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Toolkit Based Extension of the SDSS Control System

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Abstract. The capabilities of the Sloan Digital Sky Survey (Gunn et al. 1999) telescope control system have been enhanced by selective integration with components of the Experimental Physics and Industrial Control System (EPICS) toolkit. Specifically, EPICS has been used to provide graphical displays of real-time and archived telescope performance data. The real-time data access has been accomplished by the addition of an EPICS database and associated communications infrastructure to the existing Telescope Performance Monitor computer. User access to SDSS archive files was implemented using the data source independent design of XARR, the EPICS data archive tool. Due to the modular design (Thuot et al. 1996) of the EPICS control system toolkit, the implementation of these enhancements was rapid and straightforward. Future use of the EPICS toolkit is planned as support for the integration of the SDSS operations environment.

1. Introduction

The real-time control and monitoring of the Sloan Digital Sky Survey 2.5 meter telescope is handled by a pair of vxWorks-based real-time computers. Of these, we are primarily concerned with the Telescope Performance Monitor (TPM) that serves out engineering data obtained from the Mount Control Processor (MCP). This data is obtained from a shared memory board that the MCP updates at rates up to 200Hz.

In the original version of the TPM, the only function was to write the an interface to the primary and secondary mirror support systems into a series of files on a NFS-mounted workstation disk. There were no graphical tools to examine either real-time or archived TPM information.

1.1. An Extension of the TPM

Given the problem of how to examine the data we proposed a utilization of the standard Experimental Physics and Industrial Control System (EPICS) toolkit to provide graphical interfaces to both archived data and to network-based access of real-time TPM channels.

1.2. EPICS

The EPICS toolkit is the product of an on-going collaboration at over 100 international sites including many accelerator facilities and astronomical observatories (EPICS 1999).

The EPICS toolkit creates a client-server architecture on the control system with communication handled by the channel access (CA) protocol.

Channel access maintains a global name space of process variables within the local Internet sub-net. These process variables can be connected to a variety of data sources including a real-time database running on the vxWorks operating system.

2. Solutions

Two separate and independent extensions have been created to access SDSS TPM data.

First, in order to provide real-time access to TPM data across the local SDSS Internet we created an EPICS database resident on the TPM IOC (Input-Output Controller) to serve live data using the supplied vxWorks-based channel access server. We can then use a number of EPICS extensions (channel access clients) to create graphical interfaces to the real-time data.

The second solution involved the construction of a data source module for the XARR data archive viewer so it can read the TPM log files that are written on the workstation disk.

3. The TPM Real-time Database

The TPM serves EPICS process variables that map onto a real-time database. The key database components within the TPM are:

1. SUBROUTINE records that are generic wrappers around user C code. These records are used to access shared memory and to writes data into vxWorks global symbols;
2. CALCULATION records which evaluate simple expressions and are used to scale the axis position to degrees and perform housekeeping functions;
3. BINARYIN and LONGIN records which implement simple scalar variables. These are used with symbolic device support to make the vxWorks global symbols visible via channel access.

The real-time application development required only four hours to determine the hooks into the existing TPM software, create the SUBROUTINE record support, construct the database, and the initial displays.

3.1. Additional Real-time Enhancements

The TPM status records can be enhanced by defining upper and lower operating ranges and alarm limits and by creating a special device support layer instead of reliance on global vxWorks symbols.

Other EPICS client applications can be installed at Apache Point Observatory including the alarm handler and an interface between channel access and the IDL visualization product.

4. EPICS Data Archive Viewer

XARR, the X-Windows based EPICS data archive viewer, is presently used for retrieval and display of archived parameters. XARR also supports printing of displays and exporting into ASCII files. It is common practice for the facility operators at Los Alamos (accelerator physicists) to process these exported files using commercial spreadsheet programs and other off-line tools.

XARR can retrieve data from a variety of data sources, all of which described by classes derived from a fundamental data source base class. It was relatively simple to create a data source class for TPM data that called the existing TPM access library.

4.1. Caching

Due to the high-bandwidth channels such as mount encoder data, it was necessary to implement a scheme for block data caching. The major challenge was to maintain a collection of cached blocks to allow speed-optimized access to channels such as the 200Hz axis encoder data.

The algorithm used in the management of the cache is:

- When the current temporal window into the archived data needs to be filled, we start at the beginning and loop through all of the blocks that are visible;
- If the block is presently in the cache, that data is added to the new buffer and continue;
- If the count of blocks read from the TPM log file in this request exceeds a preset limit or if we have completed the window, we break out of the loop and return the resulting buffer to the higher software levels within XARR;
- Otherwise, we have to read the block from the TPM log file which is then added to the cache, and increment the read block count for this request.

Table 1. The Cache Parameters are Optimized for Fast Screen Updates

Parameter	Value	Comments
Block size	2000 samples	10 seconds of data at 200Hz
Maximum log file reads per request:	1	
Cache limit in memory	32 MB	

Each night's log file is over 150MB in length and must be maintained for long periods, perhaps forever, due to the need to assess and maintain science data consistency over the life of the survey.

5. The Toolkit Approach Continues

The initial real-time display and data archive tools are the first application of the EPICS toolkit methodology at Apache Point Observatory and the SDSS.

As the observers and engineering staff become more familiar with the features and the modularity of this approach, we expect to see an increase in the number user-written applications and displays as well as the use of EPICS on other subsystems besides the Telescope Performance Monitor.

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References

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