INTEGRATED MECHANISM OF ONLINE MONITOR AND ARCHIVE SYSTEM

Z. D. Tsai[a,b], T. S. Ueng[a] and J. C. Chang[a]

[a] National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan, R.O.C.

[b]E-Mail: ZDTsai@nsrrc.org.tw

Abstract

In the accelerator field, the instrumentation monitor system provides the machine online status to view, control and alert. A novel shared data engine developed by Labview provides the distributed PCs, PDAs, embedded devices, and local controllers to exchange data mutually via Ethernet or wireless Ethernet. The mechanism guarantees delivery with an additional function layer of the raw UDP protocol and use less network bandwidth than TCP/IP. The system's main function is to introduce a platform with reliable online information about the status of the instrumentation. The users can access data with graphic view, trend view etc. by some complementary software. Also, the users can easily take online data via binding monitor tags without programming. The mechanism benefits all system maintenance, operation, management and analysis.

INTRODUCTION

Because most of accelerator control systems are highly hybrid systems with various controllers and instruments, the integration of SCADA (supervisory control and data acquisition) systems are rather complicated [1][2]. For fully handling the machine status, the offline and online data must be well implemented and displayed equally. In Taiwan Light Source (TLS), we have investigated the related mechanism and developed a set of history program to access all offline status of machine signals [3]. Furthermore, the operators always need an intuitive human machine interface (HMI) to demonstrate and manage all system commission. This article presents a mechanism of online data communications which be applied to our previous archive system. A novel online data exchange platform based on Publish-Subscribe Protocol (PSP) [4] has been developed to solve communications of the distributed PCs, PDAs, embedded devices, and local controllers. Besides, the user friendly viewer software has also been integrated with much more functions for online data display, including table view, graphic view, web view, trend view, and FFT(Fast Fourier Transform) view. These functions can benefit the machine commissions and analysis.

NETWORK ARCHITECTURE OF ONLINE DATA COMMNICATION

The system adopts 5 layers of native network architecture, including the remote viewer level, data service level, data processing level, controller level and device level. For comprehensively reaching the data transparency of the hybrid network systems, a novel online data network protocol is added into the data service, data processing and controller level as shown in Figure 1. The system uses the PSP protocol developed by National Instrument Co. to send and receive data across the hybrid network. The PSP protocol combines the TCP/IP and UDP merits to provide a more efficient data communication. The protocol uses less network bandwidth than a TCP/IP and have the stateless and connection-less aspects as a UDP. Besides, the PSP protocol guarantees delivery by implementing an additional layer of functionality on top of the raw UDP protocol. The protocol admits users to customize the communication data type and length. Therefore, the online data can be displayed in any data type, such as digital value, Boolean, string etc. And the data length can be packet sizes, such as multi-dimension arrays to proceed complicate analysis.

In general, the controller levels are hardware layers with many distributed controllers and embedded devices, which take over machine monitor or control with interlock or proportional-integral-differential (PID) logics etc. This level often has a dedicated network protocol to transfer real-time data with each other or delivers data toward a central computer. The central computer located on the data processing level is responsible for data collecting, monitoring, alerting and controlling. The commercial SCADA systems always provide a user friendly human machine interface (HMI) software for their operating and controlling. However, these systems which can't integrate with each other have a closed architecture, especially in the experimental instruments or controllers.

Therefore, we need an upper level server to implement the online data exchange. A data exchange server located on the data service layer is used to provide an online data exchange platform. All data acquisition station can collect data via the downstream DDE (Dynamic Data Exchange), OPC (OLE Process Control) etc. and exchange information through the upstream data exchange server. For example, an abnormal alert via SMS (short message service) and Email can be built across these hybrid acquisition stations and SCADA systems. A web form status monitor can also be developed across all subsystems as shown in Figure 2.

