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Analysis of application of network time synchronization technology in plant and station automation system

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Abstract. As the inevitable result of the development of social economy and science and technology, the construction of plant and station automation system not only solves the problems existing in the traditional plant and station construction management, but also improves the fundamental requirements of the system operation. According to the accumulated experience in the construction and application of plant and station automation system in recent years, the scholars of various countries should not only ensure the accuracy and high precision of time measurement, but also scientifically control the complexity of application algorithm to reduce the amount of electric energy consumption. Therefore, on the basis of understanding the research status of plant and station automation system and network time synchronization technology, this paper mainly explores how to apply network time synchronization technology in plant and station automation system according to the structure of plant and station automation system and the key points of network time synchronization technology.

Keywords: Plant and station; Automated system; Network time; Synchronization technology; Time accuracy.

1. Introduction

In essence, the plant and station automation system refers to the plant and station secondary equipment after function combination and optimization design, the use of computer technology, modern electronic technology, communication technology, signal processing technology, etc., to realize the main equipment, transmission line, distribution line of the whole substation automatic monitoring and automatic control. In this process, the secondary equipment includes motion device, automatic device, relay protection, signal system, measuring instrument and other contents. The integrated research on the construction and development of plant and station automation system at home and abroad shows that in the development of social economy and technological innovation, the technical theory has gradually developed from the traditional substation operation mode to centralized automation system and distributed automation system. The overall system construction has a number of functions, such as data acquisition, security warning, operation control, data recording and processing, online calculation and control table, operation management, intelligent alarm, printing records, system self-diagnosis and recovery.[1-3]

Network time synchronization technology refers to the means and methods to realize the time unification of each device in a specific network system. In a narrow sense, a device is a computer that functions as a server and a client. From a broad perspective, it also includes control devices, node switches, routers, and other intelligent sensors. This paper mainly discusses the equipment time synchronization problem from the narrow point of view. Nowadays, scholars from various countries have put forward many contents in the study of network time synchronization technology, such as long wave timing, satellite timing, television timing, short wave timing and so on. Through the comparative analysis of several common technical means, it is found that the practical application conditions are quite different and the research application cycle is different. In order to better meet the requirements of plant and station automation system construction and management, enterprises should consider network interface, reliability, installation and maintenance, cost and other aspects comprehensively. While simplifying the application hardware, they should control the volume of equipment, improve the integration of equipment application, and better meet the requirements of computer network operation.[4-6]

In the process of plant station automation system operation, it is necessary to ensure the accuracy of time measurement, otherwise it is easy to cause other problems because of the uncertainty of time, such as failure to guarantee the perfection of the fault recording information, the error of the component measurement device. From the perspective of practical development, enterprises usually use GPS to provide accurate time for plant and station automation systems. After receiving relevant signals, the time is transferred to the substation, and the effective time is provided for some or all devices of the whole station through the second pulse, the RIG-B receiver, etc. If the equipment and node machine of the whole station are directly through the above connection to obtain the time, then although it can improve the accuracy of the time, but the need to install multiple receivers and expansion boxes, the overall system operation cost will rise straight, the system will become more complex wiring. When the plant and station automation system develops towards the network direction, the component devices also begin to be directly networked, and the whole system can use the network platform for timing, and this technical theory has also been paid attention to by the whole society. This paper studies how to apply the network time synchronization technology in the plant and station automation system based on the basic needs of the standard and the development of network time synchronization technology, in order to judge the positive impact of this technology theory on the practical system.

2. Methods

2.1 Time Synchronization Architecture

In a distributed operating environment, all nodes need to realize time synchronization through the network. However, in the current network architecture, the transmission path of information is not the same each time, which is likely to cause problems such as information delay. Therefore, in the design of applications, the delay of network operation should be fully considered, and the network delay and how to predict it in the system should be emphasized. If the time difference between the two clocks is kept within a certain range, it can be called time synchronization. After sorting out and analyzing a number of literatures proposed by domestic and foreign scholars, the contents shown in Table 1 below are obtained, and the common points among relevant research results are compared and analyzed. Finally, it can be found that researchers have the same points in solving the problem of time synchronization, first of all, the main source of computer time is quartz oscillator, but this kind of equipment itself because of the manufacturing process and external temperature changes, unable to provide stable time for the computer system; Secondly, in the current network system architecture, the path of information transport is not consistent, and it is easy to lose because of the heavy load of network traffic. Finally, as the most widely used synchronous time protocol at present, NTP can provide time accuracy between 20 and 50 milliseconds in the network environment, which does not meet the requirements of distributed virtual environment system operation.[7-9]

