# MONITOR AND ARCHIVE SYSTEM OF INSTRUMENTATION*

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*Abstract*

In the accelerator field, the instrumentation includes the vacuum, magnet, RF, utility, cryogenic, power, safety, optic device and so on. The highly complicate systems have many hybrid SCADA systems to ensure precise and optimum control. For the historical data integration and analysis of those signals, the monitor and archive system is introduced to provide a distributed multi-channel acquisition platform. The system possesses various connectivity of open database, communication protocols and commercial hardware. The signal data can be collected and delivered to the central storage area network (SAN) via fiber network without latency. Finally, the unique, friendly and fast trend logger and data analysis software is also developed to view, compare, and analyze relation between facility anytime and anywhere.

## INTRODUCTION

Because most of accelerator control systems are highly hybrid systems with many VME based controllers and off-the-shelf industrial controllers, the integration of SCADA (supervisory control and data acquisition) system [1] is rather complicated. For fully handling the accelerator status, the data storage must be well processed [2-3]. In TLS, we has also investigated the related mechanism and developed a set of history program to access status of signals [4-5]. Furthermore, the users always want a unique, friendly and flexible interface to monitor, compare and analysis all available signals. This article presents a full architecture of our archive system from hardware to software. On the client side, an intuitive archive viewer program has provided related functions. On the server side, more and more channel accesses and industrial protocols are adapted to the archive system.

## NETWORK ARCHITECTURE AND DATA STORAGE MECHANISM

For data transparency, the system has a hybrid network infrastructure as shown in Fig. 1. The network is divided into 5 layers, including a remote viewer level, data service level, data processing level, controller level and device level.

Both controller and device levels are hardware layers. The controller with algorithms takes over machine control. Besides, the distributed controllers often have a dedicated network protocol to communicate each other or delivery related data to the upper layer's central computer.

The central computer located on data processing level is responsible for data collecting, monitoring, alert and control. Generally, the user requires user friendly graphic interface to process the related parameters and control algorithms. In the industrial SCADA systems, they always provide a set of corresponding software for their controllers and devices. A program to access the system signals via DDE (Dynamic Data Exchange), OPC(OLE Process Control) etc. must be developed. In the VME controller system or a simple data acquisition station, the process layer also needs a program to collect data via firmware. Each subsystem's central computer embedded with this channel access and time synchronous program is called an archive server. When the recorded data of the archive server excesses five minutes, the archive server will duplicate the same files into the data center sever located on the data service layer. This mechanism gives chances for data center server maintenance or avoids data loss in case of network failure. Moreover, the archive server also provides an alert with alarm and SMS (short message service) function.

The data center server located on the data service layer provides a common network service, FTP. Any client software can access the collected data from data center servers anytime and anywhere. The data center server always uses the server class computer to provide reliable service. Each component has the redundant part, such as cups, fans, powers, networks, array disks etc. These can guarantee the data center server with high reliability and robustness. Especially, the storage adopted fiber channel's array disks provides fast, reliable, extensible storage without latency. For avoiding the archive server shutdown, the data center server also takes charge of the alive monitoring of archive servers. While the archive server failure occurs, the data center server will give an alert via Email and GSM modem. This mechanism ensures the continue functioning of all archive servers. For internet security, all data center servers and archive servers are protected under firewall. A mirror server responsible for bridging and duplicating the data is also developed for outside user access.

On the top of remote viewer level, a set of archive viewer software has been used to grab data from data center server via FTP. The viewer program provides rich functions for monitoring, compare, analysis with a unique, friendly, flexible and intuitive interface. The signal data flow from IO devices to users is shown as Fig. 2.

