Time delay measurement and compensation of Internet-based Networked Control Systems

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Abstract

Using the simulation procedure of a machine which running in the campus online as controller, and another in which a certain distance from the machine as simulate the procedures of the object. the client respectively send data packets every 0.1 s, 0.5S in the experiment, and the packets' length is 36 bytes. Comparing with the current data time and tag data time, then we can calculate the total data packet delay, which laying a foundation for the study of Network Control System.

Keywords

Networked Control Systems, Ethernet, Network time delay.

1. Introduction

Network Control System (NCS) sample data and the given (or control) signal transmitted over the network, each node must work together to complete the control tasks. Since the overhead caused by channel competition, physical signal processing, coding and communication protocols between controllers, actuators and sensors inevitably the introduction of different types delay, which are collectively referred to as network latency delays. Delay will reduce the performance of the control system, in severely cases, also make the system unstable.

Network measurement refers to in accordance with certain methods and techniques, the use of software and hardware tools to test or validate network performance indicators to characterize the sum of a range of activities. Common analytical indicators [1-2]: one-way and round-trip delay time; packet loss rate; connectivity; throughput; instantaneous packet delay difference; large transmission capacity; bandwidth utilization; bottleneck bandwidth estimation; cycle flow network performance . Among them, the most basic of the three major indicators for the delay, packet loss rate and bandwidth.

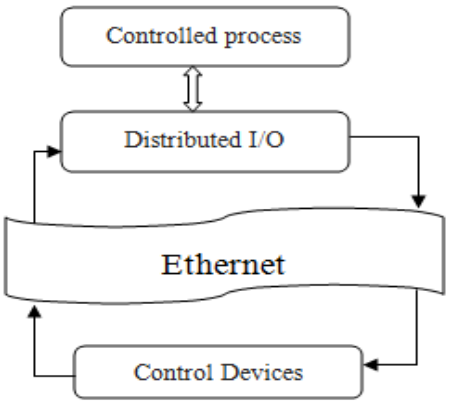

Figure 1 Ethernet Delay Measurement Chart

2. Problem Description

Figure 1 is a block diagram of the network control system under study. NCS sensor commonly used clock driver, the clock of the sensor is the system clock , the controller and actuator may be either a clock driver, or may be event-driven. For the time driven specified herein sensor node driven, event driven controller node.

3. Experimental design

The actual Ethernet-based network control system generally has the structure in Figure 1 [2]. In the experiment, the public can choose Ethernet campus network under its heavy load of situation, delay measurement test network environment shown in Figure 2, the client and server shown in the figure in two different laboratories in their respective connection HUB, exchange data in the campus network environment. Programs running on the campus network to do a machine simulation controller, in another program and it has a certain distance from the machine running the simulation for the controlled object [3-4].

Network Control Simulation structure shown in Figure 3, when the target computer and the controller are using Windows 2000 computer operating systems, test software using Visual C ++ and assembly language section, and communicating through ActiveX socket. Because Ethernet is fast, delay is in milliseconds, by calling the system function Query Performance Frequency () and Query Performance Counter () function by VC program in the controller node, using the difference between the two count obtained and the clock of the sensor frequency , calculating two delay is the difference between the data of the measurement accuracy can be achieved microsecond.

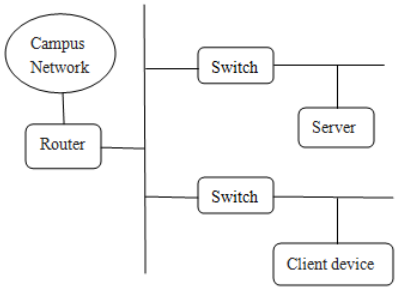

Figure 2 Delay experiment network architecture

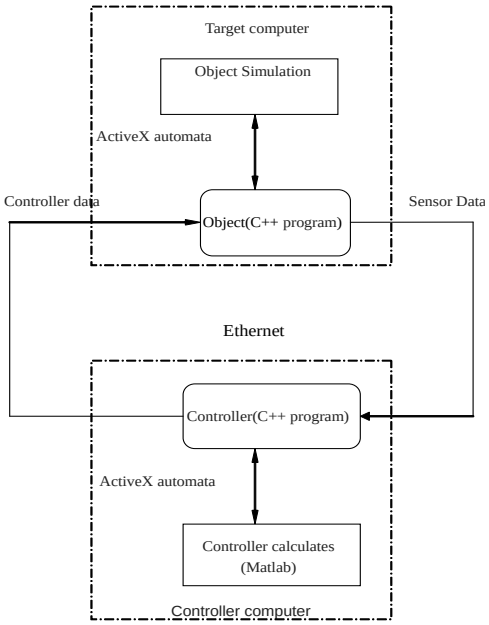

Figure 3 Network Control Simulation structure

In the program, through the use of multimedia timer in the program Time Set Event () function to set the sampling period. Send sparse data write callback functions is called.