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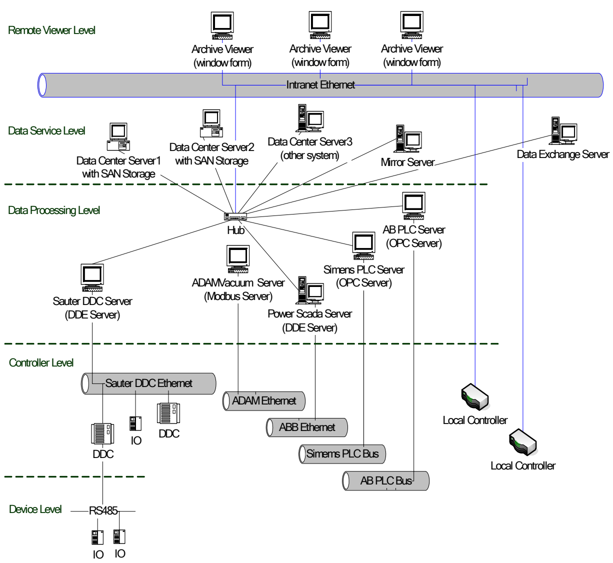

Figure 1: The network architecture of online data communication

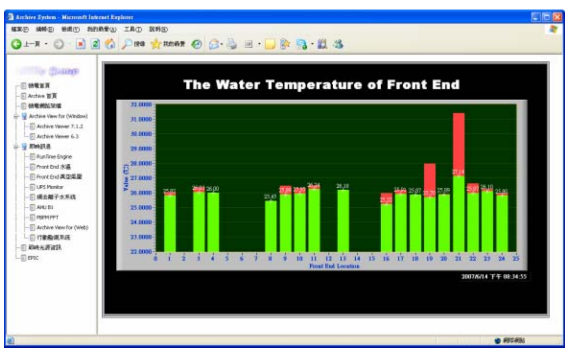

Figure 2: The web view of online monitor

MECHANISM OF ONLINE DATA COMMUNICATION

Online data is useful for the monitor of current machine status and tuned parameters in initial machine commission. An integrated mechanism of online data communication is built for all subsystems as shown in Figure 3. The data exchange server automatically hosts an engine and deploys various data types of variable, called shared variables. When SCADA PCs etc. write to a shared variable node across network, the exchange server with a shared variable engine processes and publishes the update value. Once other monitors PCs etc. subscribe this shared variable node, the latest value can be sent from this exchange server. On the other hand, the critical embedded controllers etc. can also deploy a shared variable engine by themselves. The updated value can be published as soon as possible and the subscribers receive this value immediately.

The PSP protocol also supports a buffer mechanism to guarantee all updated value reaching the subscribers. Namely, while the subscribers are busy for other process, the dedicated buffer will cache the updated value until the buffer overflows. Therefore, the mechanism can be used as an event logger without any loss when any failure events across all subsystems are recorded in the alert server.

In the aspect of programming, all systems are developed by NI LabView software. The status monitor is easily approached by binding the tag name without programming. All shared variable nodes are considered as local variables and the programming code can easily grab data across the hybrid network.

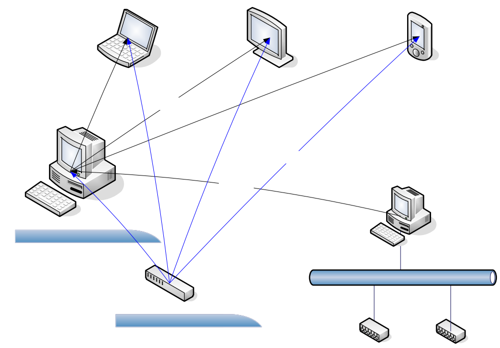

Figure 3: The mechanism of online data communication

INTEGRATED VIEWER WITH ONLINE AND OFFLINE DATA

Previously, for the purpose of unique monitoring and analysis interface, we had developed a history view to observe offline data about the machine status. It's helpful to fully observe the historical trend as a reference of machine commission conditions. For example, the value of chiller motor current varies greatly with time or season. The history view can provide the past commission status for operators to decide the operation and maintenance strategy. However, the history view is not enough information in the machine tuning stage, especially real-time information. The above online data mechanism may just meet the requirements. Therefore, the previous developed "Archive Viewer" software is also integrated with a series of online data view functions, including the table view, graphic view, web view, trend view, and FFT view.

The table view provides a table style of display for check all server data. Because of more and more servers grabbing raw data, the table view gives a clear display at a glance as shown in Figure 4. This view also shows a red bar alarm message and sound to alert operators. Once an abnormal machine status is detected, the red bar can mark where the alert node happens. Operators can easily double click this bar to change to the history view of online monitor view and to check historical reference data.