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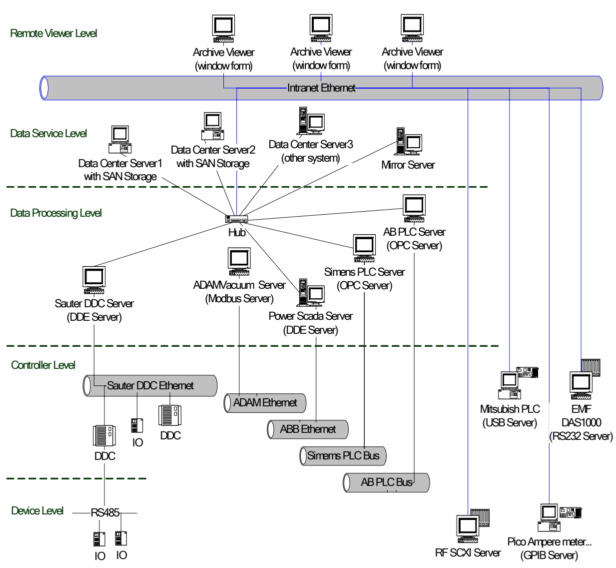


Figure 1 The network architecture of archive system

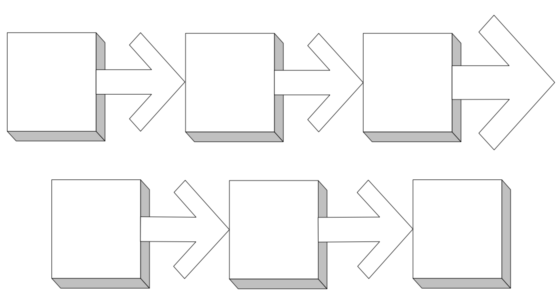

Figure 2 The data flow from hardware IO to users

## DATA CONNECTIVITY OF SERVER

Owing to the hybrid network architecture, various controllers, devices or SCADA subsystems must be integrated in the archive system. However, each of hybrid systems always has its own protocol or driver to transmit data. The data collection faces a tough connectivity problem. So, the efforts devoted to the data connectivity on the archive server are significant. The hierarchy of channel access program for archive server connectivity is shown in Fig. 3.

The communication of the hardware involves Ethernet, RS485/RS232, 1394, GPIB, or specific DAQ card. The universal hardware vendors always provide various types of firmware or drivers to acquire the analog input/output or digital input/output data, such as DLL or ActiveX library. This method has more flexible and self-defined data acquisition and gives a fast sampling rate.

However, for well dedicated control and interlock, the subsystem often adopts a commercial SCADA system. The SCADA system is responsible for data collection, monitoring and alert. Most of them have their own closed loop hierarchy network for guarantee data streaming, such as DDC (direct digital controller), PLC (programmable logic controller), DCS (distributed control system) or RTU (remote terminal unit). The systems usually provide a DDE method to link the partial internal data for the third party software. Furthermore, the advance SCADA system provides a network communication method, such as OPC, Modbus, BACNet protocol or SQL (structure query language) database.

Currently, the archive server has successfully been developed with the ability of multi-channel access, via DDE, OPC, Modbus, BACNet, ODBC, DLL, ActiveX protocols etc. The archive server has unique interface to acquire data without extra procedure. The server manager just modify an Excel file to add signals for archive server to access. The archive server can automatically adapt to different SCADA system or data acquisition station, such as Johnson, Sauter DDC, AB, Simems, Mitsubishi, ABB PLC, NI, Advantech data acquisition device etc.

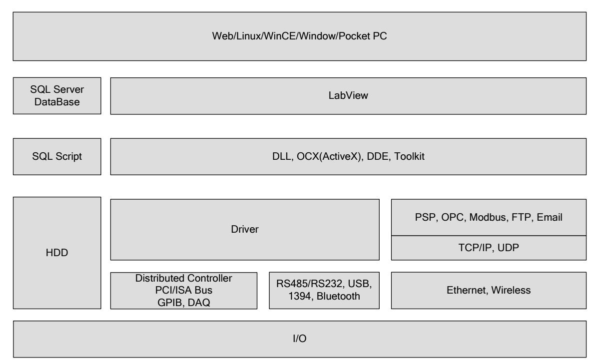


Figure 3 The hierarchy of data connectivity

## USER FRIENDLY FUNTIONALITY OF VIEWER

For the purpose of unique monitoring and analysis interface, a novel viewer program called archive viewer is developed with LabVIEW. The program has various parsers to adapt all data format and can access all data center servers via FTP. The users can use a unique interface to access, compare, analyze and monitor the related data and find the abnormal condition of the system anywhere and anytime.

