Multiple Access Control of RS232C Serial Communications Interface

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Abstract: In this paper, we proposed the multiple access control of RS232C Serial Communications protocol using collision sense method. The communications wires of data transmission and reception are tied together through the buffer each to connect to the multiple communication channels.

The hardware interface and control program are designed to build the prototype system and the experimental multiple access communications network is built by multiple PC systems and the transfer completion rate results are shown.

1. Introduction

RS232C, one of the most popular serial communications interfaces for computers, instruments and controllers uses dedicated communication channel between two Data Terminal Equipments (DTE). To establish the guaranteed connection paths among multiple DTE's, each DTE requires multiple serial ports connecting all the other DTE's and this makes it difficult to expand the connecting hosts.

The common communication channel allows multiple hosts to have guaranteed communication channels with all the other hosts through the shared communication lines and the shared communication lines implement the multiple access protocol. The common channel communication enables the dynamic network configurations and the flexible host addition and deletion.

The multiple access control system is implemented using several hosts with the performance evaluation at various configurations and data transfer speeds. The result can be applies to connection of multiple RS232C interface systems to a single common communications line without modifying the equipments. A simple adapter and control program are all that required.

2. Multiple Access Control

2.1 Common Communications Channel

RS232C communication protocol is very popular interface for instruments, computers and automation equipments. But, RS232C protocol uses one pair of wire to connect two hosts and the multiple host connection by RS232C protocol requires many wires [1].

The hosts on the multiple access channel shares the data line and only one host can transmit at one time while multiple hosts are allowed to receive the data. To enable multiple hosts to transmit data, the status of common communications channel should be checked before data transmission. When the channel status shows that no data exists in the channel, any hosts are allowed to start data transmission [2].

2.2 Collision Detection

When more than one host start transmission, the transmitted packet from each host collides with each other resulting data distortion, and the collision is detected by comparing the transmission data with the received data from channel. If the channel data is same as the transmitted data, we know that there is no other transmission host, or the transmitted data of other hosts is exactly same as the transmission data and those data are synchronized, too. In this case, multiple transmission hosts of synchronized and same data pattern do not cause any collision.

Each data transmission line and data receive line of RS232C are connected to the channel through their own tri-state buffers. Every transmitted data is sent out through the outgoing buffer and the data is looped back to incoming buffer and received by the receiver line of RS232C. Figure 1 shows the connection configuration with adapters on each host [3].

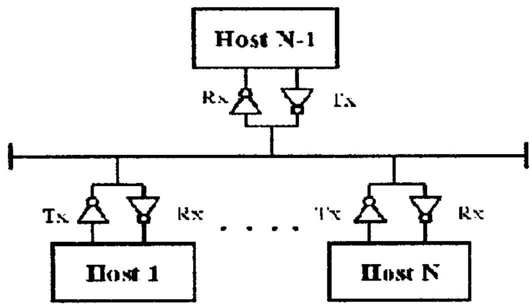

Figure 1. common communication channel connection

The loop back data is compared with the transmitted data and the comparison can be applied to either every byte or every packet. The byte comparison of transmission and reception requires more processing burden to the transmitting host than the packet comparison [4].

But the packet comparison results in the bigger retransmission data size than the byte comparison. Considering the relatively low error rate of transmission channel, packet comparison requires the lower processor burden and loop back data packet is compared with the transmitted data to detect the data collision.

2.3 Connection Detection

The proposed method does not use "idling" signal transmitting from the other hosts and each host needs to listen the channel and detect the host itself is connected to the communications channel periodically. The loop-back test is not enough when the host is disconnected from the communication channel.

By listening periodically to the communication channel, each host detects the host's ID's connected on the same communication channel [5].

2.2. Transmission Modes

When the collision is tested and detected by each transmission host, individual host waits for random amount of time duration to reduce the probability of collision of retransmission data. The seed number for inter-frame time interval is changed every instance of data collision and the initial delay time interval is multiplied with the number of data collision instances and this time interval is added to inter-frame time interval.

