

# Research and Design of Serial Server Remote Monitoring Based on Embedded System

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**Abstract.** With the development of networking of all kinds of equipment, serial interface sensors and other detectors devices are facing the problem of upgrading. The embedded serial server provides a good solution to this problem. System requirements understand is given on the basis of the overall design scheme of embedded serial server, then build the development of embedded system and driver, transplanted protocol stack in the hardware system, building embedded application development platform for the basic serial server, realize the serial data and the core of the network data transformation function, provide convenient management interface for embedded serial server. The embedded serial server availability target is verified.

## Introduction

Many electromechanical devices are widely used in the serial communication protocol and generally support serial communication in the field of control industrial. A large number of widely connected serial port devices are needed to collect data in the traditional control system. It is because of the convenience brought by serial communication that serial server has been widely used. However, it is found in these systems that they require relatively close communication distance. In traditional industrial automation, the operation distance of some equipment is far, so it is an urgent problem to connect traditional industrial automation to the Internet [1]. Serial server can immediately connect traditional serial port devices to the Internet. On the basis of TCP/IP, data can be transmitted through some protocol, or data can be directly transmitted through transparent transmission [2]. Due to the limitations of many factors in the traditional industrial field, it is difficult to realize the long-distance transmission of serial interface and the communication between multiple serial devices and remote hosts. Serial server can realize long-distance data transmission, and the data transmission is fast and reliable. Embedded system as the main system can make the serial server processing data faster and more stable, this paper designs a serial server based on STM32 embedded.

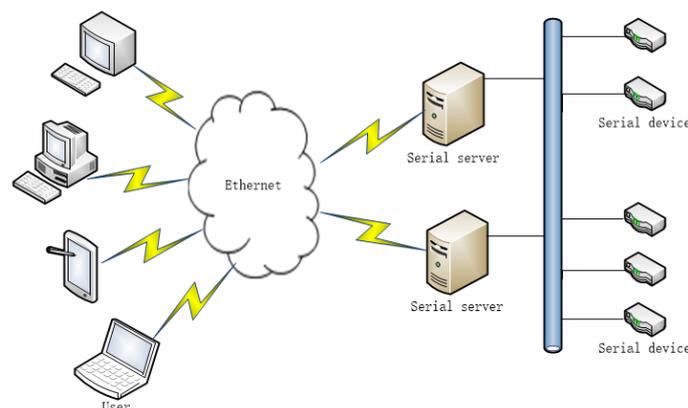


Figure 1. The remote monitoring system structure of serial server

## Embedded System Structure

This system mainly takes embedded serial server as the core, and the overall design scheme is

connected with serial equipment through RS232/RS485 bus, while the other side is connected with the client through Ethernet to realize data transmission. The overall structure of the system is shown in the figure below.

This serial server hardware using STM32 core chip to TCP/IP protocol as the main, a serial server as the core of data transmission on the main work, a serial server receives a request from the Ethernet sent command, and then realize the data reception, again through the TCP/IP protocol, the Ethernet data frame into a serial port data frame, via RS232 / RS485 bus sent to the serial port.

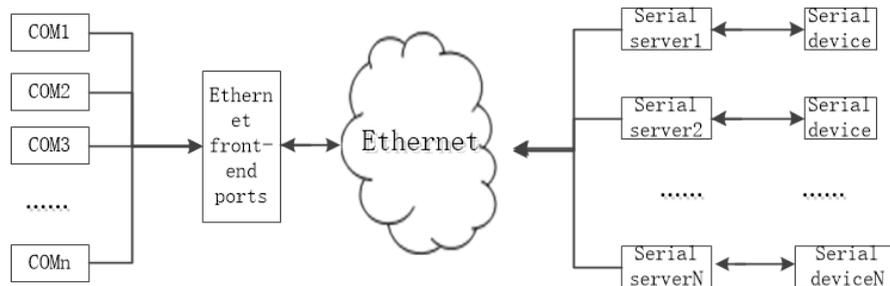


Figure 2. Serial server many-to-many transmission

According to the system framework designed by this topic, the following applications can be extended. The client connects the device, and the remote port connects one or more devices, This transmission mode can be called master-slave mode. In this connection mode, Ethernet can be regarded as an extension line of RS232/RS485 bus. In the process of data transmission, the client sends out relevant parameters of serial devices, and the corresponding serial devices send response and establish connection for data transmission. Multiple remote clients to connect to a virtual serial port on the software, because there is no actual hardware, so the actual communication data will be forwarded to the TCP/IP protocol, through the virtual serial port can be used Ethernet data transmission [3], on the server side, each serial server to connect a serial device, each client to store a serial device port parameters, establish communication, both the client and its storage parameters of serial device to communicate, so that you can achieve multiple machines at the same time the demand of the communication work.