Table 1 Comparative analysis of relevant research results

Name / Practice	A new time synchronization programming suitable for collaborative computing	Adaptive time synchronization based on poor clock accuracy
Method	In this paper, a hybrid approach is proposed in which the system is divided into bootstrap and follow-up phases 1. In the bootstrap stage, it took 20 minutes to collect data at the beginning of the	1. The primary node sends a timestamp to the client through multipoint within a fixed time period 2. The client expects to receive the message from the primary node within a fixed period

	system. 2. When 13 time differences are collected, the linear regression method is used to predict the future time differences	3. When 400 time difference samples are collected, linear regression method is used to predict the time
The problem to solve	The unstable frequency of quartz oscillations. During the synchronization phase, network connections may affect NTP time accuracy	
Predictive time method	Linear regression	
Send message	Two-way	One-Way
Network protocol	TCP/IP	UDP(multicast)
Architecture	Client-server(external synchronization)	
Server	Run the NTP server and respond to the client information	Periodically send information to the client through the way of multipoint transmission in the way of Beacon
Client	1. Analyze and save the received information 2. Calculate the time difference 3. If more timestamp information is received, we can analyze it statistically to obtain a linear recursive model to measure the slight difference between the two times	
	Periodically send out time synchronization requirements	Periodically waits for the primary node to send information

2.2 Technical Solution

On the one hand, WAN time synchronization. In this technology, satellite timing is regarded as the main basis, while short-wave timing is an auxiliary scheme. The specific design is shown in Figure 1 below:

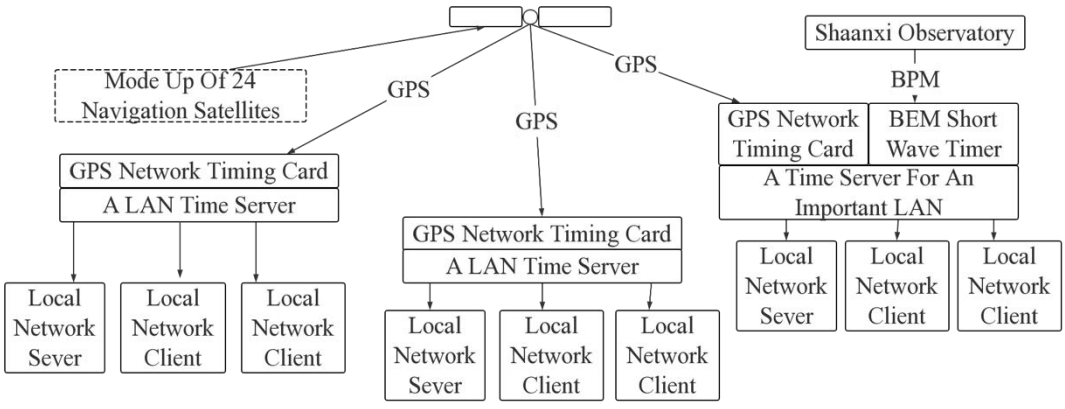

Figure 1. Structure of WAN time synchronization technology

According to the above analysis, it is necessary to install a GPS network timing card for each LAN, and the system administrator specifies the server. When dealing with important Lans, shortwave timing is installed as a backup technology. The output signal of shortwave timing 1 is connected to an input port of the GPS network timing card. Among them, the structure design of network type card is shown in Figure 2 below:[10-13]