By randomizing inter-frame time interval and the initial time, we could reduce the collision and increase the data transfer completion rate [6].

We assigned three retransmission modes. Mode I uses initial delay time multiplies with retransmission instances as the seed number for random number generation. In mode II, inter-frame time interval is added to the time of mode I for random number seed. In mode III, initial delay time alone is used for random number seed and in mode III, we did not consider the retransmission instances.

Mode I has the biggest retransmission time and the biggest transfer completion time while mode III has the smallest retransmission time and smallest transfer completion time among the modes.

3. Implementation

3.1. Experimental System

For experimental system, prototype network is built with two 486DX4-100 systems, three Pentium-133 systems and one Pentium-1.5G system. The data packet has variable length and the longer data packet takes the longer time for transfer completion due to the increased collision instances.

The data packets of different length are transmitted by mode I and mode II. Data transfer completion is experimented by various retransmission time intervals, various hosts configuration and various communication speeds as well as various packet lengths.

3.2. Results and Analysis

Figure 2, figure3, figure 4 and figure 5 show the experimental results. For performance analysis, three above mentioned transmission modes are applied. The transmission packet from all the hosts has a pre-known contents and each receiving host compares the received and compare the packet with the transmitted packet to compute the completion rates.

In figure2 various channel communications speeds are applied from 4800bps to 115200bps. The figure shows that when the communication speed is 38400 bps, with 6 host computers connection, the completion rate increases above 95%. At the communication speeds higher than 38400bps, the completion rates show a small increase in the completion rates. We expect that the big increase point moves to higher communication speeds when the number of hosts increases.

From the experiments, it is shown that at a higher communication speed, the data packet takes smaller time duration on the communication channel. Thus, the probability of data collision is lowered and the communication completion rate increases.

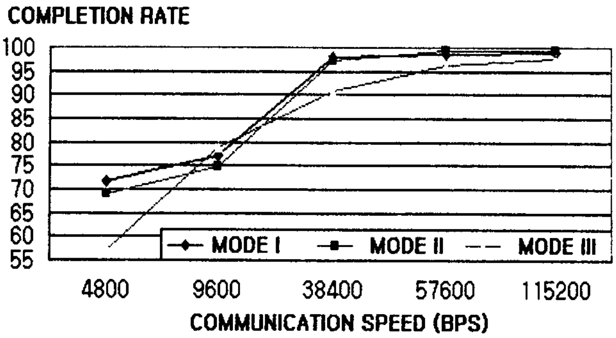

Figure 2. Completion rate vs. communication speed (bps)

Initial delay time, as well as the inter-frame delay also affects the communication performance. Figure 3 shows the completion rates with different initial delay time while keeping the communication speed constant. This figure is also applied to the inter-frame delay, because the inter-frame delay is regarded as the initial delay time for the next data packet.

In this case, the inter-frame interval of adjacent data packet on the communication channel is the key affecting factor to data transfer completion rates.

The longer delay decreases the time duration rate of packet on the communication channel and the longer inter-packet delay lowers the collision probability and increases the completion rate, too. Mode 1 has the higher completion rate than the others because it has the longer inter-frame delay between the packet transmissions.

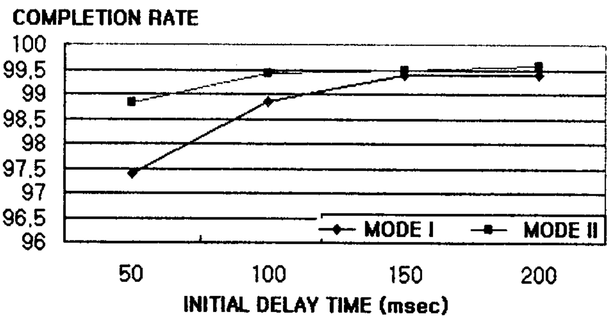

Figure 3. Completion rate vs. initial delay time

Data frame length is strict factor of time duration on the communication channel. A longer data frame packet takes longer time duration on the channel than the shorter data frame packet and this increases the probability of data collision. Figure 4 shows the completion rate decreases as the data frame length increases.