## System Protocol

In the design of this project, modbus protocol and TCP/IP protocol are mainly used. Modbus protocol is a common language through which controllers can communicate with other devices. Modbus protocol stipulates that a controller can only recognize specific information structure and communication mode [4]. When using Modbus network to communicate, the protocol requires each controller to know their device address and be able to recognize the information sent from the address. When it is necessary to respond to the sent information, the controller will generate the response information and send it through the Modbus protocol. When communicating on other networks, the protocol can transform messages and identify frame structures or packet structures used on this network.

On the controller, the standard Modbus port specifies the type of connector, the way of cable connection, transmission baud rate and random parity check, etc. The controller can connect to the network in two ways: direct access and indirect connection to the network through demodulator. The controller using master-slave technology to communicate, also known as query, that is, the host can start data transmission. The host queries to each slave are addressed and broadcast messages, and the slave needs to give the host a response. The response of slave machine includes the code of confirmation action, error check code, etc. In the process of receiving data, the slave machine will send an error signal as a response to the host machine when there is an error or the slave machine cannot execute the corresponding action [5].

In nowadays, the network is so developed that can be seen everywhere in the global network, the network is so useful because it can make the connection between the equipment and equipment, and

is an open network connections, everyone can connect to the Internet for information transmission and information sharing, this open network can achieve connected because of the international organization for standardization will be the result of the network layer, they divided the network into seven layers, each layer needs to complete certain functions in the network, finally, the function of each layer together, forming a whole can achieve the purpose of communication, The layered model that connects functions of each layer to form a network is called the open system interconnection reference model[6]. Although it is only a model, it can provide a reference for many network protocols. The TCP/IP protocol in this design is also obtained by referring to the OSI model.

In this design, TCP/IP protocol used for data transmission is the transmission layer in OSI reference model and the network layer in OSI reference model. TCP/IP occupy the main part of the protocol is mainly composed of application layer, transmission layer, network layer and network interface layer. The transmission layer in OSI corresponds to the transmission layer in TCP/IP, the network layer corresponds to the network layer. The data link layer and physical layer in OSI correspond to the network interface layer in TCP/IP between each layer and the lower level are closely linked, with the agreement of a layer of preparation for the next layer when data transmission to come over, each layer of a layer of message will be added to the front of the data, TCP transport layer protocol said to establish the connection in the TCP three-way handshake. Three-way handshake is refers to the client and the server connection is established in the process of signal transmission and respond to three times.

### Hardware of Embedded Serial Server

Firstly, the integrated analysis of the functions to be realized by the serial server of embedded system is carried out. On this basis, the overall architecture of the system is designed, and the hardware and software structure meeting the functional requirements of the system is designed. In terms of hardware, appropriate hardware chips and peripheral circuits that can meet the requirements of system function and performance are selected. After determining the tasks that the system hardware needs to complete, reasonable models of relevant hardware that can adapt to the system are selected.

The overall framework of this design is the core of embedded system serial server. Communication with Ethernet link is realized upward, and information exchange with RS232/RS485 serial port link is realized downward. The serial server using the 32-bit STM32 processor as the core, the multithread concurrent server realizes the network communication, makes the serial server as the bridge between the client and the serial equipment, Ethernet as the medium between them, finally achieves the communication function, The embedded technology of STM32 is used to accomplish the task of communication reliably and efficiently.

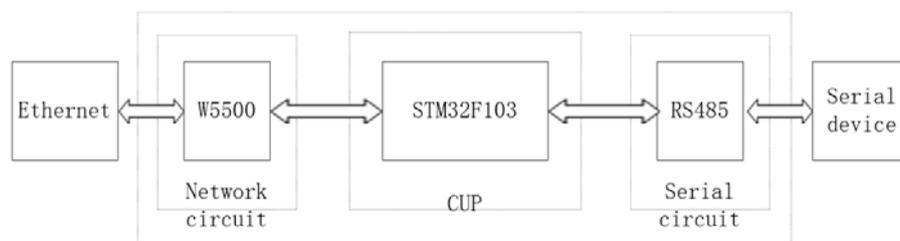


Figure 3. The overall structure diagram of system hardware

As shown in the above system hardware architecture, the system design is mainly composed of three modules. Main control chip STM32F103 primarily composed of MCU module, to need a two-way communication with serial devices RS232/ RS485 serial interface circuit module is given priority to, and network interface circuit, composed of w5500 and RJ45, w5500 as main control chip and RJ45 network can play a signal transmission, impedance matching, waveform repair, clutter suppression and high voltage isolation effect [7], In a complete system, the power supply

circuit provides stable and reliable power for the system.