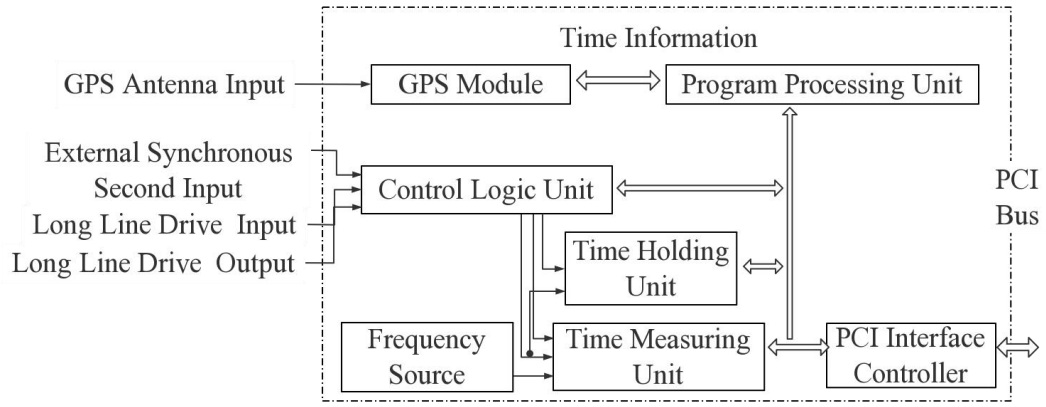

Figure 2 Structure diagram of network card

Under normal working condition, the network timing card is mainly responsible for obtaining the GPS timing signal, which will be directly converted into Beijing time; Under special working conditions, if the GPS signal is off or abnormal, then the network timing card will automatically change to receive shortwave timing 1 signal. If shortwave timing one has no signal input to the network timer, then I will be supplied by the timing unit. At the same time, the server to install the driver, in the network TV card to obtain the time information. The LAN operating system software is different, support GPS network timing card drivers are also different. Today, the most common computer bus is the PCI bus, which supports the capabilities of bus adapters. However, since this kind of bus is gradually phased out, subsequent device types no longer support adapter operation, so it is necessary to provide PCI bus interface for GPS network timing card.

On the other hand, LAN time synchronization technology. The system administrator of the local network provides a remote control module for the clients and servers that need time synchronization within the network. The server equipped with the GPS network timing card and the relevant standard time are transmitted to the computer by means of broadcasting. Firstly, the network timing card is inserted into the local network time server and the interface provided by the driver is used to obtain the time signal. Secondly, the remote executive program is regarded as a service, which is mainly used to receive all the time signals broadcast to the network by the local network server and place the acquired time signals in the computer with the remote module. Finally, place LAN time. The remote executive program is installed in the computer that needs time synchronization. The system administrator of the local network provides the time signal to the network platform, and the remote executive program will install the time signal in the local machine after receiving it.

3. Result analysis

Based on the theoretical knowledge and technical points obtained in the above studies, the uniqueness of network time synchronization technology is clearly recognized, and then the accuracy of relevant technical equipment is verified by practical cases. Nowadays, there are two kinds of algorithm protocols based on network time synchronization technology, one is network Time protocol (NTP), the other is simple network Time protocol (SNTP). The former is a time-timing protocol based on the network, which was first proposed by American scholars and has been optimized and innovated since the early 1980s. Currently, NTP V4 is used, and the clock synchronization model design is shown in Figure 3 below:[14-15]

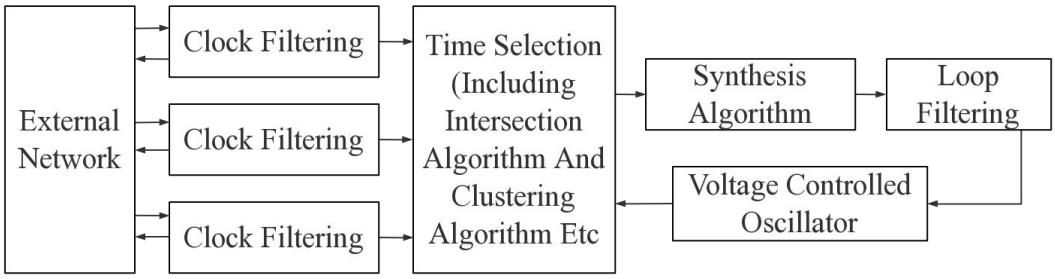

Figure 3 Model structure diagram

The latter is a simplified model of the former, which has been widely used in plant and station automation application environment. Such protocols explicitly suggest that the client should only act as the lowest level of the timing hierarchy, while the server should be placed in the first layer, directly obtain the time signal from the external high precision time source, and provide it to the client according to the new requirements. In most plant automation systems, this protocol only needs to implement the first layer and the second layer of timing hierarchy, the client only needs to calibrate the time according to a certain upper-level time server, and does not need to consider the more complex application algorithms in other protocols. In order to better verify the time deviation of network time synchronization technology, this paper mainly evaluates the packet receiving algorithm of two protocols, thus calculating the network delay and the time deviation between nodes. Combined with the request process and various parameters shown in Figure 4 below, it can be found that the absolute values of the above errors are not large, but they do not meet the expected time accuracy requirements. Due to these data errors in the plant and station automation system, the time cannot be completely calibrated at a level one node, which will inevitably lead to problems in subsequent transmission.