4. The results

In experiment, the client separately every 0.1s, 0.5s sending packets, packet length is 36 bytes. With a time stamp in each packet, the server by the data without processing the return of the book bureau package, after the client receives the returned data to compare current data time and tag data time to calculate the total packet delay. Delay measurement result data obtained as shown in Figure 4-7 (ordinate in Figure 4 - Figure 7 is a time delay (μs)).

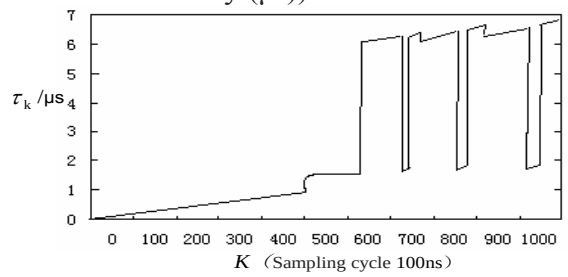

Figure 4 TCP / IP Delay characteristics (sampling cycle 100ns)

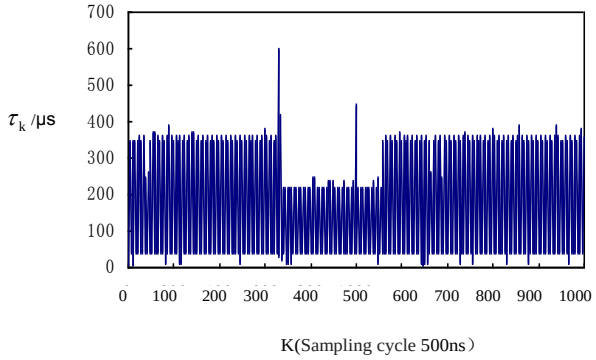

Figure 5 TCP / IP Delay characteristics (sampling cycle 500ns)

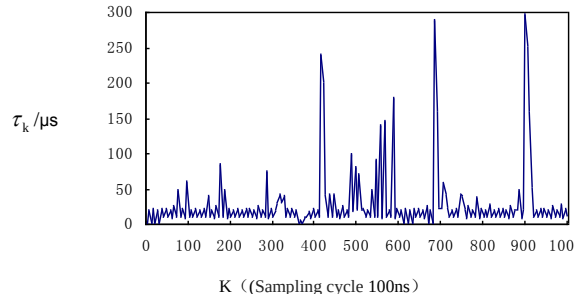

Figure 6 UDP / IP Delay characteristics (sampling cycle 100ns)

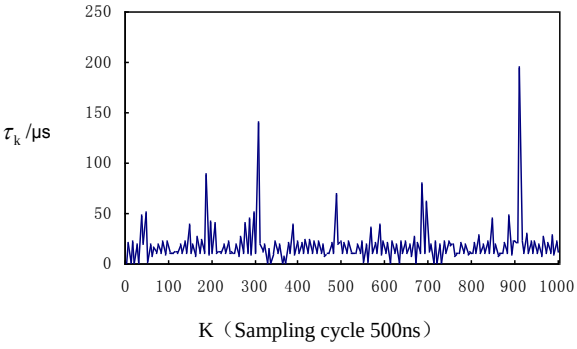

Figure 7 UDP / IP Delay characteristics (sampling cycle 500ns)

Figure 4 - 7 shows:

To the network control system, the sampling period is too large, closed-loop control system is insufficient information , it will result in not achieve the desired performance. At the same time, if the sampling period is too small, it will be transmitted on the network medium overloaded, which makes the overall system performance decreased.

Ethernet-based network control system, you can use these results construct an appropriate delay generator, laying the foundation for network-induced delay compensation.

Reference

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