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Design of the Escaping-channel in Communication Based on Master-slave Method Through Serial Port

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Abstract: In the box network communication devices, in-board channel composed of Ethernets is commonly used to manage the whole equipment. It is apparent that the single-channel management approach has the disadvantage of single-point failure that is the disconnection of the channel will directly cause the paralysis of the whole paralyzed. In this study, an escaping design based on the way of master-slave through the serial port is proposed. When the main management channel is disabled, then it will smoothly switch to master-slave channel and collect the failure information. The experimental results show that with the master-slave escaping channel the reliability of the whole system is effectively promoted.

Key words: Escaping-channel in communication, master-slave communication, serial port

INTRODUCTION

With the popularity of Internet applications, more business is sustained by the entire network communication equipment while the business types show diversification tendency. The performance of a single physical device itself is limited, so it is widely used with box-architecture communication devices (Li, 2004). It is generally consisted of master board and many other boards. The boards are managed through the master board therefore it is needed to establish a communication link among the boards to carry the control packets between them, which is called the management channel.

Li (2004) puts forward a board management method based on CPCI technology. The system only supports the single CPCI-type board and so a connector and a specialized CPCI-Compact Peripheral Component Interconnect, machine frame are needed for the non-standard CPCI boards, thus making it poor scalability. The communication method based on 1553B bus is mentioned by Guo *et al.* (2010) and it is a half-duplex communication one. There are three terminals defined there: bus controller BC, bus terminal RT and BM. The carried messages of it are instruction word, data word and status word (Hu and Xu, 2005). And it has a high transmission efficiency, reliability and good real-time performance. For its high price so it is generally used in military products. Liu (2008) proposes an idea that uses Gigabit Ethernet channel as off-board management channel. It is widely used in Internet communication devices while the method needs a set of Ethernet controllers to constitute the off-board channel besides the business channel which costs much. The idea presented

by Li (2004) is merging the management and business channels to reduce the hardware costs. But when the number of users' booms and network congestion shows up, it is likely to lose the management packets and even cause paralysis of the whole equipment. Although the possibility can be reduced through managing the priority of the packets, it cannot be completely avoided.

The master-slave communication system based on RS-485 can be used in many types of single-point to multi-point communication system (Peng *et al.*, 2009). It is not dominant in multi-device communication for its lower rate but the implementation is relatively simple with good stability and low cost. On the basis of the proposed merger of management and business channel, an escaping-channel based on master-slave communication through serial port is designed. On one hand, it could switch to master-slave communication smoothly to restore the communication when the network congestion causes management link failure. On the other hand, it is used to collect fault cause and also act as transparent-access to the boards. All these improve the reliability of the system greatly without high cost.

The principles and software architecture of master-slave communication are introduced first and then the design of the specific scheme of the escaping-channel is proposed. Finally, the reliability of the communication system is verified by experiments.

MASTER-SLAVE COMMUNICATION THROUGH SERIAL PORT

Theory of the master-slave communication: It is a relatively simple half-duplex communication method and

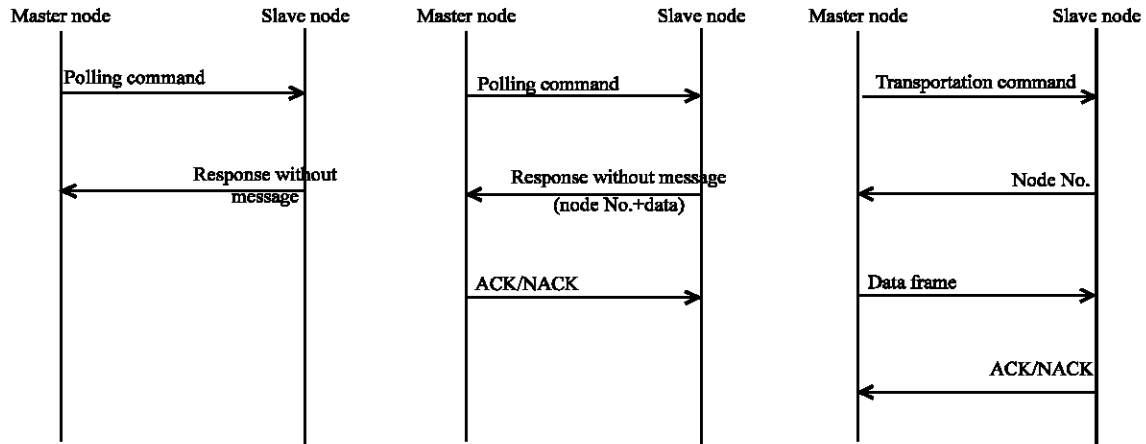


Fig. 1: Methods of the communication

all the communications are initiated by the master node (Zhou and Li, 2008). The communication methods are shown in Fig. 1.

Through the analysis of Fig. 1, there are 3 aspects: (1) There is only one master node with many slave nodes and all the communications are initiated by the master node. (2) The main node sends polling and transmitting commands alternately. Slave nodes determine whether to response to the command according to the slave number in the command. In order to avoid mistakes the data for command the data and command are distinguished through parity in the link. (3) A timeout processing mechanism is used when the master node sends polling commands or commits data transmission. This will be introduced in the following.

The master-slave timeout mechanism: In order to avoid the case that the slave nodes cannot respond to the polling commands for their own faults, timeout mechanism should be set for the master node which is the initiator of the communication. (1) Command timed-out. The master node sends polling command and the node would be regarded as in a warning state when the slave node doesn't response timely. Then the next node is polled. While a node responses overtime for 30 times consecutively then it is set to error state. Then the polling frequency is reduced to improve the whole efficiency. (2) Data timed-out. If overtime happens when sending data to the slave node, it has to resend the retransmission command and six consecutive failures will lead to packet loss. The timeout mechanism is set when message is sent to the master node.