STM32 series of products use ARM v7 architecture has a large instruction set is also a cost-effective powerful easy to learn processor, which users can play at will in its internal space without too many restrictions. Under the operating characteristics of high performance real-time low power consumption and low voltage, also has the characteristics of high integration and easy development. As the Thumb-2 instruction set is adopted, the working efficiency of instructions is higher. The effect brought by this is to improve the running speed and performance of chips by leaps and bounds. Processor series with a large number of peripherals choose STM32 series of processors needs to connect to the Internet in this system serial port equipment.

### Software Design of Serial Server Embedded System

The requirements for software design of this system are as follows: the user can operate the serial server directly by using Ethernet on the remote client, and configure the parameters of the serial server. Through the remote client operation, can receive and send data, a serial server receives the serial data stream from the serial device, through a serial server discrimination, processing and transformation, serial data stream into Ethernet data frame, sent to the Ethernet interface, through the Ethernet interface is sent to the remote client, Similarly, data from the remote client is sent over Ethernet to the Ethernet port of the serial server, processed by the serial server, and finally sent to the serial device.

The function of embedded serial server is to realize the interconnection between TCP/IP network and serial interface devices. The software part of embedded serial server mainly completes the conversion between TCP/IP data and serial data and the software management and configuration of the whole system. Embedded serial server part of the software program implementation of the overall flow chart is as follows.

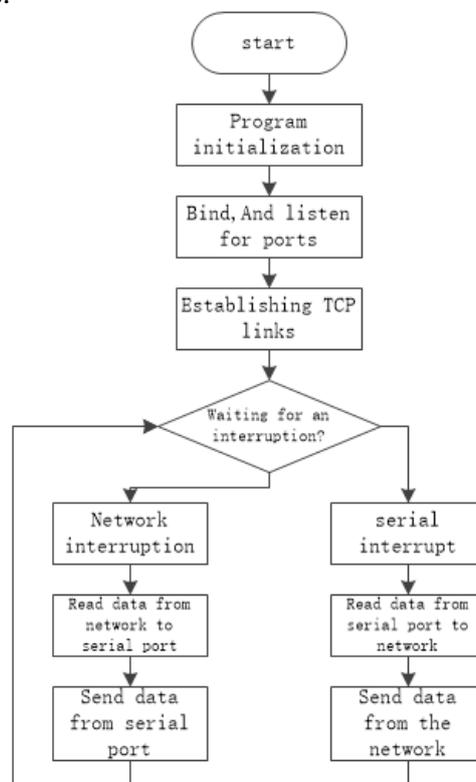


Figure 4. The brief diagram of the program flow

Under the TCP protocol, both the server and client, sending and receiving data are implemented in the specified callback function, once to receive data from the network or serial interface, the callback function is invoked, then can get from management function of the connection or session to send and receive data buffer pointer and buffer size, and directly by using buffer pointer to access

the received data buffer. Data received or sent in the buffer can then be forwarded through a serial interface or network by enabling send interrupt in the callback function. In TCP mode, both sending and receiving data depend on the sending read pointer register and sending write pointer register, which are initialized at the beginning of TCP connection. At this time, the serial server port starts to receive data. All data in the data buffer will be sent, and the sent data will be saved in the buffer. Finally, the sending command is completed. After Ethernet receives the sending command, the serial server will process the received data according to the requirements of TCP protocol, including adding verification code and other steps, and then send the processed data out. Whether the data can be successfully received depends on the size of the received data and the remaining size of the buffer from the space. If the former is larger than the latter, it cannot be successfully received and the program will report an error, otherwise, if the latter is larger than the former, the data can be successfully received to the data buffer [8].

## Summary

After the basic design of serial server is completed, the system needs to be debugged and corrected. First, the hardware of the system needs to be debugged, and then the software of the system needs to be checked to check whether the grammar structure of the system software, the function of the subsystem and the overall function are correct. It is necessary to set the parameters of the client and server and modify some parameters before the writing of the software program in the transmission test. Then, it is necessary to connect the client and server, and the transmission test can be conducted as long as the connection is successful. See if the functionality and metrics of the test are met. The test results indicate that the network has been connected, and then the data sent and received by the test program can be received at the server end by the data sent at the client end, and at the same time the data sent at the server end can also be received at the client end. This design aims to achieve the function of Ethernet serial server, and also achieves the requirements of system stability high efficiency and low cost. Subsequently, the serial server should use some of the current international mainstream technology with the development of new technology to achieve product performance price ratio higher.

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