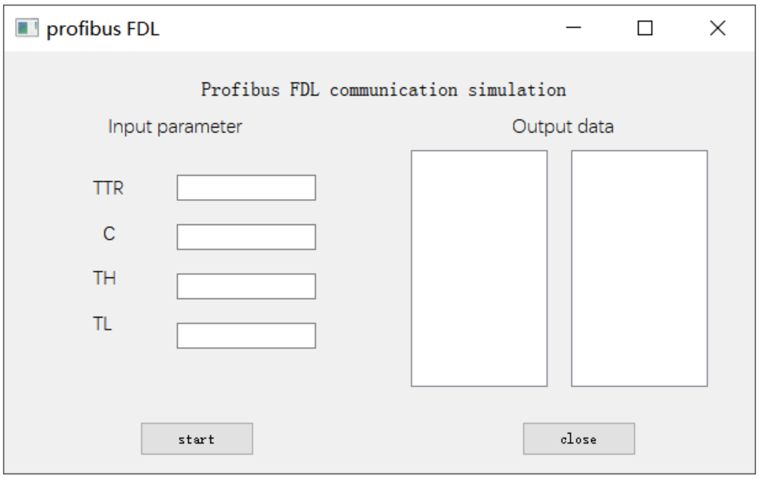

Fig. 3 Schematic diagram of Profibus single master station information transmission process

According to the data transmission characteristics of the Profibus protocol, the data of each site is divided into emergency data and non-emergency data. The simulation process is roughly divided into

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three parts: data input, data transmission, and data processing. The input indicators are the target token cycle time, the total number of sites, and the number of high and low priority messages and so on. The output indicators are transmission time, token waiting time, actual token cycle time. The Profibus bus communication law is analyzed according to the result of observing the output index of the input indicator.

In the actual system, the data may be the field detection data collected by the node itself or the data output by the node controller. In order to better conform to the actual bus communication situation during simulation, the irregularity of the number of data packets when each station transmits packets is ensured. In the design, the rand function is used to generate random data in each polling calculation.

At the time of programming, the parameter names are defined as follows:

Table 1: Parameter Name Comment Table

Parameter Name	Symbol
The number of main station	C
High priority packet number	M
Low priority number of packets	N
Emergency data transmission time	T_H
Non-emergency data transfer time	T_L
Target token cycle time	T_{TR}

3.2 Result

Parameter performance

Node token average wait time T_W^i： i is the site address value, which is 1-15; when multi-cycle information transmission is performed, when the token is polled by the token ring, each master station waits for the token time.

Packet loss rate T_M^i： i is the site address value, this document is 1-15. The efficiency of each primary station transmitting high and low priority messages. Calculated as follows.

$$T_M^i = \frac{S_r^i}{S_t^i}. \tag{1}$$

Note: S_t^i --The total number of packets to be transmitted by the i station

S_r^i --The total number of packets actually transmitted by the i station (experimental measurement)

Data analysis

Experiment parameters:C=15;M=N=randbetween[0,10];T_H=1ms;T_L=2ms;

the system's target token cycle time was setting as range between [0,180] and increasing by 10 in turn. Output results was showed by running the simulation. As were showed in the next figure.

It can found the token waiting time of each master and the data transmission amount of each master were also increased when increasing the target token cycle time. As was showed Fig. 4, in a certain range, the two are in a positive linear relationship. When the target token cycle time is large enough to complete the transmission of each node cycle data and non-periodic data, the token wait time for each node no longer was increased even if the target token cycle time increased. As the token cycle time increasing ,much more data can be transferred .Correspondingly, packet loss rate will decrease as more data are transferred .As shown in Fig. 5, it shows that the target token cycle time is inversely proportional to the packet loss rate.

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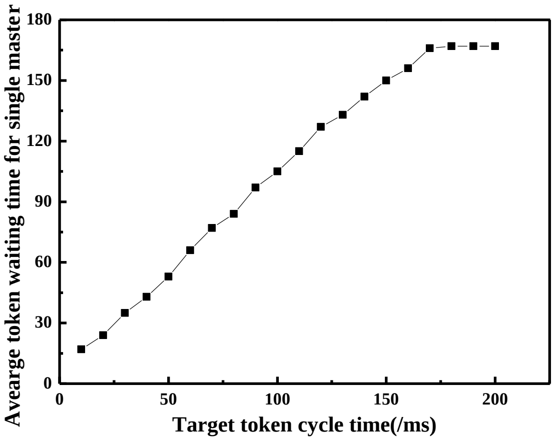

Fig. 4 The relationship between Target token cycle time and Token waiting time for single master

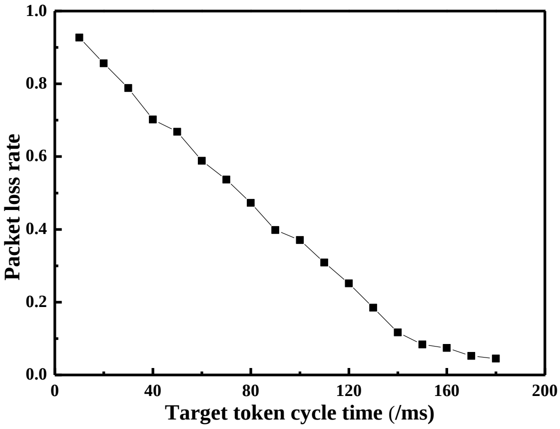

Fig. 5 The relationship between Target token cycle time and packet loss rate

4. Conclusion

The use of Qt to build the interface for the simulation platform design greatly simplified the operation and provided convenience for subsequent research. It can achieve the analysis of performance indicators by changing the corresponding parameters. It can help we get rid of the actual hardware and use the programming software to simulate the fieldbus communication protocol. This paper summarizes the characteristics of the data link layer of the bus through the simulation. The token cycle time and packet loss rate can better reflect the real-time performance of the system. These two parameters can be used as reference indicators for adjusting the overall performance of the network. The data packet loss rate was inversely proportional to the token rotation time. In the next work, we will improve the development of software and conduct research on a more comprehensive system.

Acknowledgements

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