In intuitive aspects, the program uses the tree view to categorize all signals into subgroup systematically and provide a calendar form for the selection of view days. The program can display history data just clicking without learning or pre-knowledge. Besides, the zoom(in, out, pan), scale define(log/linear, auto scale, range scale), data filter(delete zero, delete negative, delete threshold), show cursor value, or plot type are also intuitive to operate as shown in Fig. 4.

In analysis aspects, the program presents some comparison mechanism including overlap, normalize, two axes, eight drawings, moving mean, moving standard deviation, curve fitting etc. as shown in Fig. 5. These functions can be used to find correlation between signals. Furthermore, the program also has a customized mathematic function including algebra mathematics and script mathematics. The former let user define the symbolic algorithm and precede calculation instantly as shown in Fig. 6. The latter integrate with Matlab script function to implement the more complicated algorithms.

In output aspects, the archive viewer program can print out overall window and provide a periodic report. Just selecting intended or pre-defined signals, the periodic report can give graphic trend data in the self-defined day period. The raw data output is also provided in Excel or TXT logging file format.

## CONCLUSION

This paper presents the architecture of monitor and archive system of instrumentation at NSRRC. On server sides, the system devote to multi-channel access to adapt different applications. On client sides, the system creates a user friendly monitoring and analysis platform. Moreover, the integration of hybrid network data acquisition is helpful for the more and more signal monitoring in the subsystem expansion. And the system will continue to be developed toward real-time data implementation and expert analysis system.

## ACKNOLEDGEMENT

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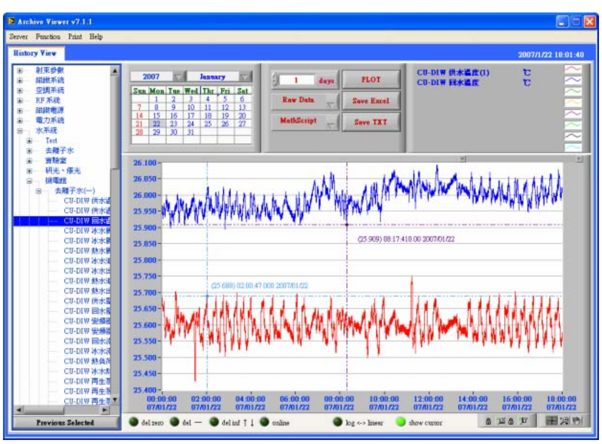

Figure 4 The show cursor function of Archive Viewer

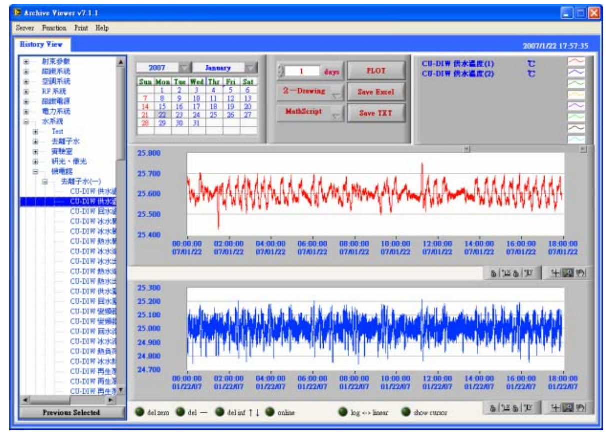

Figure 5 The two drawings function of Archive Viewer

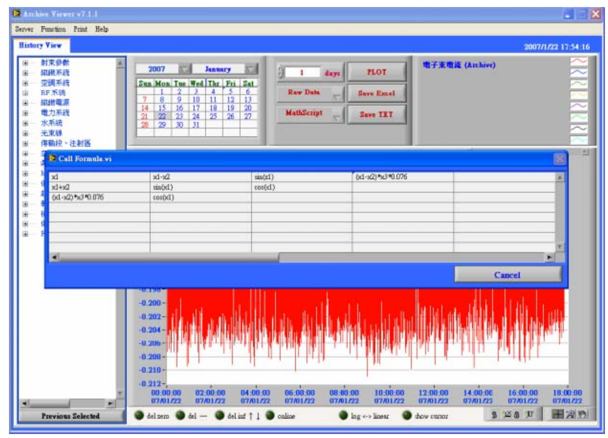

Figure 6 The algebra mathematics function of Archive Viewer

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