But, the long data frame has advantage of superior transmission efficiency to the short data frame and drawback of low completion rate of long data frame can be improved by adapting the higher communication speed and longer initial delay time.

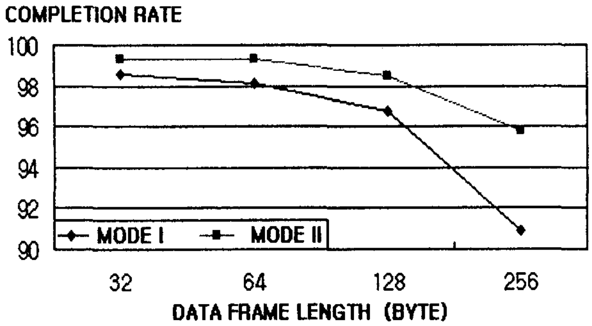

Figure 4. Completion rate vs. data frame size

The number of hosts on the common channel is another strict factor of completion rate. When a host is added to the communication channel, more hosts are transmitting data packet and thus, increases the time duration of data on the channel. So, the completion rate decreases as the number of hosts increases.

From figure 5, it is shown that the host addition does not decrease the completion rate rapidly and this draw back can be compensated by increasing the communication speed or allowing more initial delay time, which are the same methods as were proposed for figure 4.

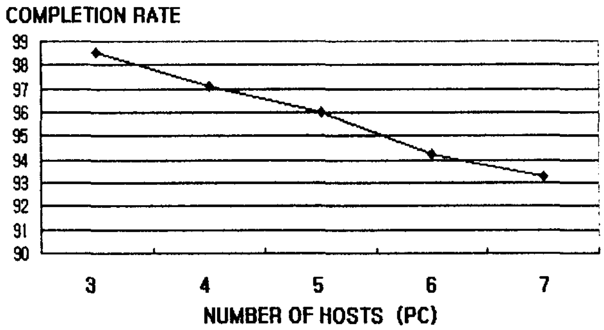

Figure 5. Completion rate vs. number of hosts on the network

The experimental result data show that the time duration taken by the data packet is the most influential factor on the collision probability. The longer time duration of data packet on the channel definitely increases the probability of data collision. So, the long data frame packet and increased hosts connections cause low data transfer completion rates while high communication speed and long initial time delay increase the completion rates. From the view of the data transfer time, the long initial delay increases the communication time slightly, but decreases packet retransmission caused by the data collision.

the shorter data packet, the longer initial delay time, the higher communication speed and the smaller number of hosts on the network achieves the higher data transfer completion rate as well as the lower retransmission instances.

4. Conclusion

From this research, we showed that most of the computers, instruments and systems equipped with the conventional RS232C interface are connected together by the common communication channel for multiple access communications. The transmitted data collision is detected by comparing the transmission data with the loop back reception data. The result of this work is useful to implement multiple access communications at minimum add-on hardware to the conventional RS232C interface. Also, by allowing multiple systems to be added and removed from the network without affecting other systems, network can be dynamically configured depending on the network requirements variation and this feature is also useful most of the automated instruments systems, low intensive traffic automation systems applications.

References

[1] Andrew S. Tanenbaum, *Computer Networks (3rd Edition)*, Prentice Hall, 1996.

[2] Frank F.E. Owen, *PCM and Digital Transmission Systems*, McGraw-Hill, 1982.

[3] Mark Nelson, *Serial Communications Developer's Guide*, IDG Books, 2000.

[4Brian J. Thomas, *The Internet for Scientists and Engineers*, SPIE Press, 1995.

[5] Douglas E. Comer, *Internetworking with TCP/IP Vol I*, Prentice Hall, 1995

[6] B. Field, T.F. Znati, D. Mosse, "V-Net, A Versatile Network Architecture for Flexible Delay Guarantees in Real-Time Networks," *IEEE Trans. on Computers*, Vol. 49, no. 8, pp.841-858, August 2000.