Meanwhile, when the slave node found itself cannot connect to the master node it would reset to restart or do

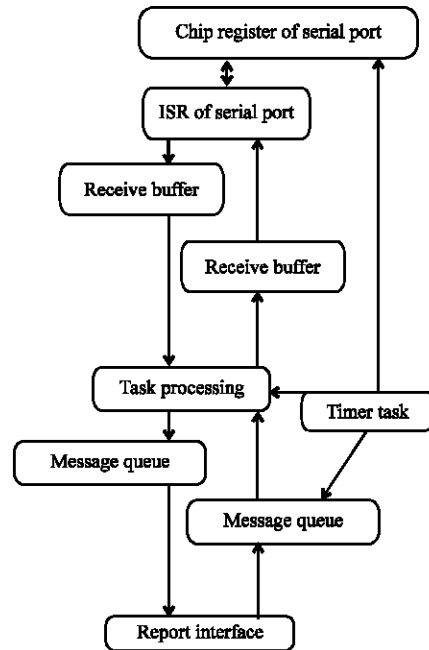


Fig. 2: Architecture of the master node

some other operations in order to release the link and turn into normal state as soon as possible.

The architecture of the Master-slave Software: The main function of the software is that the master and slave node can send and receive normally. The software architecture of the master node is shown in Fig. 2. Most kinds of architecture of the master-slave communication systems are the same including the interface with upper software and the drive. The main node sets up the timeout mechanism to guarantee the communication while the slave nodes don't have one.

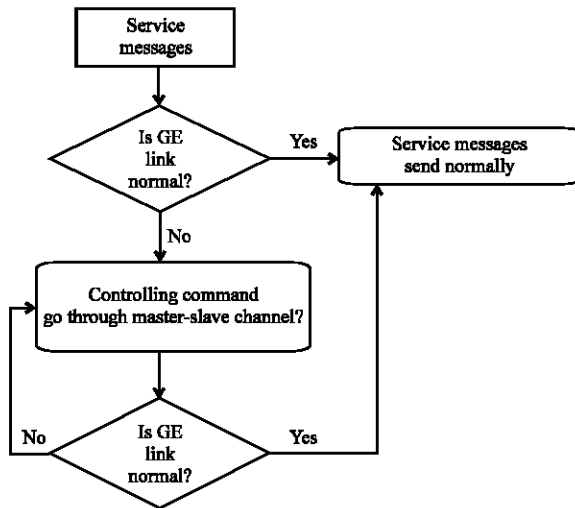


Fig .3: Principles of the escaping channel

DESIGN OF THE ESCAPING-CHANNEL

There is a lot of business in the whole system while the service message is sent through the GE (Gigabit Ethernet) channel. Even though the links are quite reliable at most times, it does not rule out the possibility that single-point failure causes link broken. Without remedial measures, large number of service messages cannot be transmitted which will lead to bad network communication and serious errors like system reset or business suspended. In the case with serial port, it will immediately switch to the master-slave link when GE link fails to keep the basic communication. When GE link is good, it will switch back as shown in Fig. 3. The application helps the system achieve better fault-tolerance.

When GE channel is failed for single-point failure, the point has to report the problem records. To help maintainers locate the problem the failure point should send messages to the master node via master-slave communication based on serial port. All the causes are managed by a master node for the maintainers. Since not all nodes have a control interface, the master-slave channel would provide a channel that can control the slave node via the master node that is transparent channel. When single failure happened, the slave node can be reset to make the GE channel back to normal. If the slave node has to update the BIOS or application software then the new version of the package should be saved in the master node (there should be some special memory). The slave node does version check during the startup process to get the newest software. Of course, the automatically loading method is used whenever it needs

Table 1: Comparative analysis of different communications means

Communication mode	Complexity	Cost	Reliability
GE communication	Low	Ordinary	Weak
Dual-GE communication	Low	High	Strong
PCI bus	High	High	Strong
1553B bus	Low	High	Strong
GE with master-slave			
Communication based on serial port	Low	Ordinary	Strong

update. For some boards there may be no external interfaces to control the costs so that the automatically loading method is essential. Similarly, if the master node needs to upgrade it can also load new software that is saved in the slave node before and the process is called reverse loading.

AVERSION OF MASTER-SLAVE COMMUNICAION FAILURE

In order to improve the performance of the master-slave communication it's necessary to consider the case that when a node in the link fails, it may lead to the failure of the entire link. Some aversion methods are proposed from the software and hardware ways:

- **Software circumvention:** It has been stated above that the master node set up timeout mechanism in the communication. In that case, if the slave node failed to failure state for software wrong then it will set a soft interrupt reset to reboot system to a normal state
- **Hardware circumvention:** When a hardware failure occurs (such as universal asynchronous receiver/send device Uart), the slave node sends 0 or 1 continuously which results in blocking of the link. A capacitor can be set in the slave node to isolate DC and disconnect the node from the link

COMPARATIVE ANALYSIS

The comparison result with other means in all aspects is shown in Table 1.

CONCLUSION

The study presents some practical applications of the master-slave communication in multi-machine communication. The use of escaping-channel promotes the performance obviously. Especially, some ideas also are presented to get around the problems that may happen. The master-slave communication can benefit a lot from it.

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