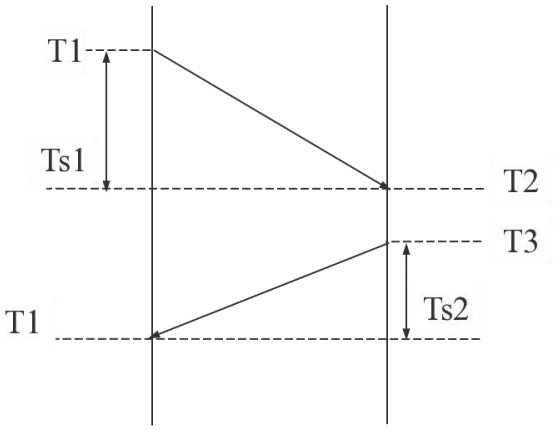

FIG. 4 Delay calculation process

At the same time, according to the accumulated experience of scholars, the numerical accuracy of the application of NTP protocol on the network platform is mainly affected by the precision of the time source and the network condition. In order to achieve higher accuracy of the network in the plant station, experimental analysis should be carried out. The specific principle is shown in Figure 5 below:

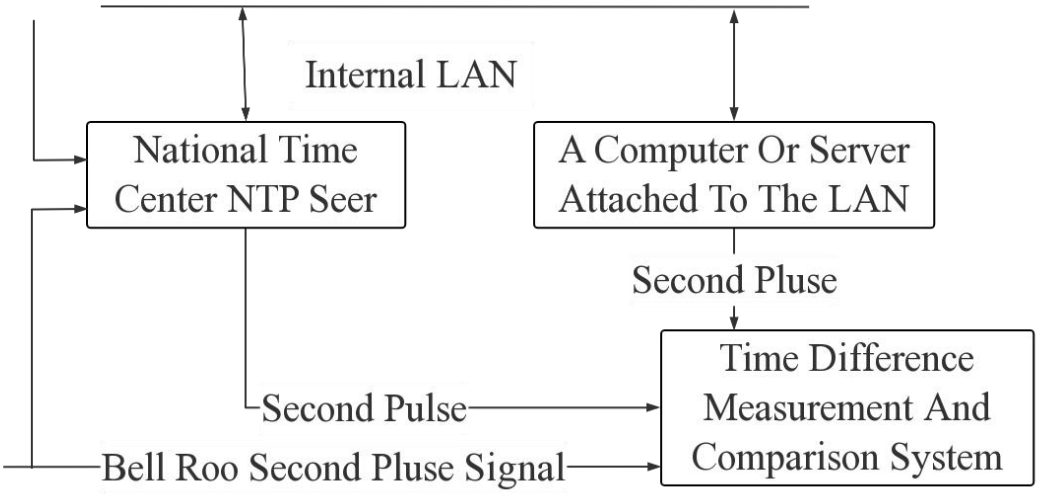

Figure 5 Experimental schematic diagram of NTP protocol

Through experimental analysis, it is found that the precision of time synchronization can be controlled within one millisecond by using NTP protocol in LAN. The result of this study proves that, in the construction and promotion of plant station automation system, we should pay attention to fully displaying the application advantages of various kinds of network time synchronization technology, combining with the existing research results and technical standards in our country, judge and analyze the application requirements of various kinds of technologies in plant station automation system, and establish perfect management measures. At the same time, it is necessary to combine various protocols and technical requirements, continuously optimize the time accuracy, and truly realize the interval layer, process layer or all network timing. The construction and development of plant and station automation system cannot do without the accurate measurement of time, and to ensure that the time information has a high precision, otherwise it is easy to appear other problems, hinder the effective operation of the system.

4. Conclusion

To sum up, therefore, on the basis of clarifying the operation of modern plant and station automation system, Chinese scholars should learn from the network time synchronization technology theory proposed by domestic and foreign scholars, pay attention to the combination of plant and station automation system internal design and work requirements, reasonable application of various technical theories and protocol, strengthen the intensity of equipment application and practice research. The relationship between the station automation system and network time synchronization technology is discussed in order to realize the goal of network time management.

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