In general, the operators need an intuitive control panel to implement or control the machine. An intuitive graphic view with the current information and system diagram is also integrated into this software as shown in Figure 5. Besides, the graphic view is also demonstrated in the web form as shown in Figure 2. This program can provide web form view to check current status anywhere

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and anytime.

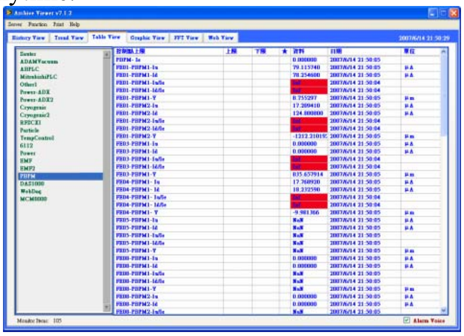

Figure 4: The table view of online monitor

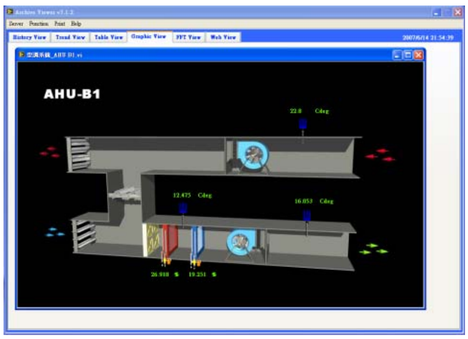

Figure 5: The graphic view of online monitor

The history view is a kind of offline trend view with the past data. However, the online trend data is also useful in the machine tuning stage. The online data with one second updating rate is demonstrated in the trend style of display as shown in Figure 6. This trend view provides operators with mouse drag and drop function to trace multi-channel machine status. For example, the transient status of the controlled water pressure and the tuning percentage of an inverter with a PID logic can be observed and compared. It's helpful to decide a well tuning strategy and avoid overshoot phenomenon.

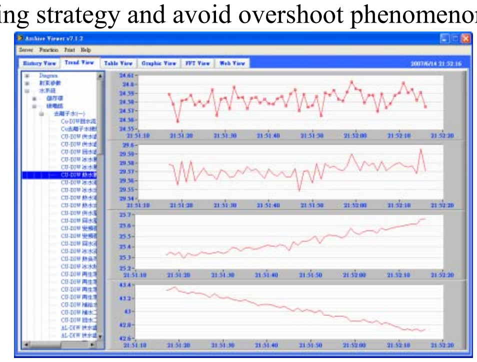

Figure 6: The trend view of online monitor

However, each online data with one second updating rate still doesn't provide enough information for all machine commission. Some phenomena like the electric harmonic or vibration variation need more packet sizes of data to undertake a spectrum analysis. Therefore, the online data is designed with the streaming data function. Typically, the FFT view is presented to display a spectrum analysis as shown in Figure 7.

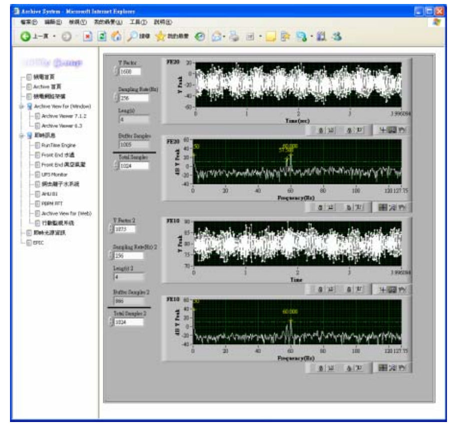

Figure 7: The FFT view of online monitor

CONCLUSION

This paper presents the integrated architecture of online monitor and archive system for machine status in TLS. The efforts are devoted to develop a set of online data communication across the hybrid network. The system adopts PSP protocol to build a data exchange platform, which admits all SCADA servers or local controllers to exchange information. And the viewer integrated with various displays of the table view, graphic view, web view, trend view, and FFT view can provide operators to handle all machine status. The system will continue to be developed toward the real-time data exchange with an EPIC system and the expert analysis functionality.

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